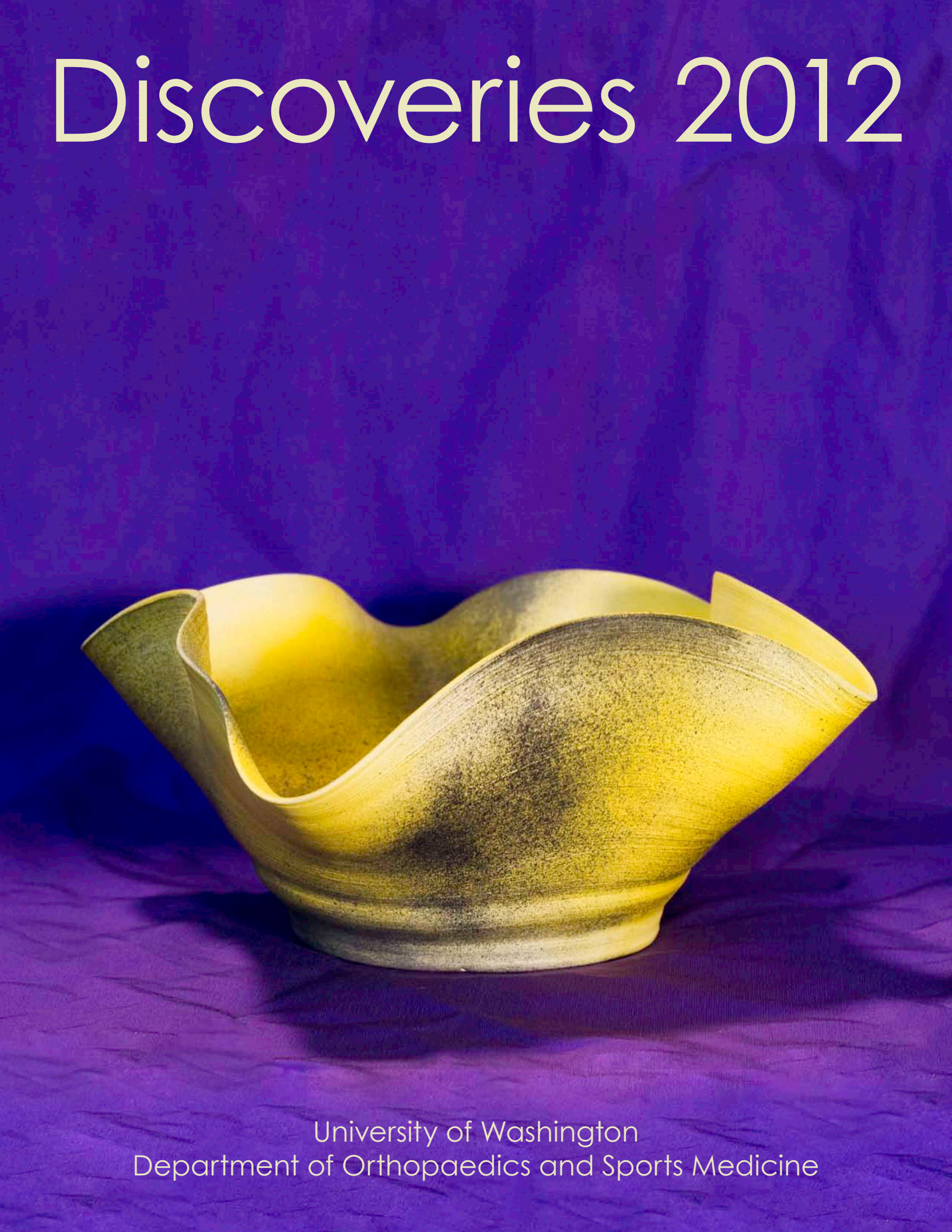
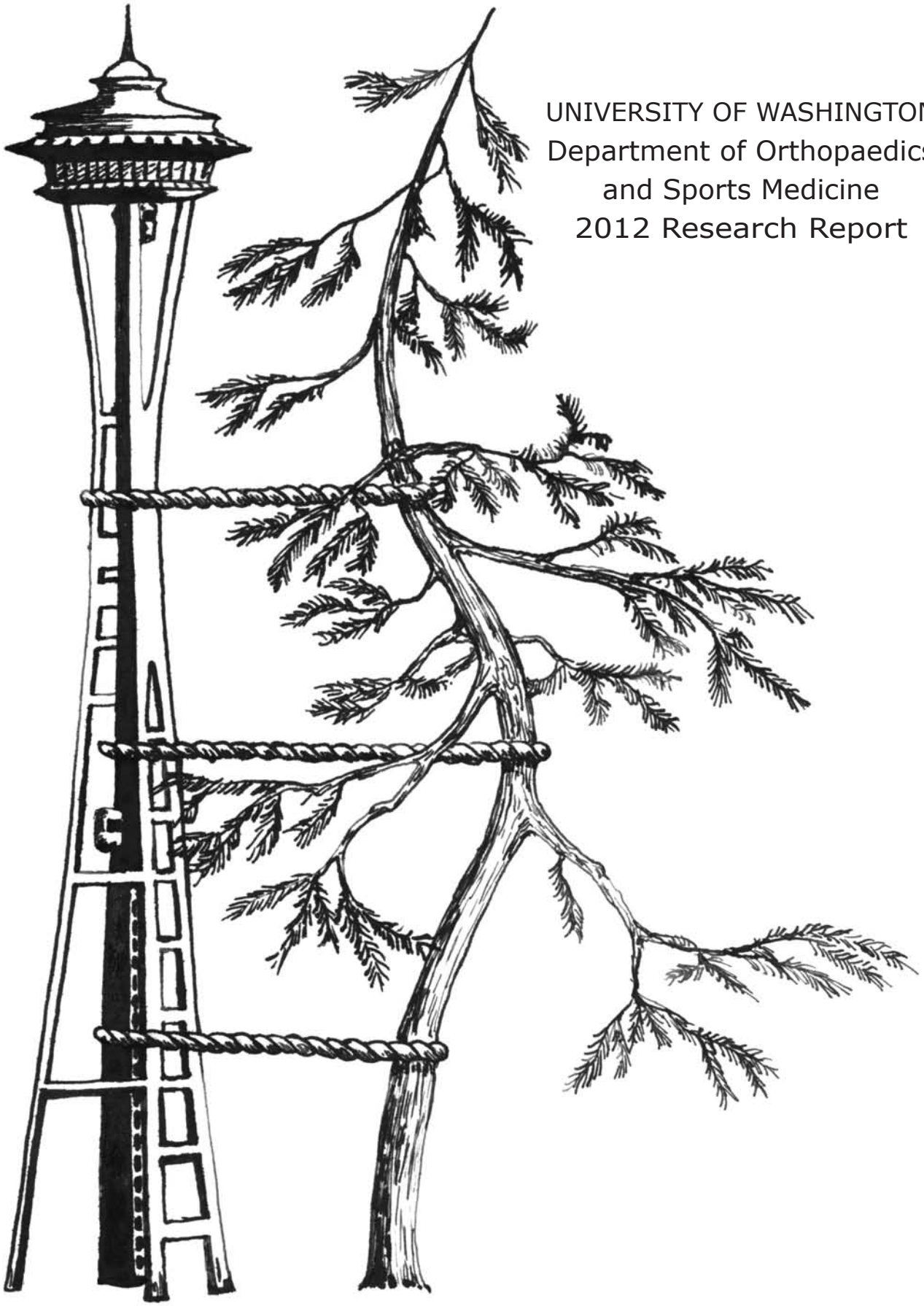
Discoveries 2012



University of Washington
Department of Orthopaedics and Sports Medicine



UNIVERSITY OF WASHINGTON

Department of Orthopaedics and Sports Medicine 2012 Research Report

UW Medicine
SCHOOL OF MEDICINE

Department of Orthopaedics and Sports Medicine
University of Washington
Seattle, WA 98195

Editor-in-Chief:
Jens R. Chapman, M.D.

Managing Editor:
Fred Westerberg

Front Cover Illustration: Pottery by Jack Routt, Photographer: Conrad Lilleness. The cover features a ceramic basin by Jack Routt. In Latin, the word for basin is sometimes translated as pelvis. Pelvic surgery is one of the orthopaedic specialities of Jack's father, Milton L. Routt, Jr., M.D., Professor.

Jack Routt (above) is a junior at King's High School in Seattle, WA who enjoys creating ceramic art.

Contents

Foreword

UW Orthopaedics
Helping Our Patients Leading Healthier Longer And Happier Lives!

Dear Friends and Supporters of UW Orthopaedics. Welcome to the 2012 issue of Orthopaedic Discoveries! It gives me great privilege to address you for the first time as formally appointed Chairman of our Department. Given the distinguished predecessors in this position I view my appointment simultaneously as a tremendous honor and as an obligation to take our Department into an even greater future. As all of you are all too aware, the anticipated profound changes in health care with emphasis on 'value' and 'transparency' combined with the sustained recession of our economy bring about many challenges, but also holds opportunities. I very much believe that our Department of Orthopaedics and Sports Medicine together with UW Medicine is uniquely well positioned to not only meet the upcoming challenges, but actually contribute to improving the quality of medicine overall to the benefit of the public through targeted breakthroughs in research, clinical care and enhanced educational programs.

Advances in Orthopaedics and musculoskeletal medicine in general are increasingly being recognized as playing a central role in improving our general health and positively impacting our daily well-being. The profound benefits of regular exercise (combined with sensible nutrition) and activities on our general health continue to make news and underscores the importance of having functionally healthy bones, joints, nerves and muscles. As our understanding of disorders affecting these structures have increased dramatically through epidemiologic, molecular genetic, biomechanical and ultrastructural research, completely novel therapies for musculoskeletal ailments are coming into tantalizingly close reach. With its long history of successful disruptions of the Orthopaedic status quo, our Department can again make a real difference by applying our expertise in all of the classic three domains of academia: clinical care, research and education. Allow me to highlight some of these evolving opportunities in this introductory note while proudly presenting to you some of the special publications and achievements of the past year.

Dr. Chapman with the first Chairman of the Department D.K. Clawson.

Special honors

I would like to start with special recognition of some particularly

impressive accomplishments that occurred this past academic year. While it is hard to single out anyone first, I do believe that our residents deserve top billing this year in recognition of not only sustaining their outstanding records over the last years, but actually eclipsing them: our program as a whole scored in the 97th percentile nationally in the Orthopaedic In-service Examination (OITE) and also had near perfect ACGME compliance scores – reflective of the tremendous talents, unremitting dedication towards excellence of our residents. I do wish to recognize and thank those who provide the foundations for success with their organizational and inspirational skills including our **Residency Director Dr. Doug Hanel**, our Program Coordinator **Angela Weiss** as well as **Amanda Schwanz**, who coordinates our Medical Student affairs, and **Dr. Lisa Taitsman** with her regulatory know-how.

Several of our faculty received well-deserved national recognition for their work and special talents. **Dr. David Eyre** received one of the most prestigious prizes in Orthopaedics, the Steindler 2012 award, from the Orthopaedic Research Society (ORS) and **Dr. Seth Leopold** has been selected to serve as the new Editor-in-Chief of Clinical Orthopaedics and Related Research (CORR) by the Association of Bone and Joint Surgeons. Both colleagues in their own ways have distinguished themselves with their groundbreaking work and their ongoing impact. Dr. Eyre is widely recognized as a leader in our understanding of collagen chemistry as well as composition and development of new markers for osteoporosis. His work (and that of his colleagues in his lab) provides the foundational work needed to counter age related changes in cartilage and bone through molecular, genetic and ultrastructural countermeasures. Dr. Leopold has been appointed as Editor-in-Chief to one of the most prestigious Orthopaedic journals in the world, CORR, in recognition of his research for instance on minimally invasive joint replacement surgery and patient safety enhancing measures and due to several thought provoking studies examining publication bias in the scientific Orthopaedic literature. By assuming this position, Dr. Leopold succeeds some of the premier names in Orthopaedic Surgery, such as Drs. Richard Brand, De Palma and Marshall Urist. Interestingly, our erstwhile Chair, **Dr D.K. Clawson**, served as Associate Editor of CORR under Dr. Urist in the 1970's. We wish Dr. Leopold the best of luck in this new endeavor as Editor-in-Chef as he also continues to serve as one of our anchors for our rapidly evolving Regional Joint Care Center at Northwest Hospital.

Research

One of our core strategic goals is to enhance and consolidate our research capabilities and expertise within our Department from ground up in support of our core mission to facilitate clinically meaningful breakthrough investigations in cartilage, bone and nerve repair. A major milestone for clinical research has been achieved by our Vice Chair for Research, **Dr. Peter Cavanagh**, who together with our Internal Review Board (IRB) was able to create a novel omnibus platform for prospective as well as retrospective clinical review based studies. This new

Drs. Brian Gilmer, PGY-4 and Dayne Mickelson, PGY-1 receiving recognition for their outstanding efforts in creating OSSMIG from Drs. Chapman and Hanel.

platform will significantly simplify the approvals process for simple review studies for our busy faculty, at the same time decrease unnecessary administrative burden on our IRB while fully protecting the public's interest. We also have the privilege to have one of our faculty members, Dr. Chris Allan from our Hand Service, be selected to serve on one of the IRB Human Subjects Division committees. With these developments and an expanded internal research infrastructure through key recruitments we are well poised to relaunch our investigative efforts to new heights over the coming years. We hope to find your interest in our proposal to launch an Institute of Translational Musculoskeletal Health Sciences (ITMSH) through integration of our exciting but currently separated research laboratories into a single cohesive unit as an unparalleled effort to make a difference in regaining, restoring or even better – never losing - musculoskeletal functional capacities. This work can truly change the lives of sufferers from arthritis, osteoporosis, it can help injured warriors and other victims of trauma, and return athletes of all ages to their activities.

Caring

Our clinical activities have incorporated the *'Patients are First'* philosophy promoted throughout UW Medicine to allow us to track and continuously improve our patient care. New data gathering infrastructure has brought about important enhancements to patient safety and quality enhancements, such as fall prevention programs and infection reduction measures.

In response to unmet needs of the public to restore or regain functional active and satisfying lifestyles through advanced interdisciplinary care we have launched in two key projects: our new **Sports Medicine Clinic in Husky Stadium** is to open in the new Husky Stadium with the start of the 2013 football season as a true multidisciplinary 'no wrong door' facility with integrated educational and research capacities. We have also made great strides in creating an unprecedented **'Regional Joint Care Center'** based at Northwest Hospital as part of a larger *'Healthy aging'* initiative at this wonderful hospital. We have substantially added to our Joint Service through the successful recruitment of two Joint Reconstruction surgeons, Drs. **Justin Klimisch** and **TJ Tanous Jr**. In the very near future, we will not only be able to offer unparalleled bandwidth of joint replacement or joint preserving surgical care, but also a comprehensive nonoperative care program in the beautiful new patient facilities at Northwest Hospital.

Education

We continue to proudly offer the premier educational opportunities for all Orthopaedically and musculoskeletally interested practitioners and patients in the Pacific Northwest right here in the heart of Seattle with a number of publically accessible offerings mostly free of charge, or for nominal CME related charges. The *Third annual Summit in Seattle: Focus on Hip and Pelvis disorders* July 26th-28 2012 promises to be a major event under the Chairmanship of Drs. **Howard Chansky** and **ML 'Chip' Routt** with several internationally renowned specialists serving as faculty. The *Spine Summit in Seattle* series has become a regional institution with its 11th Annual meeting scheduled for September 28th and 29th at the HMC R&T Auditorium This year's topic will be *"The human disc: an unresolved conundrum"* and will again feature an authoritative local and national faculty. We also offer highly recognized conferences in Hand, Sports Medicine, Foot & Ankle, Pediatric Orthopaedics in addition to our annual John LeCocq and Resident Research Days Visiting Professorship. As many of you know our monthly Grand Rounds (first Wednesday of each month, 0645-0745, Foege Auditorium, Genomics, UW School of Medicine) continues to offer high-quality lecturers and current issues presentations compressed into one hour for our busy local Orthopaedic community. As I reflect on educational efforts I take particular pride in the impressive grassroots effort of our residents who have formed a musculoskeletal interest group here at the UW School of Medicine under the acronym **OSSMIG** (ossmig.orthop.washington.edu/AboutOSSMIG.aspx) to enhance UW medical student education in this important aspect of medicine. Since my report to you last year the responses to these voluntary after-hours meetings remain impressive and have increased awareness of the importance of musculoskeletal problems among our UW School of Medicine students dramatically.

As you can see from these notes, there is a lot going on – and so much more if you read through the following pages. With the Discoveries 2012 we also provide you with a review of patient care and educational efforts of our faculty beyond the traditional walls of our home institutions here in the Puget Sound area. I hope you will take particular interest in our ability to trajectorize our commitment to excellence beyond our direct work sphere in our section on Global Orthopaedic care. Thank you again for taking an interest in our Department by following our progress – we are excited to have you be part of our mission to help our patients lead longer, healthier and happier lives through Orthopaedics!

Jens R. Chapman, M.D.
Professor and Chairman
HansJörg Wyss Endowed Chair
Department of Orthopaedics and Sports Medicine
Joint Professor of Neurological Surgery

In Memoriam: Paul J. Benca, M.D.
July 24, 1958 - June 27, 2011

Our UW Orthopaedics family lost one of our most trusted and beloved clinical faculty members and supporters of our residency with the passing of Paul J. Benca, M.D. after a lengthy and truly courageous battle with leukemia.

Paul J. Benca was born in Chicago and completed a 6 year college Medical School program at Northwestern University in Chicago in 1982. Following his residency training at Michael Reese Hospital in South Chicago he was able to convince his then newly-wed wife Patricia Benca, D.D.S. to take the leap into the great unknown and relocated to the Pacific Northwest for a Fellowship in Orthopaedic Traumatology at Harborview Medical Center from 1987-1988. Following his dream to teach, Dr. Benca became one of the mainstays of the local Orthopaedic community as faculty of Virginia Mason Medical Center. Dr. Benca was a major factor in making the UW Orthopaedic rotation there one of the favorite destinations of our residents. Throughout his career Dr. Benca was a surgeon sought after for his calm expertise, thoughtful pursuit of excellence and genuine fairness. He rapidly developed a strong interest in shoulder surgery and was well recognized as one of the region's leading experts in upper extremity disorders. During one of his cherished trips to France in the mid 1990's he observed a then radically different procedure called 'reverse shoulder arthroplasty' and was subsequently instrumental in getting this now often recommended approach introduced to the Pacific Northwest.

Dr. Benca was an uncompromising defender of quality in patient care way before 'quality' became a fashionable expression in healthcare. His attention to detail while maintaining large scale circumspection and genuine affection for his patients brought him a large and loyal following. Despite the invasion of business metrics such as 'efficiency' Dr. Benca remained an ardent defender of the importance of protecting fundamentally sound Orthopaedic education for students, residents and fellows and advanced to the rank of Clinical Professor in our Department in recognition of his dedication and efforts. More recently, Paul succeeded Tom Green, M.D. as Chief of Orthopaedic Surgery at Virginia Mason until a pernicious form of leukemia stopped his surgical career

cold in its tracks. Not surprisingly Paul continued to find great personal satisfaction in seeing his patients in clinic alongside his partners, staff and our residents until progressive illness brought him down.

In his personal life Paul valued his family with his wife Pat and his children Laura, Jeff and Eric above all. He was immensely proud of the many academic and athletic accomplishments of his children and up to the end asked for updates as to their activities and plans. Privately Paul enjoyed travel, old world literature, conversations, good food and the company of his many good friends.

With Paul's passing our UW Orthopaedics community lost one of our most selflessly dedicated Clinical Faculty members and a great spokesperson for our specialty and its values. All those who had the privilege of knowing Paul will forever cherish him and those who didn't have the honor to meet him will likely be better off for the large shadow that his influence cast.

Jens R. Chapman, M.D.

David R. Eyre, Ph.D.
Steindler Award

ORS Arthur Steindler, MD Award: Brian Johnstone, Ph.D.; David R. Eyre, Ph.D. (award recipient) and Harry McKellop, Ph.D.

Faculty Member David R. Eyre, Ph.D. was presented with the Steindler Award at the recent 2012 Meeting of the Orthopaedic Research Society (ORS) in San Francisco. The ORS is the world's premier society for bone and joint research. ORS meetings are attended by orthopaedic researchers from around the world and awards from this society are considered the most prestigious professional honors for musculoskeletal researchers.

Dr. Eyre has held the Ernest M. Burgess Chair of Orthopaedics since 1985 and was honored by the ORS for his pioneering work in cartilage biology. He is currently the principal investigator on 4 NIH grants and has published over 200 papers and reviews in refereed journals. Among Dr. Eyre's many seminal publications is the 1992 publication in the *Journal of Bone Mineral Research* which was the first to show that collagen type I telopeptides are reliable markers of bone resorption. This test has since become a clinical standard throughout the world. His most recent work includes studies of collagen diversity and pathobiology in skeletal tissues and an exploration of the pathogenesis of novel forms of Osteogenesis Imperfecta.

The Steindler Award honors the memory of Dr. Arthur Steindler who founded the Department of Orthopaedic Surgery at the University of Iowa and who was a monumental figure in pediatric orthopaedic surgery. His major medical contributions were to scoliosis of the spine and club foot deformity but he was also a tireless advocate for free care of poor children. The Award is given every other year to recognize senior scientists, clinicians and educators who, throughout their professional lifetime, have made significant contributions – nationally and internationally – to the understanding of the musculoskeletal system and musculoskeletal diseases and injuries. The awardee must have started their professional career outside the US (as did Dr. Steindler), and have advanced their specialty throughout the world. The selection is made by the Board of Directors of the ORS upon recommendation of the ORS President.

Hanson DA, Weis MA, Bollen AM, Maslan SL, Singer FR, Eyre DR. A specific immunoassay for monitoring human bone resorption: Quantitation of type I collagen cross-linked N-telopeptides in urine. Bone Miner. Res. 1992 Nov;7(11):1251-8).

Peter Simonian, M.D.
2012 Grateful Alumnus
University of Washington School of Medicine

This year's Grateful Alumnus 2012 is Peter Simonian, M.D., who practices at the Simonian Sports Medicine Clinic in Fresno, California. During residency and later as a faculty member, Dr. Simonian distinguished himself with a still unbroken record of successful completions of peer reviewed academic publications exceeding 75 PubMed listed studies on a wide diversity of subjects. Dr. Simonian was selected due to his continuous generous support of our Residency program and his ongoing clinical interactions with many of our faculty. Upon learning of his selection Dr. Simonian wrote the following note to us:

"I am forever grateful to the University of Washington Department of Orthopaedics and Sports Medicine for all the amazing teachers, role models, mentors, faculty and co-residents. Their guidance has shaped my current practice of Orthopaedic Surgery. I continually reflect on the lessons, examples and experiences I had during the residency years; they have served me well and continue to provide a sound basis for every patient encounter. It seems like yesterday, the memories and experiences are thankfully still vivid and intense.

As a third year medical student at the University of Southern California, I asked the current residency director, Dr. Donald Wiss, where he thought the best training in orthopaedic surgery could be obtained in the country. His response was "the University of Washington in Seattle." I certainly did not feel like I had the credentials or qualifications to qualify for such a program, but from that point, I had a goal to aspire. After many interviews around the country, I still remember the day that Dr. Roger Larson called my home to offer a residency position; I accepted with gratitude, humility, and honor.

Although it was always a challenge, residency at UW was one of the most exciting times of my life. It was a period of exponential growth through complete immersion. I am truly grateful for each of my senior residents that

Peter Simonian, M.D.

worked with me and served as such amazing examples: Phil Kregor, Lyle Sorensen, Eric Vanderhooft, Susan Cero, Brodie Wood, Eric Bowton, Jim Vahey, Sohail Mirza, Bill Obremskey, Ron Kristensen, Scott Hormel, Tim Beals, Todd Clarke, and the late Bill Mills. I am thankful for the wonderful residents of my class. They are all amazing men and some of my best friends: David Deneka, Vern Cooley, Pete Mitchell and Bill Wagner. I am thankful for the tireless efforts and skills of the other residents that worked with me during this period: Dan Stechschulte, Mohammad Diab, David Levinsohn, Tony Agtarap, Randy Viola, Oriente DiTano, Colin Poole, David Belfie, Don Ericksen, Jay Crary, Jeff Garr, John Michelotti, Julie Switzer, Craig Boatwright, and Tom Chi. Finally, I would like to thank a group of extremely talented and hard working doctors serving their year of Advanced Clinical Experience. Each provided a source of wisdom and comfort including Brendon Patterson, Hugh Selznick, Les Grujic, Jud Ott, Howard Chansky, Tony Romeo, Lyle Sorensen, Jim Krieg, Greg Thomson, Kevin Smith, and Richard O'Donnell. Each of these people have shaped, influenced, and taught me to be a sound orthopaedic surgeon and a good doctor. I list each one of these gifted doctors with pride and thanks.

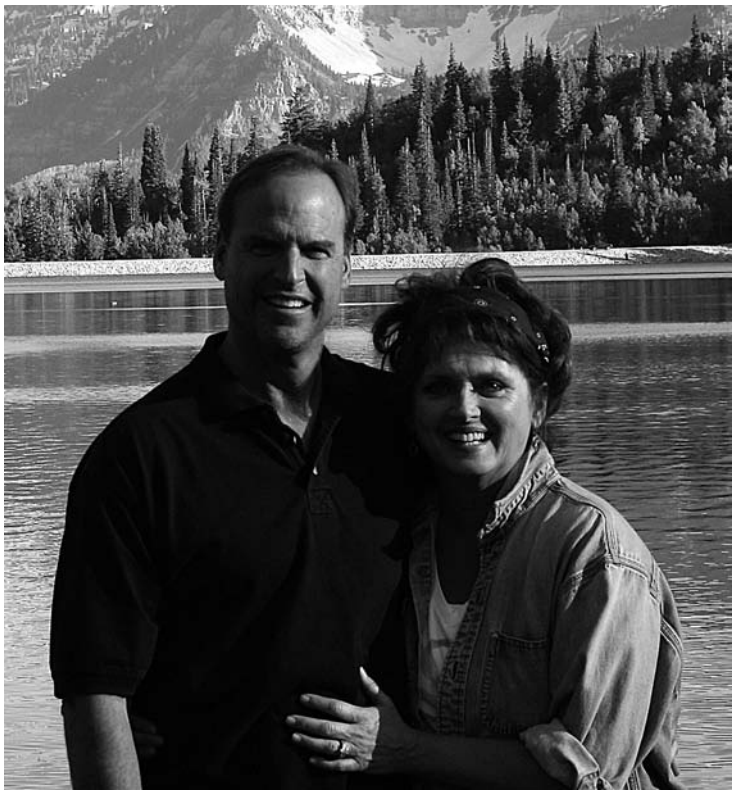
I am thankful for my wonderful faculty while a resident. They generously shared their surgical skills and techniques, their analytical thought processes, their diagnostic skills, their patient relationships, and their research: Rick Matsen, Chip Routt, Jens Chapman, Marc Swiontkowski, Chappie Conrad, Howard Chansky, Bruce Sangerozan, Steve Benirschke, Ted Hansen, Brad Henley, the late Kathy Cramer, Doug Smith, Ted Greenlee, Doug Hanel, Tom Trumble, John Sack, John Clark, Carol Teitz, Roger Larson, Jim Bruckner, the late Doug Harryman, Ray Robinson, Tom Greene, Mike Morris, Peter Mandt, the late Paul Benca, Bill Barrett, Craig Arntz, Bob Winquist, Lynn Staheli, Vince Mosca, Kit Song, Mark Dales, Dick Kirby, Paul Anderson, Stan Bigos, John Sidles, Allan Tencer, and Richard Harrington. Each has served as an amazing role model and mentor. They taught me to be a confident and competent orthopaedic surgeon. I often still refer complex patients from Central California to this expert group in Seattle. Again, I list each of these talented, gifted, generous and selfless teachers with pride and thanks.

After completing residency at the University of Washington, I sought further training in a Sports Medicine Fellowship. I was amazed at the opportunities that were available after completing my residency. I essentially had the chance to attend the sports medicine fellowship of my choice. After discussing the choices with Rick Matsen, I chose the Hospital for Special Surgery in New York. Upon completion, I returned to join the faculty at UW. During this exciting time, under the leadership of Dr. Matsen, we had a chance to resume care of the Huskies and begin a Sports Medicine Fellowship.

I promised my wife Patricia, a native of Fresno, California, like myself, that we would return home when our children were ready to begin school. We have been blessed with two very special girls Lauren, now 13 and Taylor, now 10, both of whom were born in Seattle.

I am eternally grateful to the University of Washington Department of Orthopaedics and Sports Medicine. I am eternally grateful to each of the committed and selfless doctors, professors, colleagues, and dear friends that make this Department great. Thank you!"

Robert M. Berry, M.D.
2012 Distinguished Alumnus
University of Washington School of Medicine



Bob and Gail Berry at home in Utah.

We are proud to announce Dr. Robert Berry as the 2012 Distinguished Alumnus. Dr. Berry is a nationally known and recognized spine surgeon in Salt Lake City, Utah and a successful entrepreneur in medical education. He was raised in Bellevue, Washington and graduated from Issaquah High School. He attended Stanford on a Football scholarship and managed to play in two Rose Bowls during his college career. He subsequently attended USC for Medical School and following graduation there came to the University of Washington for his internship and residency in Orthopaedics. It was at Harborview when Bob ran into the love of his life on a MedSurg floor, a beautiful nurse named Gail. After a 5 week romance they eloped to Hawaii and together set out for their life together. Dr. Berry graduated in 1983 in a class filled with distinguished alumni such as Drs. Ed Farrar, Keith Mayo, Elizabeth Ouellette, Henry Yee and Joe Zuckerman.

After completing his spine fellowship with the famed neurosurgeon Ralph Cloward at Queens Medical Center in Honolulu, Hawaii, Dr. Berry proceeded with a very successful private practice in Las Vegas and later in Salt Lake City. During a time of significant faculty departure Dr. Berry left his practice and joined the University of Washington Spine faculty from 1994 through 1997. He was a welcome addition to our program and an outstanding contributing surgeon and colleague. He returned to Utah with his family to remain close to his son's football career at BYU.

Dr. Berry has accomplished something that few if any of us in academia can ever hope to achieve. Together with his son Matt he has successfully published medical educational materials in well over a million copies of Apps and has produced one of the most successful medical downloads in this new publication format. To the present date he remains in close contact with members of our spine service and takes great delight in debating finer points of surgical efficiencies and need for more stratified early care approaches in Low Back pain care.

We honor Dr. Berry for his selfless support of our faculty by joining us for two crucial years and we recognize his accomplishments in medical publications using new delivery formats.

New Faculty

Darin J. Davidson, M.D.

Dr. Darin J. Davidson joined our department in September 2011 as an Assistant Professor on our Tumor Service.

He started his medical education at the University of British Columbia in Vancouver, Canada. In 2009, he completed his residency there. Afterwards, he went to Boston for a fellowship at Children's Hospital, which is affiliated with Harvard Medical School. From there he went to Toronto, where he completed another fellowship – this time working at Mount Sinai Hospital at the University of Toronto.

Dr. Davidson is very active nationally and internationally. He is currently a member of the American Academy of Orthopaedic Surgeons, Paediatric Orthopaedic Society of North America, Royal College of Physicians and Surgeons of Canada, Canadian Medical Association, British Columbia Medical Association, and the British Columbia Orthopaedic Association.

His research publications have been quite comprehensive. He has published original research on monitoring the adequacy of open biopsies of bone and soft tissue lesions as well as length of stay, mortality, morbidity and delay to surgery in hip fractures. Monitoring the status of surgical margins after resection of bone and soft tissue sarcomas, epidemiology in orthopaedic research, as well as outcomes research are some of the fields Dr. Davidson will continue to research here at the University of Washington.

Justin Klimisch, M.D.

Justin Klimisch, M.D. originally comes from North Dakota and after relocating to the great State of Texas attended UTMB Galveston. Following graduation in 2004 he completed his residency in Orthopaedics at the same location in 2009. He then went on to Adult Reconstructive Surgery fellowship training at Baylor College of Medicine in Houston, TX finishing in 2010 and has been in private practice at NWH at the Bone and Joint Clinic since then. Justin has a noteworthy background having served with distinction in our Airborne Infantry from 1989 – 1993 and then entered the field of Medicine as a Physician Assistant, prior to attending Medical School.

He also has published research in a number of fields. Treatment of failed Darrach procedures, metal-on-metal resurfacing of the hip, and stump overgrowth in pediatric burn patient amputations are some of the subjects for which Dr. Klimisch has published research.

Thomas Louis Tanous, Jr., M.D.

Thomas Louis 'TJ' Tanous Jr., M.D. comes from Denton, Texas and received his Doctorate in Medicine from the University of Texas, Houston in 2004. He completed his residency at UTMB Galveston, TX in 2009 and then successfully completed an Adult Reconstructive Surgery Fellowship at the Scripps Clinic in Sand Diego, CA in 2010.

He has some experience working in biological studies as a cell biology lab instructor.

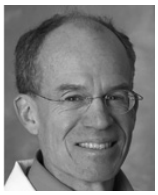
Dr. Tanous has published research on the following topics: orthopaedic approach to knee pain, fragility fractures and osteoporosis, arthroscopic treatment of symptoms after total knee arthoplasty, as well as new advances in arthritis treatment.

He joins Justin at the Bone and Joint Clinic at NWH in building up a dedicated Adult Reconstruction Surgery practice from the ground up.

Department of Orthopaedics and Sports Medicine Faculty

Jens R. Chapman, M.D.
Professor and Chairman
Harborview Medical Center
Spine
jenschap@uw.edu

Michael E. Brage, M.D.
Associate Professor
Harborview Medical Center
Foot and Ankle
bragem@uw.edu



Christopher H. Allan, M.D.
Associate Professor
Harborview Medical Center
Hand and Wrist
callan@uw.edu

Richard J. Bransford, M.D.
Associate Professor
Harborview Medical Center
Spine
rbransfo@uw.edu

Steven D. Bain, Ph.D.
Research Associate Professor
Harborview Medical Center
Research
sdbain@uw.edu

Cordelia W. Carter, M.D.
Clinical Assistant Professor
Seattle Children's Hospital
Pediatric Orthopaedics
cordelia.carter@seattlechildrens.org

David P. Barei, M.D.
Associate Professor
Harborview Medical Center
Trauma
barei@uw.edu

Peter R. Cavanagh, Ph.D.
Professor
University of Washington Medical Center
Research
cavanagh@uw.edu

Daphne M. Beingessner, M.D.
Associate Professor
Harborview Medical Center
Trauma
daphneb@uw.edu

Howard A. Chansky, M.D.
Professor
VA Puget Sound Health Care System
Adult Reconstructive Surgery
chansky@uw.edu

Carlo Bellabarba, M.D.
Professor
Harborview Medical Center
Spine and Trauma
cbella@uw.edu

Ernest U. Conrad III, M.D.
Professor
Seattle Children's Hospital
Orthopaedic Oncology
chappie.conrad@seattlechildrens.org

Stephen K. Benirschke, M.D.
Professor
Harborview Medical Center
Foot and Ankle
beniskb@uw.edu

Mark C. Dales, M.D.
Clinical Associate Professor
Seattle Children's Hospital
Spine
mark.dales@seattlechildrens.org

Department of Orthopaedics and Sports Medicine Faculty

Darin J. Davidson, M.D.
Assistant Professor
University of Washington Medical Center
Orthopaedic Oncology
djdavi@uw.edu

Douglas P. Hanel, M.D.
Professor
Harborview Medical Center
Hand and Wrist
dhanel@uw.edu

Robert P. Dunbar, M.D.
Associate Professor
Harborview Medical Center
Trauma
dunbar@uw.edu

Sigvard T. Hansen, Jr., M.D.
Professor Emeritus
Harborview Medical Center
Foot and Ankle
hansetmd@uw.edu

David R. Eyre, Ph.D.
Professor
University of Washington Medical Center
Research
deyre@uw.edu

M. Bradford Henley, M.D.
Professor
Harborview Medical Center
Trauma
bhenley@uw.edu

Russell J. Fernandes, Ph.D.
Research Associate Professor
University of Washington Medical Center
Research
rjf@uw.edu

Jerry I. Huang, M.D.
Assistant Professor
University of Washington Medical Center
Hand and Wrist
jihuang@uw.edu

Michael J. Goldberg, M.D.
Clinical Professor
Seattle Children's Hospital
Pediatric Orthopaedics
michael.goldberg@seattlechildrens.org

Justin Klimisch, M.D.
Clinical Assistant Professor
UW Medicine Joint Care Center @ NWH
Adult Reconstructive Surgery
jjklimis@uw.edu

John R. Green III, M.D.
Associate Professor
University of Washington Medical Center
Sports Medicine
jgreen3@uw.edu

Walter F. Krengel III, M.D.
Clinical Associate Professor
Seattle Children's Hospital
Spine
wally.krengel@seattlechildrens.org

Ted S. Gross, Ph.D.
Professor
Harborview Medical Center
Research
tgross@uw.edu

James C. Krieg, M.D.
Associate Professor
Harborview Medical Center
Trauma
jckrieg@uw.edu

Department of Orthopaedics and Sports Medicine Faculty

Roger V. Larson, M.D.
Associate Professor
University of Washington Medical Center
Sports Medicine
drlarson@uw.edu

Sean E. Nork, M.D.
Associate Professor
Harborview Medical Center
Trauma
nork@u.washington.edu

Michael J. Lee, M.D.
Assistant Professor
University of Washington Medical Center
Spine
mjl3000@uw.edu

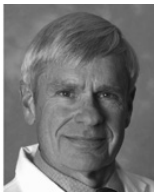
John W. O'Kane, M.D.
Associate Professor
University of Washington Medical Center
Sports Medicine
jokane@uw.edu

Seth S. Leopold, M.D.
Professor
University of Washington Medical Center
Adult Reconstructive Surgery
leopold@uw.edu

Milton L. Routt, Jr., M.D.
Professor
Harborview Medical Center
Trauma
mlroutt@uw.edu

Paul A. Manner, M.D.
Associate Professor
University of Washington Medical Center
Adult Reconstructive Surgery
pmanner@uw.edu

Bruce J. Sangeorzan, M.D.
Professor
Harborview Medical Center
Foot and Ankle
bsangeor@uw.edu



Frederick A. Matsen III, M.D.
Professor
University of Washington Medical Center
Shoulder and Elbow
matsen@uw.edu

Gregory A. Schmale, M.D.
Associate Professor
Seattle Children's Hospital
Pediatric Orthopaedics
gregory.schmale@seattlechildrens.org

Vincent S. Mosca, M.D.
Professor
Seattle Children's Hospital
Pediatric Orthopaedics
vincent.mosca@seattlechildrens.org

John A. Sidles, Ph.D.
Professor
University of Washington Medical Center
Research
sidles@uw.edu

Carol A. Mowery, M.D.
Clinical Associate Professor
Seattle Children's Hospital
Pediatric Orthopaedics
carol.mowery@seattlechildrens.org

Douglas G. Smith, M.D.
Professor
Harborview Medical Center
Foot and Ankle
dgsmith@uw.edu

Department of Orthopaedics and Sports Medicine Faculty

Sundar Srinivasan, Ph.D.
Research Associate Professor
Harborview Medical Center
Research
sundars@u.washington.edu

Suzanne E. Steinman, M.D.
Clinical Assistant Professor
Seattle Children's Hospital
Pediatric Orthopaedics
suzanne.steinman@seattlechildrens.org

Lisa A. Taitsman, M.D., M.P.H.
Associate Professor
Harborview Medical Center
Trauma
taitsman@uw.edu

Thomas Louis Tanous Jr., M.D.
Clinical Assistant Professor
UW Medicine Joint Care Center @ NWH
Adult Reconstructive Surgery
tjtanous@uw.edu

Carol C. Teitz, M.D.
Professor
University of Washington Medical Center
Sports Medicine
teitz@uw.edu

Allan F. Tencer, Ph.D.
Professor
Harborview Medical Center
Research
atencer@uw.edu

Theodore A. Wagner, M.D.
Clinical Professor
University of Washington Medical Center
Spine
wagner@uw.edu

Christopher J. Wahl, M.D.
Associate Professor
University of Washington Medical Center
Sports Medicine
wahlc@uw.edu

Winston J. Warme, M.D.
Associate Professor
University of Washington Medical Center
Shoulder and Elbow
warmewj@uw.edu

Klane K. White, M.D., M.Sc.
Associate Professor
Seattle Children's Hospital
Pediatric Orthopaedics
klane.white@seattlechildrens.org

Jason J. Wilcox, M.D.
Assistant Professor
VA Puget Sound HealthCare System
Sports Medicine
jwilcox2@uw.edu

Jiann-Jiu Wu, Ph.D.
Research Professor
University of Washington Medical Center
Research
wujj@uw.edu

Emeritus Faculty

Stanley J. Bigos, M.D.
Professor Emeritus

Theodore K. Greenlee, Jr., M.D.
Associate Professor Emeritus

Lynn T. Staheli, M.D.
Professor Emeritus

Visiting Lecturers

Stuart L. Weinstein, M.D.
2012 LeCocq Lecturer

Dr. Weinstein is the Ignacio V. Ponseti Chair and Professor of Orthopaedic Surgery and Professor of Pediatrics at The University of Iowa. Dr. Weinstein received his A.B. Honors degree in Political Science and History from the University of Illinois in 1968. He received his medical degree (Alpha Omega Alpha) from the University of Iowa in 1972. After interning in Internal Medicine at The University of California San Francisco, he returned to the University of Iowa for a residency in Orthopaedic Surgery. In 1976 he joined the faculty of the Department of Orthopaedic Surgery at The University of Iowa.

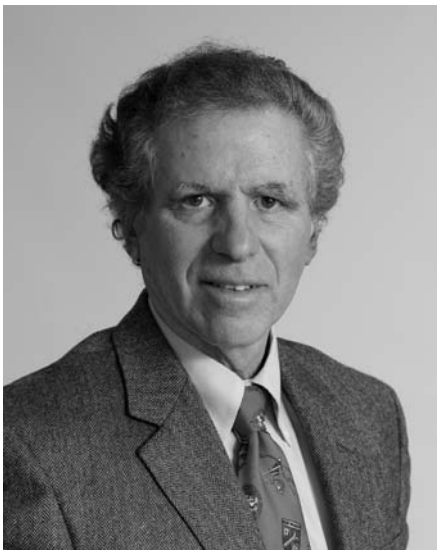
Dr. Weinstein is an NIH funded researcher. He has published more than 190 scientific articles in peer review journals on a wide variety of pediatric orthopaedic conditions. His research work has focused on spinal deformity in children, children's hip and foot problems, and the natural history and long-term outcome of pediatric musculoskeletal conditions. He has edited three major textbooks including The Pediatric Spine: Principles and Practice; Lovell and Winter's Pediatric Orthopaedics and Turek's Orthopaedics. Dr. Weinstein's many contributions to orthopaedics have been recognized by his receipt of the Bristol-Myers Squibb/Zimmer Award for Distinguished Achievement in Orthopaedic Research; The Kappa Delta /Orthopaedic Research and Education Foundation Clinical Research Award; The Russel Hibbs Award for Clinical Research given by the Scoliosis Research Society; and The Arthur H. Heune Memorial Award, given by the St. Giles Foundation and The Pediatric Orthopaedic Society of North America in recognition of outstanding research contributions to pediatric orthopaedics. In 2005, Dr. Weinstein was the recipient of the Alfred R. Shands, Sr., M.D. Award, presented by the Orthopaedic Research Society and The American Orthopaedic Association. This award is presented each year to a United States or Canadian citizen who has made significant contributions to orthopaedics. This award recognizes the devotion of a significant portion of the professional lifetime to furthering knowledge in the fields of musculoskeletal disease.

Dr. Weinstein received the 2000 Iowa Board of Regents Award for Faculty Excellence for sustained record of excellence across the spectrum of faculty endeavors. In 2003, he received the Ernest O. Theilen Clinical Teaching and Service Award presented by the Roy J. and Lucille Carver College of Medicine. In 2009, he received the Distinguished Mentor Award presented by the Roy J. and Lucille Carver College of Medicine. In 2011, Dr. Weinstein received the William W. Tipton, Jr., M.D., Award for Outstanding Leadership in Orthopaedics from the American Academy of Orthopaedic Surgeons and the Orthopaedic Research and Education Foundation.

Dr. Weinstein was a recipient of an American, British, Canadian (ABC) Traveling Fellowship in 1985. He has been honored for his contributions to Orthoapedic Surgery by honorary memberships in National Orthopaedic Associations around the world including Australia, New Zealand, Germany, Great Britain, Thailand and Argentina. In 2007 he was made a Fellow of The Royal College of Surgeons of England.

Dr. Weinstein is past president of the American Academy of Orthopaedic Surgeons, The American Orthopaedic Association, The American Board of Orthopaedic Surgery, The Pediatric Orthopaedic Society of North America, The United States National Action Network of the International Bone and Joint Decade, The International Center for Orthopaedic Education (ICOE) and Doctors for Medical Liability Reform (DMLR). He has served as an Associate Editor of JBJS and currently serves as a member of the Board of Trustees of the Journal of Bone and Joint Surgery. Dr. Weinstein currently serves as Chairman of the American Association of Orthopaedic Surgeons Political Action Committee.

Visiting Lecturers



Jesse B. Jupiter, M.D., M.A.
2012 OREF Hark Lecturer / Resident Research Day

Jesse B. Jupiter, M.D., M.A. is the Hansjorg Wyss / AO Professor of Orthopaedic Surgery at Harvard Medical School. He graduated from Brown University with a degree in classics and lettered in soccer and baseball. Dr. Jupiter was inducted into the Brown University Athletic Hall of Fame in 2008. He earned his M.D. at Yale in 1972 and completed his surgical internship at the University of Pennsylvania Hospital in 1973.

A two year commitment followed as a general medical officer in the United States Public Health Service Indian Health branch with the Pima Indians in Arizona. His interest in medical education was enhanced with the development of educational programs improving primary care for both diabetic and arthritic patients.

In 1975, he began a year of surgical residency at the Massachusetts General Hospital and a 3 ½ year orthopaedic residency within the Harvard Combined Residency Program.

In 1980 Dr. Jupiter traveled to Basle, Switzerland where he completed an AO Fellowship and went on to a hand and microvascular fellowship in Louisville, Kentucky.

He returned to Boston in 1981 and began his academic and clinical career at the Massachusetts General Hospital. During his 31 years on the academic faculty he has had the opportunity to head the Trauma Service, Foot and Ankle Program, and the Hand Service.

Dr. Jupiter is an honorary member of over 20 different international societies of either Hand Surgery or Orthopaedic Surgery and has been named to America's Top Surgeons annually and Best of Boston since 2007. He is currently the President of the American Association of Hand Surgery.

Dr. Jupiter is an internationally known and sought after hand and upper limb specialist. He has given over one thousand scientific presentations, almost 200 Visiting Professorships, published over 220 original publications, 140 analytic reviews, 115 chapters in scientific texts, and co-author or co-editor of 10 major texts in upper limb and Orthopaedic problems. Dr. Jupiter has developed a worldwide reputation especially related to problems of the wrist and elbow along with all other conditions involving the hand and upper limb.

A Very Successful Year in Orthopaedics

Liu Yang and Michael Lee at the Center for Urban Horticulture during our 2012 Faculty Retreat.

With Dr. Peter Cavanagh a Keynote Speaker at the 2012 i-FAB Congress in Sydney, Australia, he provided the faculty an update on the research side of our department through a videotaped presentation.

Doug Hanel, Maureen Johnson (our new Manager of Faculty Affairs), and Jens Chapman.

Ted Wagner, Bruce Sangeorzan, Carol Mowery, Klane White, Wally Krengel, Rick Matsen, and David Dunning at our faculty retreat.

We are fortunate to have so many fine visitors to our department. Pictured above with Dr. Wagner and Dr. Chapman are two of our distinguished visitors this year, (second from left) Dr. Joerg Auer from Basel, Switzerland and (second from right) Dr. George Bagby of Pullman,WA.

Our 2nd Annual Summit in Seattle was a great success! Pictured above are a number of the faculty, participants, and visitors who collaborated to make this event so special. We are excited to announce the dates for our 3rd Annual Summit in Seattle conference: July 26 – 28, 2012. We have a very exciting agenda and this year's focus will be on traumatic and degenerative conditions of the hip and pelvis. We will have nationally and internationally renowned guest lecturers.

The agenda will include lectures, robust discussion and cadaveric demonstrations of surgical techniques in our ISIS Surgical Skills Laboratory. In addition, we will have evening social activities for attendees following each day's events and the weather in Seattle is reliably beautiful this time of year. We hope you can join us.

Dr. Bob McGuire, Jackson, MS at 10th Spine Summit with Dr. Jens Chapman.

Our Graduating Residents pictured with Chairman Dr. Jens Chapman, Dr. Doug Hanel, and our distinguished visitor Jesse B. Jupiter, M.D., M.A. 2012 OREF Hark Lecturer / Resident Research Day.

Salvage of Failed Custom Total Ankle Replacement: A Case Report

Michael E. Brage, M.D.

Presenting Problem

A 65-year-old otherwise healthy female presented with increasing pain and increasing deformity of her right foot and ankle. She had six previous major foot and ankle reconstructive surgeries since 2003 for presumed pantalar arthritis. Despite these surgeries, she described daily severe pain. She required a brace to allow for ambulation due to pronounced hindfoot deformity and stiffness. She described progressive numbness, weakness and a generally worsening trend upon presentation.

Physical Findings

Her swollen, semi-rigid hindfoot was in extreme valgus. Her peroneal and Achilles tendons were contracted and inversion strength was absent. She walked on the inside of her foot and was extremely tender over the distal fibula. Her ankle was grossly unstable to eversion stress with apparent deltoid ligament insufficiency.

Imaging

Her x-rays showed a subluxed custom total ankle replacement (Figure 1) with a deltoid ligament rupture in 45 degrees of valgus. There was a tension band around the medial malleolus. Calcaneal screws fixed a well healed calcaneal osteotomy. There was pseudo-articulation between the lateral tibial component and the calcaneus. The medial midfoot was fused with screws and a plate.

Assessment

We identified a failed custom total ankle replacement (TAR) with incompetent deltoid ligament. Her prior operations included pantalar fusion (April 2003), conversion to total ankle replacement in November 2003, derotational tibial osteotomy for varus TAR failure in January 2005, due to loosening, revision to custom TAR (October 2007) and medializing calcaneal osteotomy to compensate for valgus deformity (March 2008). Due to continued valgus drift the medial malleolus was repaired with a revision calcaneal osteotomy In April 2010 in a futile effort to further stabilize the ankle.

Plan

The patient declined re-fusion or amputation. Alternatively we discussed a two-stage reconstruction to salvage her leg and motion. The first stage would involve removing the failed implant, inserting a cement spacer to preserve the balance of the ankle joint, and reconstruction of the deltoid ligament with an allograft tendon. Upon healing with a stable ankle joint, then a new prosthetic ankle could be placed. After detailed explanation of the experimental nature of this procedure without long term published data, and under the prospect of complications requiring amputation or life with a deformed limb the patient requested that we proceed.

Figure 1: AP image of failed and subluxed custom total ankle replacement.

Figure 2: 6 weeks after prosthesis extraction, deltoid ligament reconstruction and placement of cement spacer.

Figure 3: Lateral view of ankle 6 weeks after prosthesis extraction, deltoid ligament reconstruction and placement of cement spacer.

Figure 4: Immediate post-operative AP view following revision total ankle replacement.

Figure 5: Lateral view following revision total ankle replacement.

Figure 6: AP view 6 months following revision total ankle replacement.

Figure 7: Lateral view 6 months after revision total ankle replacement.

Procedures

Stage 1: In October 2011, we proceeded with removal of the previously placed ankle implant and hardware, placement of a cement spacer and a deltoid ligament reconstruction with an anterior tibial allograft tendon[1]. She was kept non-weight bearing for six weeks. At six weeks, we found her ankle to be stable to stress maneuvers and her wound to be well healed (Figures 2 and 3).

Stage 2: In December 2011, the cement spacer was removed and a Wright Medical InBone 2 ankle was placed (Figures 4 and 5). Postoperatively the patient was casted and kept non-weight bearing for six more weeks. At six weeks, she was relatively pain free and her x-rays showed her prosthesis was well aligned and ingrown to bone. She began to walk in a CAM boot for six weeks while undergoing physical therapy.

Follow-up: The patient has remained quite happy with her ankle and foot being straight, minimal swelling and occasional pain with decreasing trend. On physical exam, her ankle was non-tender to palpation. She had a 10 degree motion arc with a stable ankle. She has been weaned to shoe and is resuming normal activities (Figures 6 and 7).

Discussion

This case exemplifies the dangers of motion preserving arthroplasties in major weight-bearing articulations such as the ankle. Unless performed expertly at the index procedure dynamic forces may lead to an undesirable cascade of deformities and subsequent corrective interventions. Implementation of new technologies such as ankle replacements holds both promise and obligation to provide diligent follow-up. In case of failure, early referral to a major reconstructive center with extensive experience, such as available at the Sigvard T. Hansen Foot & Ankle Institute, can help avoid lengthy morbidity and promote return to function.

Bibliography

1. Haddad SL, Dedhia S, Ren Y, Rotstein J, Zhang LQ. Foot Ankle Int. 2010 Jul; 31(7):639-51.

Temporary External Fixation in Calcaneal Fractures

John Munz, M.D., Patricia A. Kramer, Ph.D., and Stephen K. Benirschke, M.D.

Abstract

High energy events that result in calcaneal fractures injure not only the osseous anatomy of the hind foot, but also the soft tissue envelope. Definitive treatment of the osseous injury must wait until the soft tissue swelling has resolved and the blisters or open wounds have re-epithelized. Temporary external fixation has the advantage of grossly reducing the displaced fragments, minimizing the time to the definitive treatment (formal open reduction and internal reduction) and facilitating incisional wound closure. We investigated the experience of 29 patients (31 fractures) treated with temporary external fixation and found that only one patient developed a (tibial) pin tract infection that resolved with 10 days of oral antibiotics. No other complications from the external fixation procedure were noted. External fixation is a safe and effective provisional treatment of substantially malaligned calcaneal fractures.

Introduction

High energy calcaneal fractures often result in substantial displacement of fracture fragments. This displacement injures the soft tissue, resulting in extensive swelling, often with blisters and with occasionally in open wounds, all of which must be allowed to resolve before definitive fixation can be performed. Provisional external fixation of the fracture returns the foot to gross alignment and allows the soft tissue envelope to "calm down" and to "rest" in approximate anatomic position until definite reduction can occur. External fixation, however, requires an additional surgical procedure and exposes the patient to the risk of infection from pin tracts. Our question is: Do patients who have external fixation done prior to definitive treatment experience infections or other complications from the provisional fixation?

Methods and Materials

- Retrospective review of medical records
- All calcaneal fractures treated by senior author from 1/1/2007- 6/1/2011
- 31 displaced calcaneal fractures in 29 adult patients (17 men) treated with temporary external fixation
- External fixation applied medially using tibial, calcaneal and transcuneiform pins (Figure 1; Figure 2)
- Skin assessed for tension and released around pins if necessary
- Limb encased in plaster splint, but completely covering the fixation device including the pins and pin tracts
- External fixation removed at time of definitive fixation (open reduction and internal fixation via an extensile lateral approach)

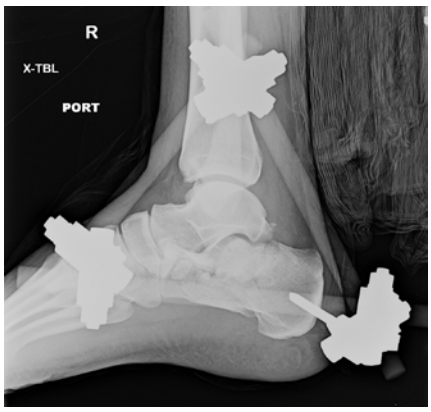


Figure 1 (left) and Figure 2 (right): External fixation applied medially using tibial, calcaneal and transcuneiform pins.

Results

- Soft tissue condition: 5 feet with swelling only; 16 with medial and/or lateral blisters; 10 with medial or plantar open wounds
- Average time with external fixation in place = 17 days (range 7-35 days)
- 1 infection (MSSA) in tibial pin, treated with 10 days of oral antibiotics (Bactrim)
- No other complications associated with the external fixation, including no superficial or deep infections
- Definitive management of calcaneal facture not jeopardized by placement of calcaneal pin of external fixator

Discussion

Three aspects of our standard care contribute to the low complication rate associated with the external fixation. First, avoidance of thermal necrosis of the soft tissue or bone is a critical component in application of external fixation. Second, as the fracture is distracted using the fixator, the skin can experience tension around the pins. Release of skin around pins eliminates this skin tension. Third, enclosing the external fixation device in plaster seals the pin tracts from the environment, eliminating an important source of infectious agents. We believe that adherence to this protocol reduces the likelihood of infection.

External fixation does not, therefore, present a substantial risk of complications in calcaneal patients, even in those patients with severely traumatized soft tissue envelopes. Future work will seek to quantify the benefits of external fixation, which we believe include shorter time between injury and definitive treatment and simpler incisional wound closure. External fixation is a safe and effective provisional treatment of substantially malaligned calcaneal fractures.

Enhancing Pedicle Screw Fixation in the Lumbar Spine Utilizing Allograft Bone Plug Interference Fixation: A Biomechanical Study

Harsha Malempati, M.D., Bopha Chrea B.S., Jeffrey Campbell M.S., Sonja Khan B.S., Randal P. Ching, Ph.D., and Michael J. Lee, M.D.

Study Rationale

- Pedicle screw fixation in the osteoporotic spine can be challenging, particularly with deformity correction[1,2]
- Augmentation techniques, particularly with bone cement, enhance fixation however with significant risk of complication[3,4,5,6]
- Cement embolization to the lungs after vertebral cement augmentation has been reported to be as high as 25%[7]

Research Question

- Does insertion of a bone dowel into a cannulated pedicle followed by pedicle screw insertion provide significantly improved fixation as compared to pedicle screw fixation alone?

Materials and Methods

- 12 human cadaveric non-scoliotic lumbar spine specimens were obtained and utilized for testing.
- Within each specimen a 6.25 mm diameter pedicle screw was inserted into one pedicle. In the contralateral pedicle, the pedicle screw fixation was augmented by the insertion of a bone dowel prior to screw insertion.
- Screw pullout tests were conducted at a constant rate of 30 mm/min using a materials testing machine (MTS, Eden Prairie, MN) (Figures 1 & 2).
- Mechanical pullout strengths, failure displacements, and stiffness were compared using a paired t-test, and were correlated with BMD.

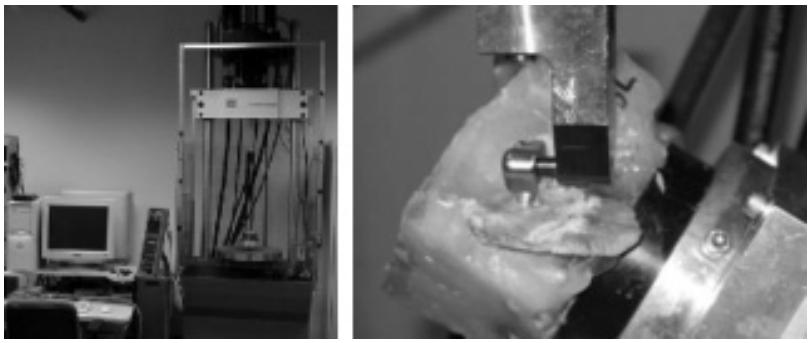


Figure 1: A) (left) MTS test frame in the UW Applied Biomechanics Laboratory (UW-ABL); B) (right) Example of a previous "off-axis" pedicle screw pull out test performed at the UW-ABL. In the current proposal, all of the pullout tests will be conducted under direct axial (vertical) tension.

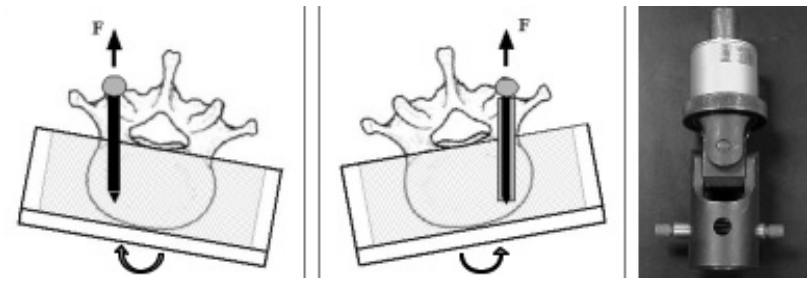


Figure 2: Correct alignment of the pedicle screws for vertical pullout will be facilitated using a lower universal joint to allow the potting cup to rotate. For example, A) (left) standard pedicle screw alignment with potting cup allowed to rotate clockwise; B) (middle) contra-lateral pedicle screw + allograft dowel alignment with potting cup allowed to rotate counter-clockwise; C) (right) universal joint used to allow the pedicle screw to vertically self-align during testing.

Results

- The average pullout strength for the pedicle screws augmented with allograft bone dowel was 1772±652 N while the average pullout strength for the pedicle screws alone was 1780±575 N (Figure 3).
- The displacement at failure and the stiffness for the augmented pedicle screws were 1.7±0.9 mm and 1637 N/mm±786 N/mm respectively, compared to 2.1±1.8 mm and 1896±1612 N/mm for the pedicle screws alone.
- There was no significant difference between pedicle screws alone and pedicle screws augmented with allograft bone dowel in terms of pullout strength ($p>0.05$).

Discussion

- Preliminary study of pedicle screw augmentation using a cannulated allograft bone dowel does not appear to show improvement of fixation with pedicles in the spine.
- This was particularly true in osteoporotic specimens, where augmentation would seem to be of considerable benefit.
- Further study with larger numbers may provide further

Figure 3: Mean pullout force for all specimens.

insight.

- In addition, while the addition of the bone dowel did not appear to improve fixation, this technique may be useful as a salvage strategy for intra-operative screw pullout, but warrants further study.

References

1. Halverson TL, Kelley LA, Thomas KA, Whitecloud TS, Cook SD. Effects of bone mineral density on pedicle screw fixation. Spine 1994;19(21):2415-20.

2. Pfeifer BA, Krag MH, Johnson C. Repair of failed transpedicular screw fixation. A biomechanical study comparing polymethylmethacrylate, milled bone, and matchstick bone reconstruction. Spine 1994;19:350-3.

3. Chen LH, Tai CL, Lai PL, Lee DM, Tsai TT, Fu TS, Niu CC, Chen WJ. Pullout strength for cannulated pedicle screws with bone cement augmentation in severely osteoporotic bone: Influences of radial hole and pilot hole tapping. Clin Biochem 2009;24(8):613-618.

4. Chang MC, Liu CL, Chen TH. Polymethylmethacrylate augmentation of pedicle screw for osteoporotic spinal surgery: a novel technique. Spine 2008;33(10):E317-324.

5. Zhuang XM, Yu BS, Zheng ZM, Zhang JF, Lu WW. Effect of the degree of osteoporosis on the biomechanical anchoring strength of the sacral pedicle screws: an in vitro comparison between unaugmented bicortical screws and polymethylmethacrylate augmented unicortical screws. Spine 2010;35(19):E925-31.

6. Burval DJ, McLain RF, Milks R, Inceoglu S. Primary pedicle screw augmentation in osteoporotic lumbar vertebrae- biomechanical analysis of pedicle fixation strength. Spine 2007;32:1077-83.

7. Venmans A et al. Percutaneous vertebroplasty and pulmonary cement embolism: results from VERTOS II. Am J Neuroradiol 2008;31(8)1451-3.

Antegrade Femoral Nailing in the Setting of Acetabular Fracture Requiring a Kocher-Langenbeck Approach

Julius A. Bishop, M.D., William W. Cross, III, M.D., James C. Krieg, M.D., and Milton L. Routt, Jr., M.D.

Abstract

Ipsilateral displaced acetabular and femoral shaft fractures represent a dilemma for the treating orthopedic surgeon since antegrade medullary femoral nailing may complicate a standard posterior acetabular surgical exposure in a variety of ways. This study examines these uncommon combination injuries and their relationship with routine treatment and complications.

Introduction

Ipsilateral fractures of the femur and acetabulum represent a severe combination of injuries for which optimal management remains uncertain. When confronted with this constellation of fractures, most surgeons advocate stabilizing the femur fracture first and then treating the acetabulum either in the same setting or as a delayed procedure. While reamed antegrade nailing is the preferred treatment for fractures of the femoral shaft and is evolving into the treatment of choice for many peritrochanteric fractures as well, an ipsilateral acetabular fracture, particularly one for which a Kocher-Langenbeck approach is anticipated, is considered by some to be a relative contra-indication.

Antegrade femoral nailing has several important advantages over other treatment strategies. It is a versatile technique which can be performed in the supine, lateral, or even prone position through either a piriformis or trochanteric entry portal. With the development of percutaneous insertion techniques, surgical wounds are minimized and can be located to avoid the anticipated Kocher-Langenbeck incision. Cephalomedullary fixation can be employed to treat complex proximal femur fractures while multiplanar distal interlocking can be utilized to stabilize distal fractures. Although retrograde nailing has been advocated as a preferable alternative in the setting of ipsilateral acetabular fracture, this technique has distinct disadvantages. It must be performed in the supine position, violates the knee joint, and cannot be used to treat some proximal femoral lesions. Plate fixation is another alternative for femoral shaft fixation, but requires a more extensive exposure, adversely impacting the Kocher-Langenbeck approach, increasing operative time and the potential for blood loss.

Although some surgeons caution against antegrade femoral nailing below an acetabular fracture requiring a Kocher-Langenbeck approach, at our Level I trauma center, an acetabular fracture for which a Kocher-Langenbeck (KL) approach is anticipated is not considered a contra-indication to antegrade femoral nailing. The relationships of these two operations has never been assessed.

Methods

- Retrospective review of HMC trauma database from Jan 1999 through Dec 2010.
- Identification of all surgically treated patients who received antegrade femoral nailing and ipsilateral acetabular ORIF via Kocher-Langenbeck (KL) exposure.
- Classification of acetabular and femoral shaft fracture patterns.
- Evaluation of patient demographics, injury mechanisms, surgical care details, and complications including wound problems and ectopic bone formation.

Results

There were only 16 total patients with this injury and treatment combination in the observation period. The mean patient age was 40 years (range 14-76). 15 patients were male (94%) and 1 was female (6%). The

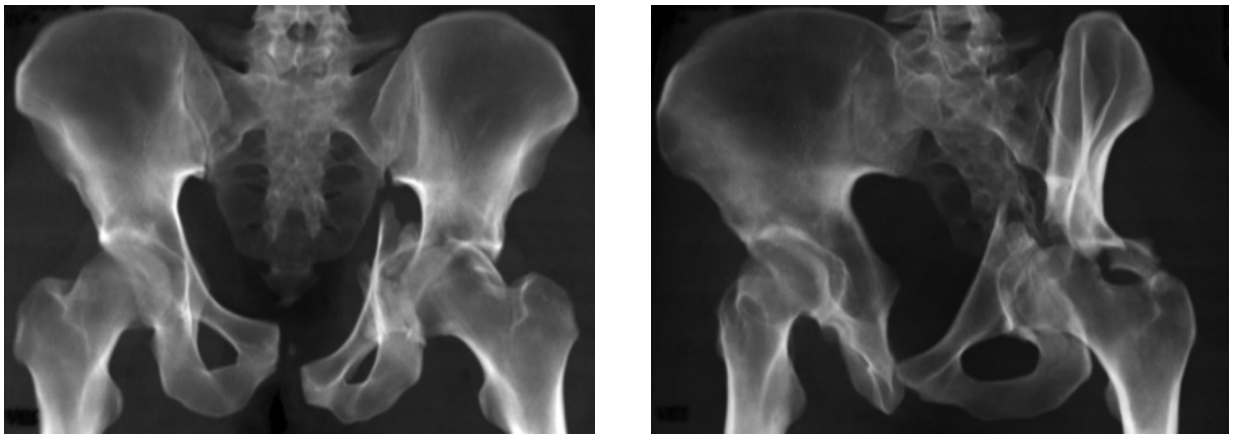


Figure 1: (A, left, & B, right) This 22 years old male sustained numerous injuries including a pelvic ring disruption, a left sided acetabular fracture-dislocation, and an ipsilateral open femoral shaft fracture due to a high speed motorcycle accident.

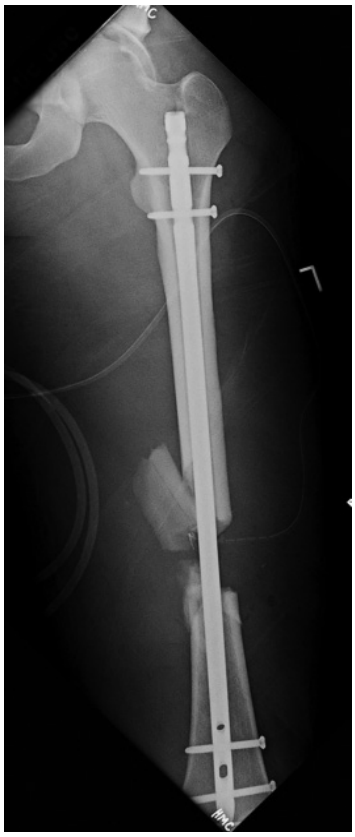


Figure 1: (C) The open femoral shaft fracture had bone loss and was treated with irrigation, debridement, and antegrade reamed locked medullary nailing. The acetabular fracture was subsequently treated with open reduction and internal fixation using a Kocher-Langenbeck exposure. The femoral nail insertion site wound was remote from the KL exposure, while the proximal locking screw wounds were incorporated into the lower portion of the KL incision.

average follow-up was 12.6 months (range 0-84). 8 (50%) patients also had hip dislocations associated with their acetabular fractures. The fracture patterns are summarized in Table 1. Three patients (19%) presented with sciatic nerve palsies as a result of their injuries. Three others had open femoral shaft fractures, all of which were type IIIA according to the Gustilo classification. Three patients underwent a single anesthetic during which both injuries were definitively treated, while 13 patients had staged treatment initially undergoing antegrade reamed locked femoral nailing, followed by acetabular fracture fixation under a subsequent anesthetic. The mean time from injury to femoral nailing was 1.2 days (range 0-6), and the mean time from injury to open reduction internal fixation of the acetabulum was 4.5 days (range 0-14). The same surgeon performed both surgeries in 6 patients (38%). 11 nails (69%) were inserted through a piriformis starting point and 5 (31%) through a trochanteric starting point. Eleven patients (69%) had evidence of femoral medullary reaming debris in their abductor musculature on post-operative CT scan. Radiation therapy for HO prophylaxis was not utilized.

One patient died and two more had follow-up at outside institutions and were therefore not available for long term follow-up. One patient (8%) developed a KL wound deep infection requiring a return to the operating room for irrigation and debridement along with intravenous antibiotics. Another developed a KL wound hematoma in the setting of therapeutically dosed low molecular weight heparin (LWMH) and required a return ot the operating room for evacuation. At final follow-up, two out of thirteen patients (15%) had no heterotopic ossification (HO) about the hip, four (31%) had Brooker class I HO, three (23%) had Brooker class II HO, two (15%) had Brooker class III HO and two patients had Brooker class IV HO requiring resection. The severity or location of ectopic bone formation

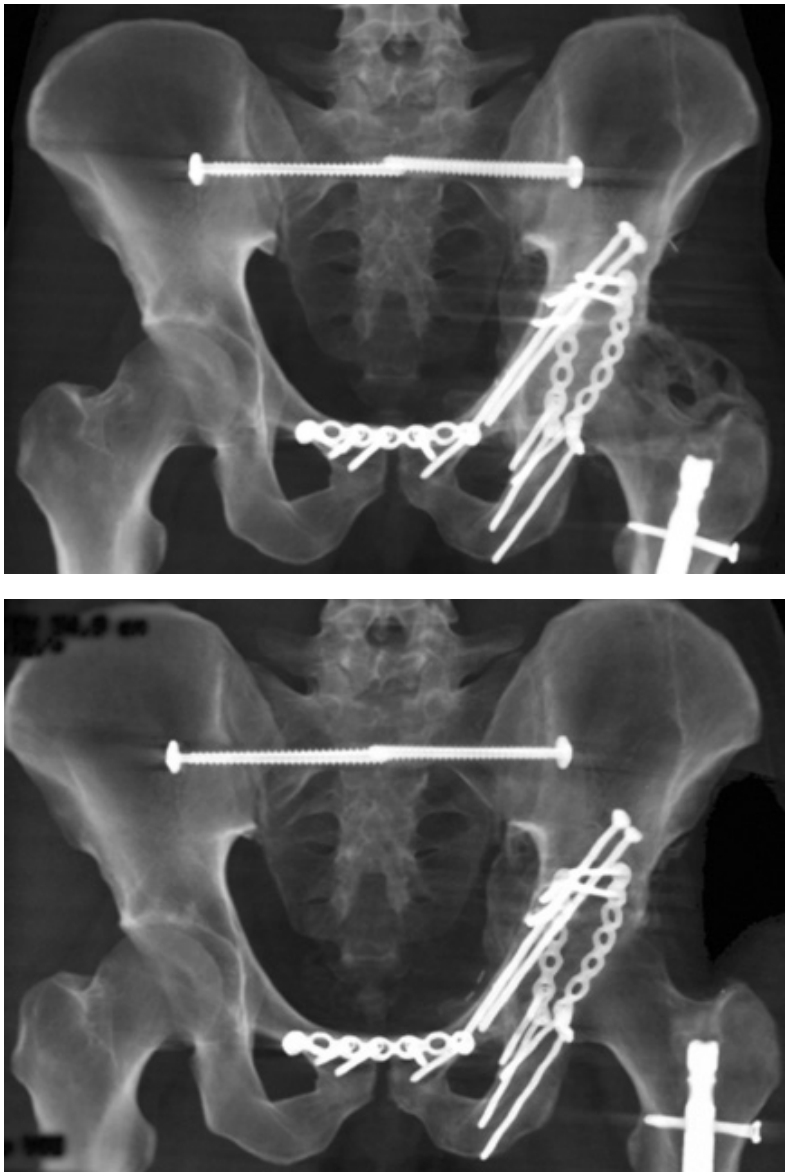


Figure 1: (D) (top) Four months after injury, the patient had no notable hip motion due to ectopic bone formation. (E) (bottom) He underwent surgical excision of the ectopic bone mass and manipulation of the left hip joint. He maintained a functional range of hip motion after surgery and returned to work as a manual laborer.

Patient	Judet Classification Acetabulum	AO/OTA Classification Acetabulum	Fracture Classification Femur	Hip Dislocation
1	T + PW	62A1.2 62B1.2	32A3.2	-
2	T + PW	62A1.3 62B1.3	31B2.3 32B3.2	Posterior
3	BC	62C3.2	32A2.1	Posterior
4	PC + PW	62A2.3	31A2.2	-
5	PC	62A2.2	32A2.3	-
6	T	62B1.2	32B2.3	-
7	T + PW	62A1.3 62B1.3	32C3.1 IIIA	Posterior
8	T + PW	62A1.3 62B1.3	31A3.3 32A3.3	-
9	PW	62A1.2	32A3.3 IIIA	Posterior
10	T + PW	62A 62B1.3	32B2.2	Medial
11	T + PW	62A1.1 62B1.2	32A2.2	Posterior
12	T + PW	62A1.3 62B1.3	32B3.2	-
13	T-Type	62B2.2	32A3.2	Posteromedial
14	T + PW	62A1.3 62B1.2	32C3.2	None
15	T	62B1.3	32B1.1	Medial
16	T + PW	62A 62B	32C3.1 IIIA	*

Table 1: Fracture types according to the AO/OTA Classification, Judet Classification, Gustilo Classification in the case of open fracture, and details of associated hip dislocation. T: Transverse, PW: Posterior Wall, BC: Both Column, PC: Posterior Column

Figure 1: (F) His open femoral shaft fracture healed.

did not correlate with the hip abductor medullary reaming material noted on the postoperative CT scans.

Conclusions

Fortunately, ipsilateral fractures of the femur and acetabulum that require antegrade femoral nailing and a Kocher-Langenbeck approach are uncommon. These patients did not demonstrate an increased risk of wound complications and although heterotopic bone formation was common, it was not clinically significant in most patients. Based on our experience, the presence of an ipsilateral acetabular fracture requiring a Kocher-Langebeck approach is safe and is not a contra-indication to antegrade femoral nailing. Additional measures to prevent HO formation may be warranted in some cases.

References

1. Liebergall M, Lowe J, Whitelaw GP, et al. The floating hip. Ipsilateral pelvic and femoral fractures. J Bone Joint Surg Br. 1992;74(1):93-100.

2. Muller EJ, Siebenrock K, Ekkernkamp A, et al. Ipsilateral fractures of the pelvis and the femur--floating hip? A retrospective analysis of 42 cases. Arch Orthop Trauma Surg. 1999;119(3-4):179-182.

3. Brooker AF, Bowerman JW, Robinson RA, et al. Ectopic ossification following total hip replacement. Incidence and a method of classification. J Bone Joint Surg Am. 1973;55(8):1629-1632.

4. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 1976;58(4):453-458.

	Heterotopic Ossification	None (%)	Brooker I (%)	Brooker II (%)	Brooker III (%)	Brooker IV (%)
Patients		2 (15)	4 (31)	3 (23)	2 (15)	2 (15)

Table 2: Heterotopic Ossification After Antegrade Femoral Nailing and Kocher-Langenbeck Approach.

Simple Techniques Can Prevent Inadvertent Iliosacral Screw Intrusion

F. Parke Oldenburg, M.D., James C. Krieg, M.D., and Milton L. Routt, Jr., M.D.

Abstract

Iliosacral screw breach through the lateral iliac cortical bone surface decreases the fixation stability risking fixation failure. We have identified several simple and reproducible surgical techniques to prevent such iliosacral screw intrusion.

Introduction

Over the past 25 years, iliosacral screws have become standard fixation devices for unstable sacral fractures, sacroiliac joint disruptions, and combination injuries of the posterior pelvic ring. These screws are inserted using fluoroscopic guidance either following open or closed manipulative reduction. Like other bone fixation screws, iliosacral screws rely on the screw head and washer's contact with the lateral iliac cortical bone surface to reliably stabilize the posterior pelvic injury. Unfortunately, preoperative planning and intraoperative imaging of the lateral iliac cortical bone surface have not been consistently been part of the iliosacral screw insertion technique and as a result inadvertent screw intrusions can occur. When the iliosacral screw and washer penetrate the lateral iliac cortical bone, the screw effectiveness is compromised and fixation failure can more readily result. We describe the simple techniques of: (1) accurately measuring the lateral iliac cortical surface obliquity preoperatively on the injury CT scan, (2) matching the intraoperative tangential fluoroscopy to this cortical surface obliquity, and (3) palpating the washer-cortical bone surface relationship using real time fluoroscopy immediately prior to terminal screw tightening to reliably avoid iliosacral screw intrusion.

Material/Methods

- Prospective technique adaptation of iliosacral screw placement in posterior pelvic ring trauma over 9 month period (October 2007-June 2008).
- Preoperative CT measurements of lateral iliac cortical bone surface obliquity in horizontal plane.
- Intraoperative measurement of iliac cortical obliquity with tangential fluoroscopy.
- Tightening of screw under live fluoroscopy in tangential

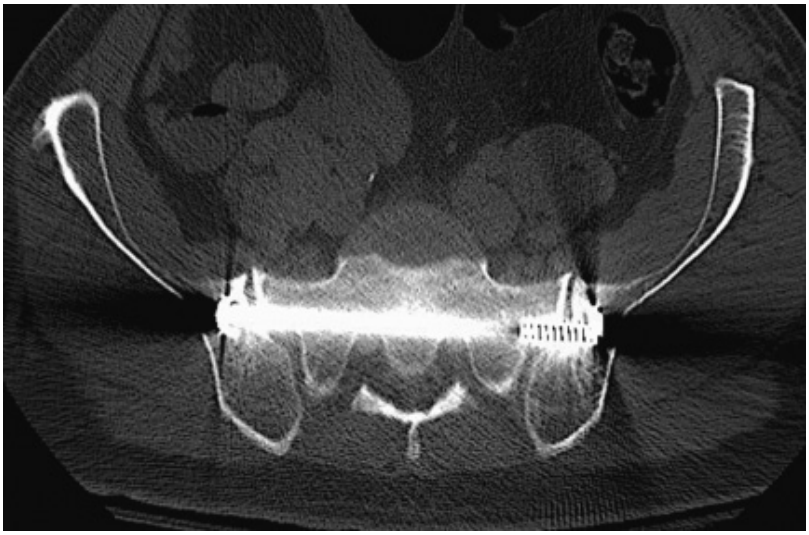


Figure 1: Bilateral iliosacral screw intrusions are noted on this postoperative axial image. The screwheads and washers are located medial to the lateral iliac cortical bone surface. Fixation failure resulted less than one week after surgery.

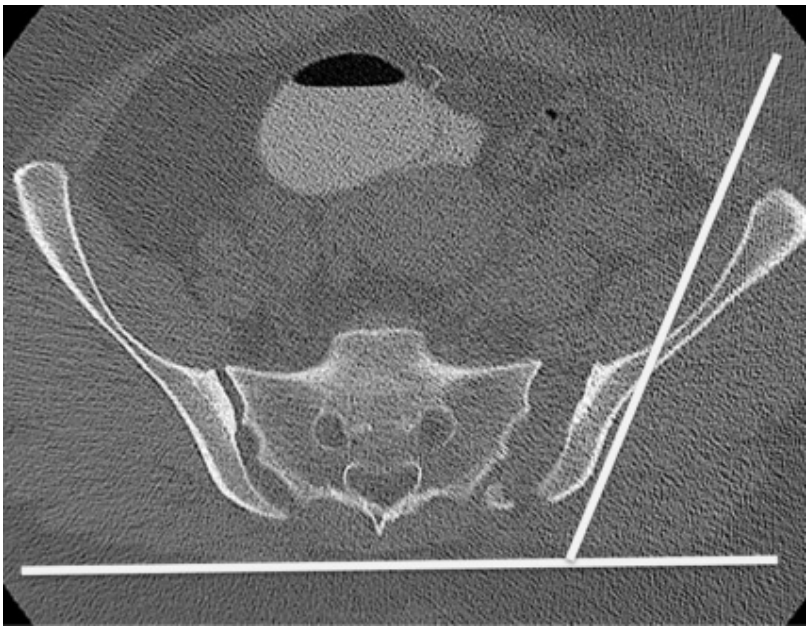


Figure 2: The injury CT scan is used to measure the posterior lateral iliac cortical surface obliquity in the region of the planned iliosacral screw insertion so that intraoperatively the C-arm fluoroscopic imaging can be oriented tangential to it.

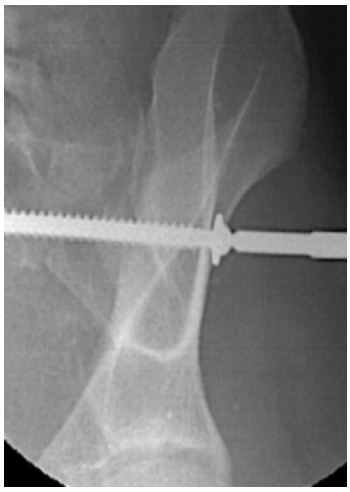


Figure 3: This intraoperative fluoroscopy view is a combination of obturator-oblique and pelvic outlet images. The C-arm is oriented tangential to the posterior iliac cortical bone surface so its relationship with the screwhead and washer are easily seen during final screw tightening. The lateral iliac cortical surface obliquity is matched to the preoperatively measured posterior iliac crest obliquity, while accounting for anticipated changes related to reduction maneuvers prior to or during screw insertion.

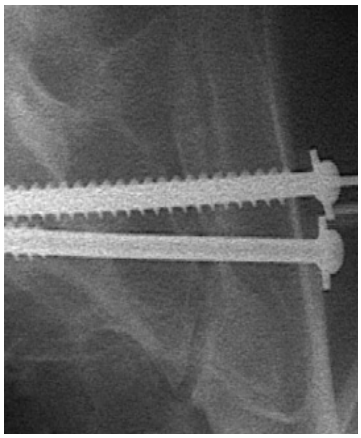


Figure 4: This intraoperative pelvic inlet real time fluoroscopic image demonstrates blunt guide wire palpation of the washer and lateral iliac cortical surface just prior to final screw tightening. Palpation of the washer with a blunt guide pin using real time imaging tangential to the lateral iliac cortical surface provides the surgeon with both visual and tactile information as the screw is tightened.

trajectory while probing washer with blunt probe.

- Postoperative CT scan to assess reduction and hardware placement.

Results

One hundred eighty one screws were inserted in 115 patients during the observation period. Using the described simple preoperative and intraoperative techniques, only three screw washers (1.67%) were noted to partially intrude into the lateral iliac cortical bone surface. In all three, the entire screw head and majority of the washer remained lateral to the cortical bone and only the cranial-anterior portion of the washer partially intruded at the transition area between posterior ilium and iliac wing. There were no failures in fixation or radiographically apparent cases of loss of failure in the observation cohort.

Discussion

Iliosacral screw stability relies on an intimate fit between the screwhead-washer unit and lateral iliac cortical bone surface. Numerous published reports identify iliosacral screw fixation failures but none have identified screw intrusion as potentially responsible for biomechanical failures. Most surgeons rely on tactile sensation to tighten an iliosacral screw, and few series report postoperative pelvic CT scans to assess screw accuracy. To date there are no published reports on the incidence of posterior pelvic ring fixation failure or the rate of lateral screw penetration into the ilium. Our results of greater than 98% accurately placed screws support accurate preoperative measurement of the posterior iliac lateral cortical surface obliquity on the injury pelvic CT scan axial images so that intraoperative fluoroscopy can be adjusted to specifically visualize that surface in profile during screw insertion. Palpation of the screw washer under the same tangential fluoroscopy just prior to final tightening provides the surgeon with both tactile and visual information regarding the screw-washer relationship with the lateral iliac cortical surface. Screw intrusion can thereby be avoided reliably and thus allows the screw to function optimally. This technique adaptation will hopefully decrease fixation failures caused by insufficient lateral iliosacral screw purchase caused by lateral screw intrusion.

References

1. Routt ML, Jr., Simonian PT, Mills WJ. Iliosacral screw fixation: early complications of the percutaneous technique. J Orthop Trauma 1997;11-8:584-9.

2. Routt ML, Jr., Simonian PT. Closed reduction and percutaneous skeletal fixation of sacral fractures. Clin Orthop Relat Res 1996-329:121-8.

3. Griffin DR, Starr AJ, Reinert CM, Jones AL, Whitlock S. Vertically unstable pelvic fractures fixed with percutaneous iliosacral screws: does posterior injury pattern predict fixation failure? J Orthop Trauma 2003;17-6:399-405.

4. Keating JF, Werier J, Blachut P, Broekhuyse H, Meek RN, O'Brien PJ. Early fixation of the vertically unstable pelvis: the role of iliosacral screw fixation of the posterior lesion. J Orthop Trauma 1999;13-2:107-1.

Operative Treatment of Extra-Articular Medial Clavicle Fractures

Winston J. Warme, M.D. and Matthew Jenkins, M.D.

Abstract

- Medial clavicle fractures are rarely encountered, and as such are often under-treated, leading to symptomatic non-unions.
- Surgical treatment can be safely accomplished with the discussed techniques leading to very satisfying results.

Introduction

- Medial clavicle fractures are uncommon injuries, comprising only about 3% of all clavicle fractures. (1) These injuries have been traditionally managed non-operatively, except in cases of open fracture, posterior displacement with airway or vascular compromise, impending skin penetration, and symptomatic nonunion (2) Due to the rarity of this injury, literature on treatment outcomes is sparse. The available retrospective series describe up to a 50% incidence of poor outcomes with non-operative treatment, with the incidence of nonunion of up to 15% for medial fractures treated without surgery. (2) Operative treatment is rarely considered as surgeons are unfamiliar with operating in this area. A recent report has shown encouraging outcomes with early operative treatment for displaced medial clavicle fractures. (3)
- A common problem with many peri-articular fractures is the bone available for fixation on the articular fragment is limited. One solution to this problem in medial clavicle fractures is to use a plate designed for peri-articular fixation. A T-plate designed for the distal radius can be easily contoured to fit the medial clavicle using the multiple holes at the end of the plate to provide increased options for fixation in the smaller medial fragment. The end of the plate can then be bent in such a fashion that is creates converging screw fixation in the medial fragment from both superior and inferior angles, allowing for interfragmentary compression as well as hardware interdigitation and the ability for the construct

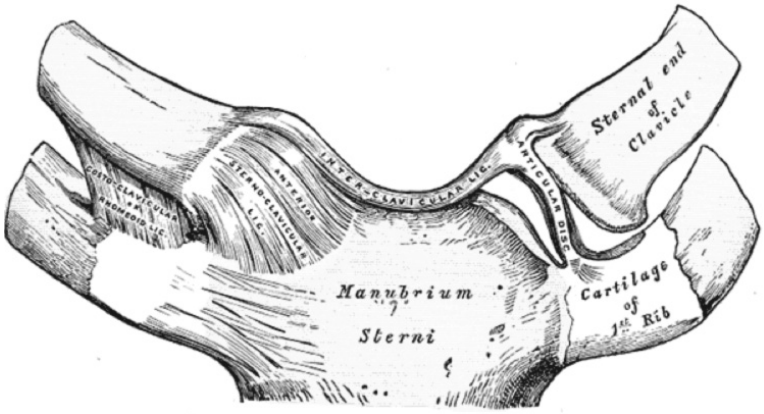


Figure 1A: Anatomy of the manubrium and medial clavicles. (From Gray's Anatomy 20th ed. USA 1918.)

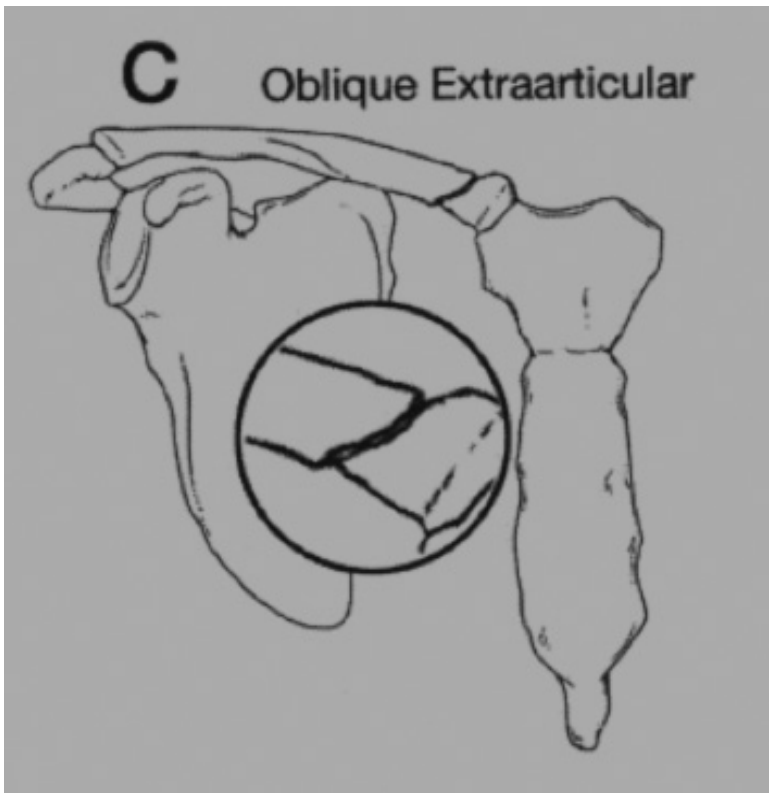


Figure 1B: Oblique extra-articular fracture. (From Reference 1.)

Figure 2: Visible anterior deformity of medial clavicle fracture non-union.

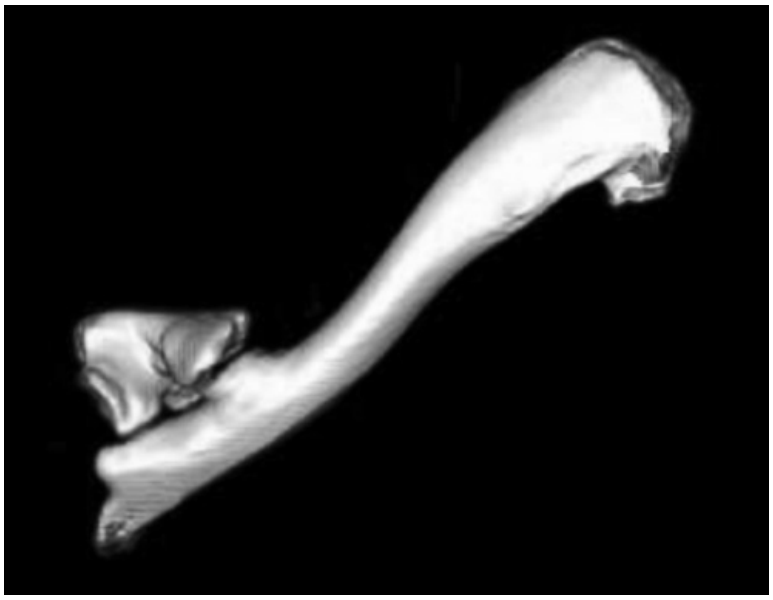


Figure 3: CT 3D Reconstruction of nonunion viewed from the superior aspect.

to better resist displacement forces when the patient begins active motion of the shoulder.

- Knowledge of the local anatomy and the fracture pattern can assist in reducing the fracture and maintaining the bone in a stable position for plate fixation. The displacement of clavicular shaft in extra-articular fractures is typically anterior and medial due to the pull of the pectoralis major with the proximal fragment stabilized by the sternoclavicular ligaments and the sternocleidomastoid muscle, Figure 1. In oblique extra-articular fractures, the obliquity of the fracture allows shortening and the bone may require significant lengthening in order to achieve reduction. Intraoperative neuromuscular relaxation may be helpful in this situation.
- The medial end of the clavicle has numerous soft tissue attachments that stabilize it in place. The rhomboid, or costoclavicular ligament on the infero-medial surface is broad and stabilizes the medial clavicle to the first rib costal cartilage and likely determines the propagation of the oblique fracture line, which remains anterior and lateral to this ligament. On the supero-medial aspect, the attachment site of the interclavicular ligament (Figure 1A) and sternocleidomastoid creates an area of increased cortical thickness that often remains intact in a Throckmorton Type C (Oblique Extra-articular) fracture, (Figure 1B). This may have the appearance of an anterior "knob" of bone which can be useful to "key in" to the corresponding hole on the anterior side of the more medial fracture fragment. Often, this fit will hold the fracture reduced while fixation is placed.
- Great care needs to be taken with operative management of this fracture type due to the proximity of the subclavian and innominate veins. Vascular surgery back up is routinely arranged.

Material / Methods

- Surgical Case: A 63 year old woman who works as an ICU nurse presented to our institution for a consultation regarding her left medial clavicle fracture. She was involved in a bicycle accident two years prior to presentation in which she fell onto her left shoulder. Non-operative treatment had failed, and consultations elsewhere recommended against surgery, leaving her with painful motion at the fracture site and a visible anterior deformity (Figure 2).
- The fracture was approached through a necklace skin incision placed in Langer's lines for cosmesis. The clavipectoral fascia was split longitudinally and the nonunion site exposed with sub-periosteal dissection. After thorough release of the lateral fragment from the fibrous callus, the fracture was able to be reduced, keying in the notch in the anterior cortex of the lateral fragment with the "thumb" of bone at the site of the interclavicular ligament attachment on the anterosuperior aspect of the medial fragment. Hypertrophic

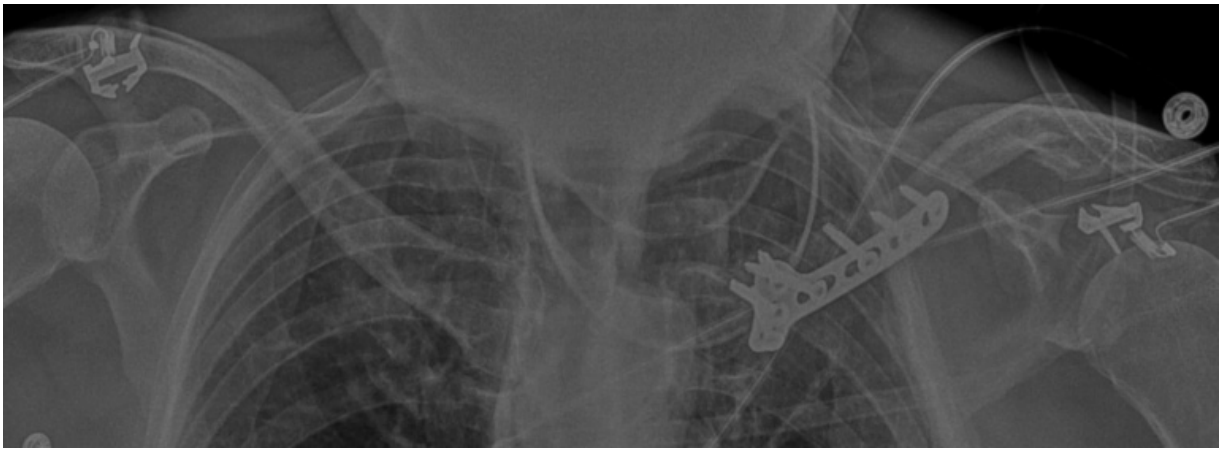


Figure 4: Post-operative chest x-ray demonstrating the fixation as well as an old asymptomatic distal clavicle fracture.

Figure 5: Cosmetic final result.

excess bone was removed with a rongeur, morcellized, and placed as bone graft.

- The obliquity of the fracture allowed for placement of four interfragmentary 3.5mm cortical lag screws on the medial end of the distal radius T-plate, which had been contoured to wrap around the superior and inferior aspects of the medial clavicle. 3.5mm bicortical screws were placed in the remaining lateral holes in the shaft of the clavicle. After testing the construct for stability, the wound was irrigated and closed with a running non-absorbable subcuticular stitch. A chest x-ray was obtained in recovery (Figure 4).

Results

- Post-operatively, the patient was placed in a sling for 6 weeks and allowed to lift no object heavier than a coffee cup during that time. We also counsel these patients to avoid lying on the affected side to avoid axial loading of the clavicle, which could create undue stress on the fixation. At 2 week follow-up the patient reported complete relief of her prior symptoms of painful motion and deformity of her medial clavicle with use of her arm. She regained full use of her upper extremity and returned to nursing at 3 months, with a very cosmetic result (Figure 5).

Discussion

- In summary, these fractures can be very amenable to surgical intervention. Careful subperiosteal elevation of the medial clavicle fragment, sparing the costoclavicular and sternoclavicular ligaments, safely allows for direct visualization of the screws inserted with posterior retractors placed to protect the proximate vasculature.

References

1. Throckmorton T, Kuhn J. Fractures of the medial end of the clavicle J Shoulder Elbow Surg. 2007 Jan-Feb;16(1):49-54.

2. Robinson CM, Court-Brown CM, McQueen MM, Wakefield AE. Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture. J Bone Joint Surg Am. 2004;86:1359 –1365.

3. Low K et al. Operative outcome of displaced medial-end clavicle fractures in adults. J Shoulder Elbow Surg. 2008 Sep-Oct;17(5):751-4. Epub 2008 May 21.

Traumatic Dural Tears: What Do We Know and Are They a Problem?

Myles Luszczyk, D.O., Gregory Blaisdell, M.D., Brett Wiater, M.D., Carlo Bellabarba, M.D., Jens R. Chapman, M.D., Julie Agel, M.A., and Richard J. Bransford, M.D.

Study Rationale

- Iatrogenic dural tears are common complications encountered in spine surgery with known ramifications. The incidence of iatrogenic durotomy during elective spine surgery has been reported to occur at a rate of 1-16% and appears to be higher in cases of revision surgery or previously irradiated spines.[1-3] The most common is persistent CSF leak leading to pseudomeningocele and/or chronic wound drainage occurring at a rate of 2-3 %.[1-3]
- Traumatic lacerations of the dura are commonly associated with spine injuries with reports ranging from 18-36%. The classic fracture pattern most associated with traumatic tears are lumbar burst fractures with associated vertical lamina fractures in which the dura may become trapped.[4-5]

Research Question

- What are the demographics and nature of traumatic dural tears?
- What is the complication rate associated with traumatic dural tears in patients who have undergone surgical treatment for spine injuries?

Materials and Methods

- The prospectively collected trauma registry at a level I trauma center was assessed to identify all traumatic spine fractures managed operatively between January 1st, 2003 and Dec 31st, 2009.
- A total of 1,615 operatively managed, traumatic spine cases were reviewed. Operative reports for each case were scrutinized for any evidence of a traumatic dural tear mentioned in the body of the report and were subsequently classified.
- Complications related to the traumatic dural tears were documented as was the treatment and outcome of the tear.
- Documentation of the preoperative neurological status was stratified into complete (ASIA A), incomplete (ASIA B-D) and no neurological injury (ASIA E).
- The surgical method used to address the dural tear was also documented. Tears were repaired using suture, fibrin sealants, commercial collagen matrix, fascia, fat, muscle or absorbable sponges. These products were used either alone or as a combination in an attempt to achieve a watertight seal.

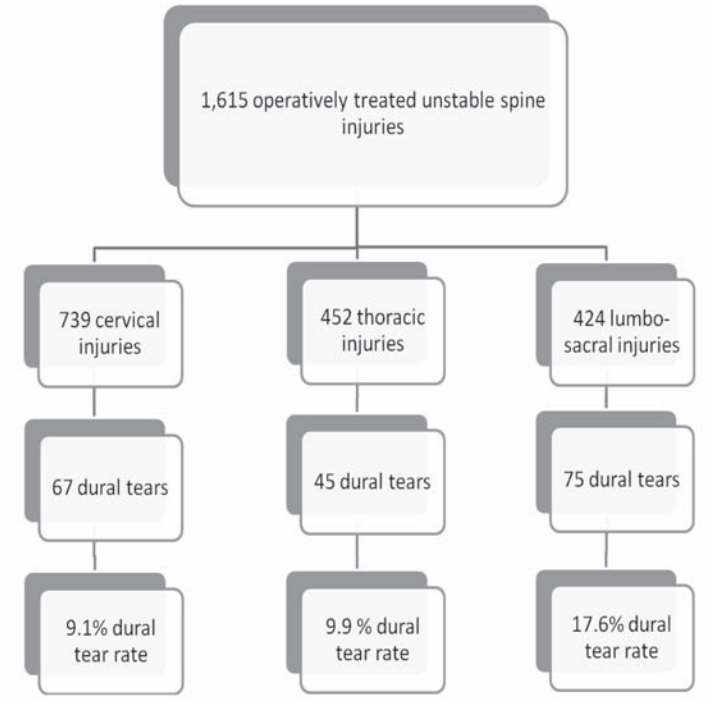


Figure 1: Description of incidence of traumatic dural tears by fracture level.

Results

- Of the 1,615 operatively managed spine injuries treated operatively at our facility, 739 involved injuries to the cervical spine, 452 to the thoracic spine, and 424 to the lumbar spine. Traumatic dural tears occurred in 67/739 cervical spine injuries (9.1%), 45/452 (9.9%) thoracic spine injuries, and 75/424 (17.6%) lumbosacral spine injuries, for a total of 187/1615 (11.6%) patients with traumatic dural tears (Figure 1).
- Fracture patterns and complications in our patient population with traumatic dural tears are represented in Figures 2-4.

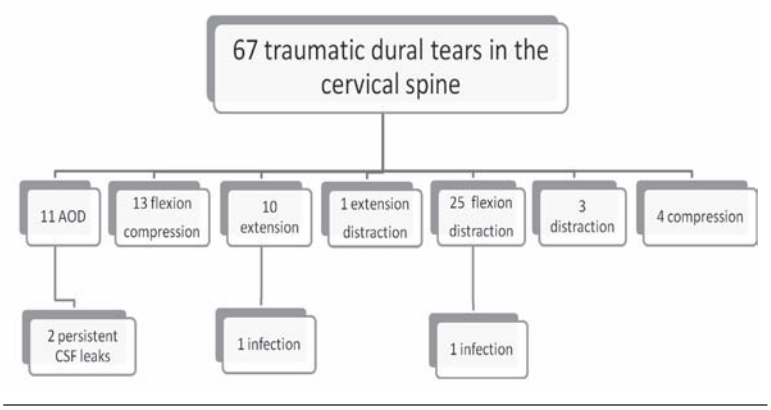


Figure 2: Description of traumatic dural tears in the cervical spine by fracture pattern.

- Thirty two (17.1%) of patients with traumatic dural tears were neurologically intact (ASIA E). The remaining 64 (34.2%) patients with dural tears were noted to have incomplete neurological injuries (Figure 5). Figure 6 illustrates the breakdown of preoperative neurological injuries into individual regions of the spine.
- In assessing the dural lacerations, 104 were described as complex and 83 were described as simple in nature. 157 involved tears of the main central dura and 30 involved tears along the root sleeves. In assessing location, 14 were primarily anterior, 126 were primarily posterior, and 47 had both anterior and posterior components.
- 2.1% (4/187) of patients with traumatic dural tears were noted to have a complication directly attributable to the dural tear: two patients developed a persistent CSF leak that necessitated an irrigation and debridement with exploration and closure of the CSF leak and two patients developed a pseudomeningocele: one required a return to the operating room for irrigation and debridement, and the other was suspected of having developed meningitis and treated with intravenous antibiotics.
- Ten of the 187 total patients (5.3%) with traumatic dural tears required an irrigation and debridement secondary to a wound infection.

Discussion

- The incidence of dural tears was 9.1% in the cervical spine, 9.9% in the thoracic spine and 17.6% in the lumbosacral spine for an overall incidence of 11.6%.
- Our study demonstrated a high rate of neurological injury in the setting of traumatic dural tears. We observed a neurological deficit in 83% of patients who sustained a traumatic dural tear as a result of a spine injury with 48.7 % of patients sustaining complete neurological injuries.
- This study demonstrated an overall direct complication rate of 2.1% in patients (4/187) who sustained traumatically induced dural tears as a result of spine injuries. This is similar to that described in the iatrogenically created dural tear literature with rates of 1.8% described by Khan [1], 3.4% by Wang [2], and 7.6% described by Cammisa [3].

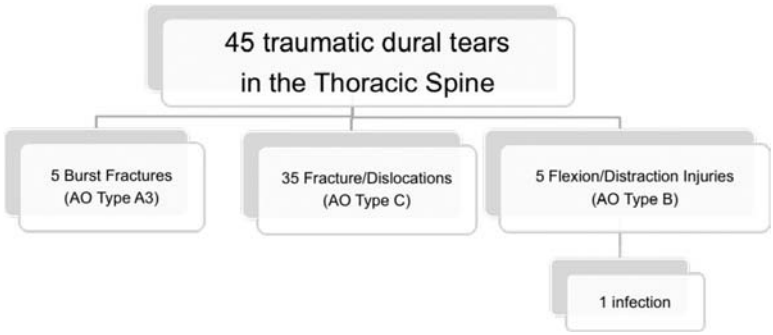


Figure 3: Description of traumatic dural tears in the thoracic spine by fracture pattern.

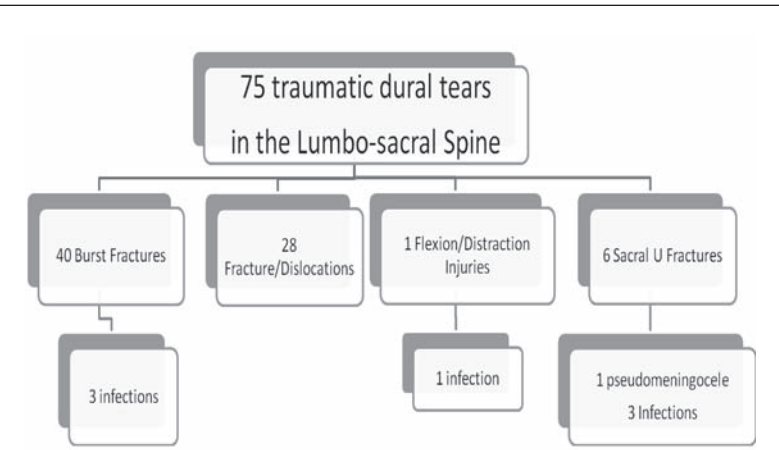


Figure 4: Description of traumatic dural tears in the lumbo-sacral spine by fracture pattern.

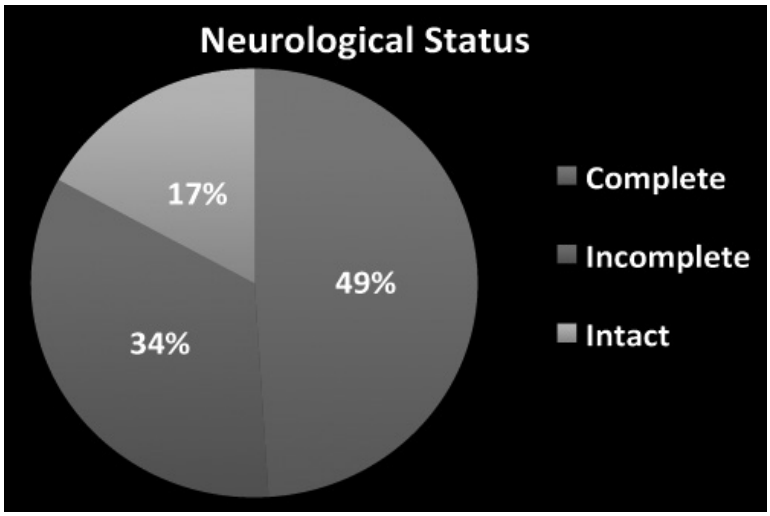


Figure 5: Pie chart depicting neurological status of patients with dural tears.

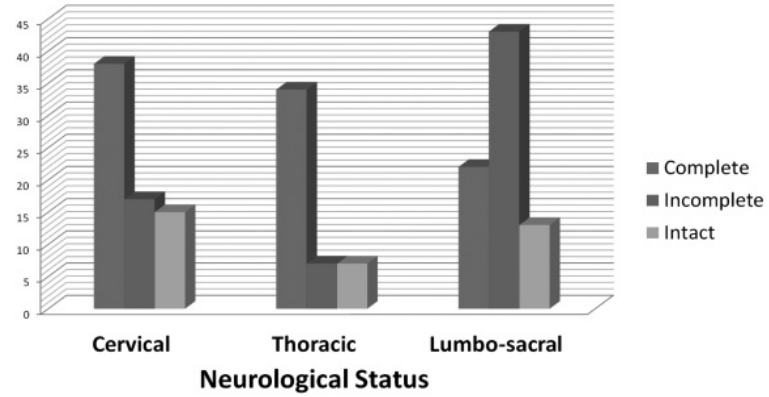


Figure 6: Bar chart depicting neurological status of patients with dural tears by fracture level.

- Though impossible to ascertain with the current study's methodology, our experience suggests that traumatic dural tears are generally more complex than iatrogenically created dural tears. The fact that postoperative complications related to CSF leakage were noted to be similar to those reported for iatrogenic dural tears suggests that traumatic CSF leaks may have a lower propensity for complications when normalized for severity or complexity of the tear.

References

1. Khan M, Rihn J, Steele G, et al. Postoperative Management Protocol for Incidental Dural Tears During Degenerative Lumbar Spine Surgery. Spine. 2006; 31:2609-13.

2. Wang J, Bohlman H, Riew K. Dural tears secondary to operations on the lumbar spine. Management and results after a two-year-minimum follow-up of eighty-eight patients. J Bone Joint Surg Am. 1998;80:1728-32.

3. Cammisa F Jr, Eismont F, Green B. Dural laceration occurring with burst fractures and associated laminar fractures. J Bone Joint Surg Am. 1989;71:1044-52.

4. Cammisa F Jr, Girardi F, Sangani P, et al. Incidental durotomy in spine surgery. Spine. 2000;25:2663-7.

5. Aydinli U., Karaeminoğullari O, Tiskaya K, et al. Dural tears in lumbar burst fractures with greenstick lamina fractures. Spine. 2001;26:E410-5.

Risk Factors for Readmission of Orthopaedic Surgical Patients

Elizabeth A. Dailey, M.D., Amy Cizik, M.P.H., Jesse Kasten, M.A., Jens R. Chapman, M.D., and Michael J. Lee, M.D.

Introduction

There is a strong sense of urgency to decrease the incessant rise of healthcare costs in the United States of America through increased emphasis on 'quality' and 'value'. Steadily improving data gathering and analysis tools allow for unprecedented insight opportunities into many hitherto obscure aspects of health care delivery. In the laudable quest for 'quality in medicine' a priority emphasis has been placed on identifying parameters reflective of '*patient safety*' and '*quality*'.

In this search for quality and patient safety parameters unplanned hospital readmissions are one of the key indicators of possibly poor quality of care. Hospital readmissions are an event which can be reasonably easily captured through already utilized software programs feeding into existing databases such as the Comprehensive Hospital Abstract Reporting System (CHARS), which has been operational since 1987 in many states and on a federal level. These database systems have been upgraded repeatedly over the years and capture diagnosis related groups (DRG), create hospital based case mix indices and attempt to quantify access to care, quality of care and are used to implement cost containment.

Likely applications of insights gained from such databases include 'pay for performance' (P4P) or 'value-based purchasing' or conversely penalties for 'underperforming' medical centers. With such impactful developments in health care underway a critical assessment of variables which may affect hospital readmissions beyond pure care delivery warrant closer review in order to assure proper weighting of case mix indices and risk factor adjustments.

Research Question

Do sociodemographic variables such as ethnicity, marital status and income affect hospital readmission rates in an orthopaedic population? Are there medical predictors affecting hospital readmission beyond ICD-9 diagnosis categories and general comorbidity coefficients?

Materials and Methods

- All 3,264 orthopaedic surgical admissions during fiscal years 2009-2010 were retrospectively reviewed from the hospital's quality improvement database.
- Risk factors examined included age, gender, race, length of stay, ICU stay, diagnosis of diabetes, alcohol and tobacco use, disposition from hospital, insurance and marital status.
- Cases of readmission within 30 days underwent univariate and multivariate analysis to determine odds ratios (OR) for readmission.

Results (Table 1)

- The rate of unplanned 30-day readmissions was 3.8% (138 patients).
- Any ICU stay gave the highest OR of readmission (OR, 2.429; 95% CI, 1.25-1.31; p=0.001).
- Mean length of stay was 5.9 days in the unplanned readmission group, and was significantly longer than 3.6 days for patients not readmitted (p=0.002).
- Widowed marital status significantly increased the risk of readmission (OR, 1.821; 95% CI, 1.057-3.137; p=0.03).
- Race significantly increased odds of readmission in patients identified as Black or African-American (OR, 2.1; 95% CI 1.077-4.408, p=0.03), or American Indian or Alaskan Native Race (OR, 3.55;95% CI 1.429-8.815; p=0.006).
- Medicaid insurance status approached significance (OR 1.547; 95% CI 0.941 – 2.545; p=0.09).

Discussion

This study identified important covariables previously not addressed

Risk Factors	Odds Ratio	95% CI		p-value
ICU Stay	2.356	1.361	4.079	0.002
Length of Stay, mean (sd)	1.038	1.014	1.062	0.002
Widowed	1.846	1.070	3.184	0.03
Medicaid	1.547	0.941	2.545	0.09
Black or African American Race	2.178	1.077	4.408	0.03
American Indian or Alaskan Native Race	3.550	1.429	8.815	0.006

Table 1: Multivariate Analysis of Unplanned Readmissions following any Orthopaedic Surgical Admission.

in the weighting of 30 day readmission rates when used as a quality indicator measure in health care. Current data gathering has struggled to adequately quantify underlying patient illness as one of the seminal modifiers of length of stay and readmission rates. We found a strong correlation of admission to an ICU and length of stay in an ICU with underlying baseline patient illness and complexity of care provided. Based on our findings we recommend capturing this important variable in any readmission studies in order to provide proper weighting and risk adjustment.

In addition we found important socio-demographic risk factors to be present, neither of which are being captured in current database tools. Widowed marital status and African-American as well as Native American ethnicity were at statistically significantly increased risk for readmission in our study. Underlying causes for these findings are currently unknown, but may reflect insufficient availability of post-discharge care and other factors. These findings encourage us to study the underlying causes for readmission in closer detail.

The current use of some health care 'quality indicators' such as 'unplanned 30 day readmission rates' deserves further refinement in order to properly calculate important risk variables such as socio-demographic factors and underlying baseline health status as well as complexity of treatment. It stands to reason that current datacapture does not take some of these risk factors for unplanned hospital readmission into adequate consideration. Consequences of such incomplete risk adjustments for readmissions could be grave, for instance by reducing access to care for at-risk patients and infrastructural degradation of affected medical centers through reduced reimbursement and poor hospital ratings.

Important insights into improved outcomes may be gained by a better understanding of the causes for readmissions. Currently causes for hospital readmissions are poorly studied and deserve further investigation to improve healthcare outcomes of patients.

References

1. Allaudeen, N.; Vidyarthi, A.; Maselli, J.; and Auerbach, A.: Redefining readmission risk factors for general medicine patients. Journal of hospital medicine : an official publication of the Society of Hospital Medicine, 6(2): 54-60, 2010.

2. Billings, J.: Case finding for patients at risk of readmission to hospital: development of algorithm to identify high risk patients. BMJ, 333(7563): 327-0, 2006.

3. Bini, S. A.; Fithian, D. C.; Paxton, L. W.; Khatod, M. X.; Inacio, M. C.; and Namba, R. S.: Does discharge disposition after primary total joint arthroplasty affect readmission rates? The Journal of Arthroplasty, 25(1): 114-117, 2010.

4. Bohm, E. R.; Dunbar, M. J.; Frood, J. J.; Johnson, T. M.; and Morris, K. A.: Rehospitalizations, Early Revisions, Infections, and Hospital Resource Use in the First Year After Hip and Knee Arthroplasties. The Journal of Arthroplasty, 2011.

5. Bozic, K. J.; Maselli, J.; Pekow, P. S.; Lindenauer, P. K.; Vail, T. P.; and Auerbach, A. D.: The influence of procedure volumes and standardization of care on quality and efficiency in total joint replacement surgery. The Journal of Bone and Joint Surgery, 92(16): 2643-2652, 2010.

6. Coley, K. C.; Williams, B. A.; DaPos, S. V.; Chen, C.; and Smith, R. B.: Retrospective evaluation of unanticipated admissions and readmissions after same day surgery and associated costs. Journal of clinical anesthesia, 14(5): 349-353, 2002.

Role of the Tumor Suppressor Prolyl 3-Hydroxlyase 2 in the Post-Translational Modification of Collagen: Clues from Research on an Osteosarcoma Cell-Line

Russell J. Fernandes, Ph.D., Mary Ann Weis, B.S., Geoffrey R. Traeger, Alex W. Farnand, and David R. Eyre, Ph.D.

Abstract

The estrogen-receptor-positive human osteosarcoma-derived cell line SAOS-2, exhibits many of the phenotypic characteristics of osteoblasts including the deposition of types I and V collagens in an extracellular matrix. When P3H2 expression was turned off, as we have discovered is natural for these cells, mass spectrometric analysis showed 3-Hydroxyproline (3Hyp) occupancy at P986 in α1(I) collagen chains was unaffected, whereas 3-hydroxylation of residue P944 in the α2(V) collagen chain was largely lost and 3-hydroxylation of P707 in α2(V) and α2(I) collagen chains sharply reduced. The results imply that P3H2 has preferred substrate sequences among the classes of 3Hyp sites type I and type V collagen chains. The findings open new avenues of research into the role of this collagen-modifying enzyme in sarcoma tumorigenesis, proliferation and metastasis in the field of orthopaedic oncology.

Introduction

Epigenetic inactivation of prolyl 3-hydroxylase 2 in human estrogen-receptor-positive breast cancer cells, implies that this gene family represents a novel class of tumor suppressors (1). Genomic database analyses indicate the presence of three isoenzymes in the vertebrate prolyl 3-hydroxylase family, P3H1, P3H2 and P3H3, encoded by the genes *LEPRE1*, *LEPREL1* and *LEPREL2* respectively in humans (2). Prolyl 3-hydroxlase 1 (P3H1) another member of the 2-oxo-glutarate dependent dioxygenase family catalyzes the post-translational 3-hydroxylation of proline residue 986 (P986) in fibril forming collagens. The function of P3H2 is not clear. The presence of conserved residues in the catalytically important 2-oxo-glutarate dependent dioxygenase domain suggest that P3H2 and P3H3 may well be involved in the 3-hydroxylation of proline residues in additional chains of the collagen family, for example type IV collagen chains.

The fibrillar collagen types I, II and V/XI have recently been shown to have partially 3-hydroxylated proline (3Hyp) residues at sites other than the established primary P986 site in the collagen triple helical domain. These sites showed tissue specificity in degree of hydroxylation and a pattern of D-periodic spacing (3). This suggested a contributory role in fibril supramolecular assembly (Figure 1). The sites in clade-A fibrillar α1(II), α2(V), and α2(I) collagen chains share common features with known prolyl 3-hydroxylase 2 (P3H2) substrate sites in α1(IV) chains implying a role for this enzyme. We hypothesized that P3H2 was responsible for the 3-hydroxylation of proline at these candidate substrate sites.

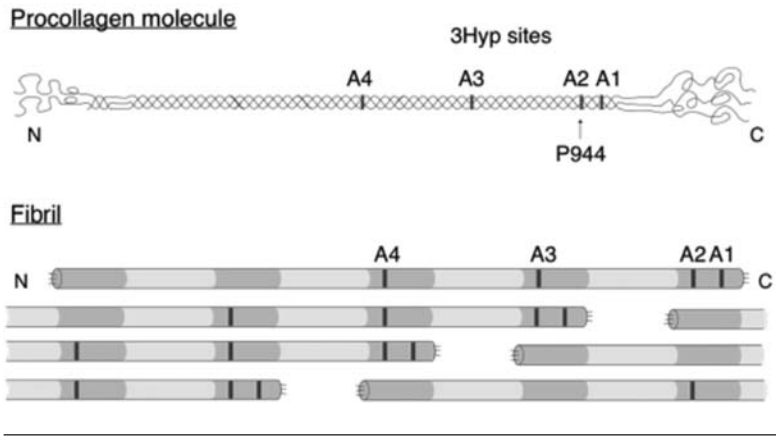


Figure 1: The potential 3Hyp sites on a procollagen molecule and how axial relationships required for tri-functional intermolecular cross-links form in collagen to produce the collagen fibril is illustrated.

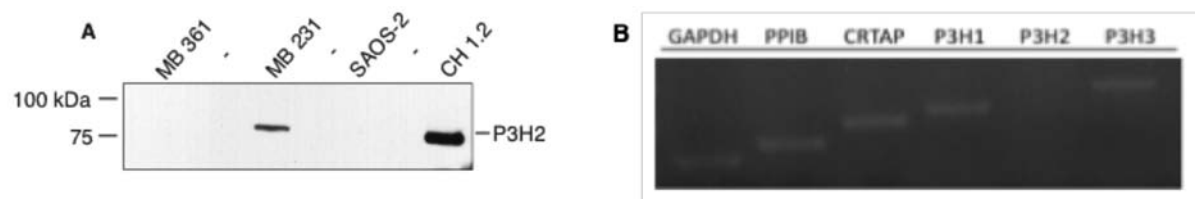


Figure 2: Expression of *PPIB*, *CRTAP*, *P3H1*, *P3H2*, *P3H3* in the SAOS-2 cell line. (A) Cell lysates from MBA 361 and MBA 231 human breast cancer cells, CH1.2 human chondrosarcoma cells and SAOS-2 human osteosarcoma cells were probed with P3H2 antibody on western blots. The antibody failed to detect P3H2 protein in the MBA 361 and SAOS-2 cells. (B) RT-PCR expression studies confirmed the lack expression of *P3H2* by SAOS-2 cells. *P3H1*, *CRTAP*, *PPIB* and *P3H3* were strongly expressed.

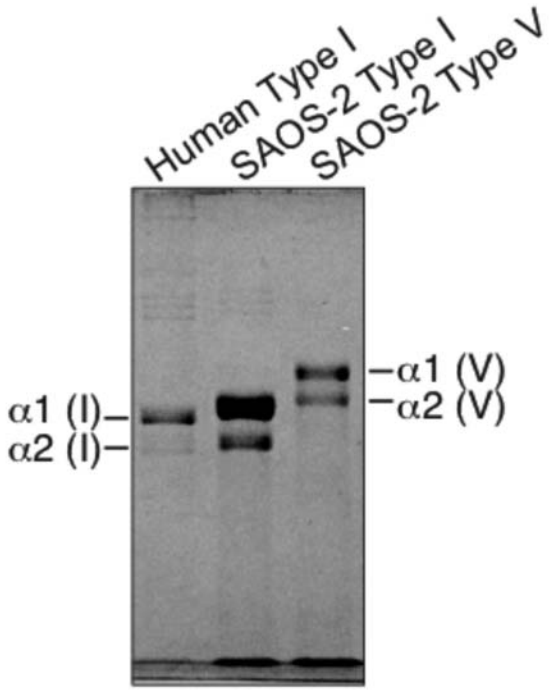


Figure 3: Coomassie Blue stained gel showing purified type I collagen (middle lane) and type V collagen (last lane) from the extracellular matrix of the SAOS-2 cell line in culture. For comparison, human type I collagen was also electrophoresed (first lane). The α1(I), α2(I) and the α2(V) bands were cut out and analyzed by mass spectrometry.

Methods

• Cell culture: The SAOS-2 cell line was maintained as monolayer cultures for a month in McCoys media containing 10% FBS and 50 μg/ml ascorbate (4).

• Gene expression analysis:

SAOS-2 cell total RNA was obtained from the cells using the RNeasy kit. cDNA was generated from 2μg RNA using the High Capacity cDNA Reverse Transcription Kit. cDNA, as generated above, was used to generate gene products.

• Immunoblot analysis: Total lysates from plates of cultured cells were prepared by adding RIPA buffer containing protease inhibitors. Equal aliquots of protein in samples were separated by SDS-gelelectrophoresis on 6% polyacrylamide gels, and transferred to PVDF membranes and probed according to standard procedures using P3H2 antibody.

• Collagen extraction and purification: After a month in culture, the SAOS-2 cell layers were extracted with 1M NaCl, 50 mM Tris, pH 7.5, containing protease inhibitors for 2 days at 4 °C, followed by centrifugation. The residue was further digested with 0.1 mg/ml pepsin in 0.5M acetic acid for 24 hours at 4 °C to solubilize the cross-linked collagen. Types I and V collagens were precipitated from the pepsin digest at 0.8M and 2.2M NaCl respectively and harvested by centrifugation and analyzed by SDS-gel electrophoresis.

• Gel electrophoresis and Mass Spectrometry: Collagen chains were resolved by SDS-PAGE gel electrophoresis under reducing conditions and identified by staining with Coomassie Blue. Individual collagen α-chains were cut out and subjected to in-gel trypsin digestion. Electrospray MS was performed on the tryptic peptides using an LCQ Deca XP ion trap mass spectrometer equipped with in-line liquid chromatography. Sequest search software was used for peptide identification using the NCBI protein database. The percentage 3-hydroxylation at a particular site was determined from the abundance of the 3Hyp-containing ion as a fraction of the sum of both 3Hyp and Pro versions of the same tryptic peptide.

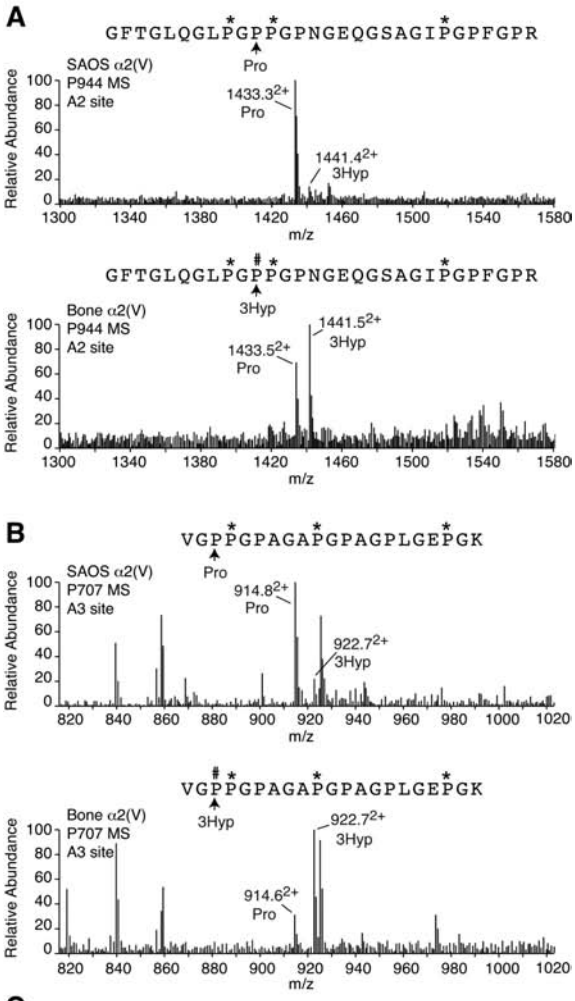
Results

Based on a recent report that P3H2 is epigenetically silenced and could act as a tumor suppressor in some breast cancer cells (1), we investigated an osteosarcoma cell line that we have previously shown to synthesize and post-translationally modify type I collagen cross-linked in the extracellular matrix (4). RT-PCR confirmed the absence of P3H2 message in SAOS-2 cells while P3H1, PPIB, CRTAP and P3H3 were robustly expressed (Figure 2A). Next, cell lysates of cultured human breast cancer, chondrosarcoma and osteosarcoma cells were screened for P3H2 protein on western blots. Figure 2B shows P3H2 protein detected in a lysate of the MB 231 breast cancer cells as expected since these cells are reported to express this gene (1). P3H2 was also detected in CH1.2 cells, a human chondrosarcoma cell line. Figure 2A also shows that P3H2 protein was not detected in a lysate of SAOS-2 osteosarcoma cells. The specificity of the antibody to P3H2 was confirmed when P3H2 was not detected in a lysate of MB 361 breast cancer cells (Figure 2A). The P3H2 gene is reported to be epigenetically silenced in these cells (1).

Purified collagen from the matrix laid down by SAOS-2 cells revealed type I and type V collagen chains on electrophoresis as expected for an osteoblast phenotype (Figure 3). Since the α2(V) collagen chain (from human bone) had the most complete pattern of occupation of 3Hyp residues at sites A1, A2, A3 and A4 of all clade-A collagen chains (3), the pattern of occupancy of α2(V) from SAOS-2 cultures was assessed. Figure 4A, B shows 12.5% 3-hydroxylation of P944, and 18% of P707 hydroxylated compared with α2(V) from normal human bone (59% and 70% respectively). Figure 4C summarizes the results and shows that P986 in α2(V) was unaffected compared with normal bone. As in normal bone, α1(I) from SAOS-2 cells was fully hydroxylated at P986 and no 3Hyp was detected in the GPP repeat at its C-terminus or that of α2(V) chains.

Discussion

The current findings implicate P3H2 as the enzyme responsible for the 3-hydroxylation of the proline residue, P944 at the A2 site in clade-A collagen chains, hitherto an unknown function. In the SAOS-2 cells, clearly, a loss in P3H2 protein leads to a significant



C

Chain	Site	% 3Hyp Occupancy	
		Bone	SAOS
α2(V)	A4	14	17
	A3	76	18
	A2	59	12.5
	A1	98	98
	C-terminus $(GPP)_4$	0	0
α2(I)	A3	82	58
	A2	0	0
	C-terminus $(GPP)_4$	0	0
α1(I)	A1	98	98
	C-terminus $(GPP)_5$	0	0

Figure 4: Tandem mass-spectrometric analysis of the chains from clade-A collagen from the SAOS-2 cell line. A) α2(V) chains from the SAOS-2 cell line were compared to human bone. Full scan mass spectra from the tryptic peptide LC-MS profiles of α2(V) across the elution window of the post-translational variants containing P944 (A2) and B) for P707 (A3) are shown. C) Summary of % prolyl 3-hydroxylation levels at sites in α2(V), α1(I) and α2(I) collagen chains from SAOS-2 and normal human bone.

loss of 3Hyp at the A2 site in α2(V) as seen in Figure 4. The residual 3Hyp detected here is not atypical in collagen chains isolated from cell cultures. Further, since the 3-Hyp occupancy at the primary A1 site at P986 was unaffected in α2(V) and α1(I) (Figure 4C), the effect of reduced P3H2 enzyme activity is specific for non-A1 sites. Based on this finding, we have published that P3H2 specific RNAi can modulate gene expression and protein synthesis in a rat chondrosarcoma cell line (RCS-LTC) and this consequently modifies the 3-hydroxylation of proline at similar sites in the α1(II) chain of type II collagen, another member of the A-clade (5).

Our finding, that the expression of P3H2 a tumor suppressor protein, previously considered silenced only in some breast cancer cell lines, also fails to be synthesized in a human osteosarcoma cell line is interesting from an orthopaedic oncologist's point of view. Establishing whether other skeletal sarcomas also fail to express P3H2 and the role of this post-translational collagen-modifying enzyme in tumorigenesis, proliferation and metastasis warrants further investigation.

Acknowledgements

This work was supported in part by NIH (NIAMS) grants AR057025 to R.J.F. and AR036794 to D.R.E. and the Ernest M. Burgess Endowed Chair research program at the University of Washington.

References

1. Shah, R., Smith, P., Purdie, C., Quinlan, P., Baker, L., Aman, P., Thompson, A. M., and Crook, T. (2009) The prolyl 3-hydroxylases P3H2 and P3H3 are novel targets for epigenetic silencing in breast cancer. Br J Cancer 100, 1687-1696.

2. Jarnum, S., Kjellman, C., Darabi, A., Nilsson, I., Edvardsen, K., and Aman, P. (2004) LEPREL1, a novel ER and Golgi resident member of the Leprecan family. Biochem Biophys Res Commun 317, 342-351.

3. Weis, M. A., Hudson, D. M., Kim, L., Scott, M., Wu, J. J., and Eyre, D. R. (2010) Location of 3-hydroxyproline residues in collagen types I, II, III, and V/XI implies a role in fibril supramolecular assembly. J Biol Chem 285, 2580-2590.

4. Fernandes, R. J., Harkey, M. A., Weis, M., Askew, J. W., and Eyre, D. R. (2007) The post-translational phenotype of collagen synthesized by SAOS-2 osteosarcoma cells. Bone 40, 1343-1351.

5. Fernandes, R. J., Farnand, A. W., Traeger, G. R., Weis, M. A., and Eyre, D. R. (2011) A role for prolyl 3-hydroxylase 2 in post-translational modification of fibril-forming collagens. The Journal of biological chemistry 286, 30662-30669.

Utility of Flexion, Extension, AP and Open Mouth Views in Assessment of Down Syndrome Patients

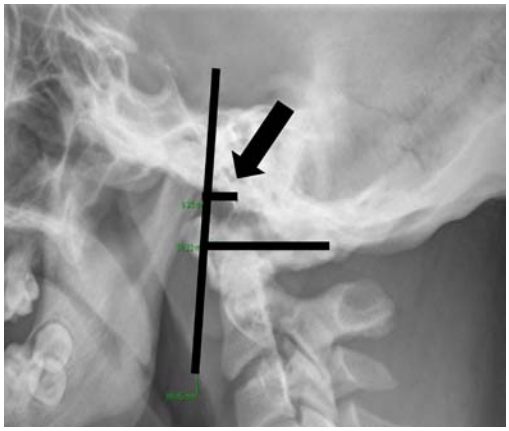
Walter F. Krengel, M.D., Sid Baucom, M.D., and Sam Browd, M.D., Ph.D.

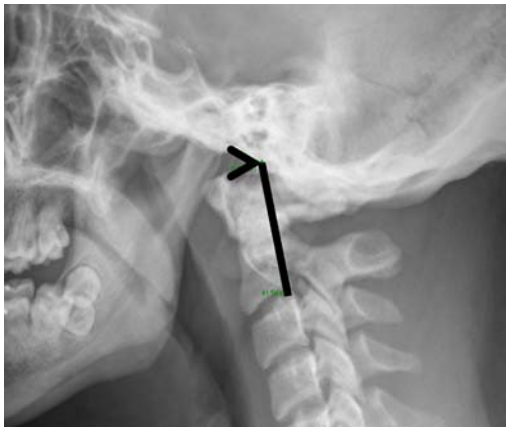
Introduction

Patients with Trisomy 21 (Down Syndrome, DS) develop Atlantoaxial Instability with the potential to create Spinal Cord Injury through acute or subacute compressive trauma. Isolated Atlanto-Occipital instability may also occur but appears to be rarely symptomatic or associated with Spinal Cord Injury. Clinical screening of patients with Down Syndrome for symptoms or signs of cervical instability or myelopathy is difficult and unreliable. There is considerable debate about the utility of obtaining routine screening cervical spine xrays prior to surgery or sports participation, but most authors who recommend x-rays suggest lateral flexion/extension films. However, obtaining flexion and extension views in patients with significant stenosis or instability could potentially be harmful. We performed this study to look at the utility of flexion / extension x-rays as opposed to a simple neutral lateral x-rays for the detection of "at-risk" radiographic signs of instability in patients with Down Syndrome.

Method

Retrospective review of patients having cervical Spine radiographs between 1/1/2007 and 9/30/2011, where "Down Syndrome", "Trisomy 21", or "Down(s)" was listed as indication were identified from radiological records. Atlas-Dens Interval (ADI), Space available for cord (SAC), Basion-Axis Interval (BAI), and Weisel-Rothman (WR) measurements were made on all films where adequate visualization was present, the measurements were recorded to 0.01mm, and rounded to the nearest 0.1mm. Clinical review of patients for the presence or absence of myelopathic findings or a recommendation for surgical intervention is planned but pending. At-Risk radiographic criteria were based on previous literature review, and included, the presence of Os Odontoideum, SAC ≤ 14mm, ADI ≥ 6mm, BAI (Basion-Axial Interval) of >12mm, or the Weisel-Rothman





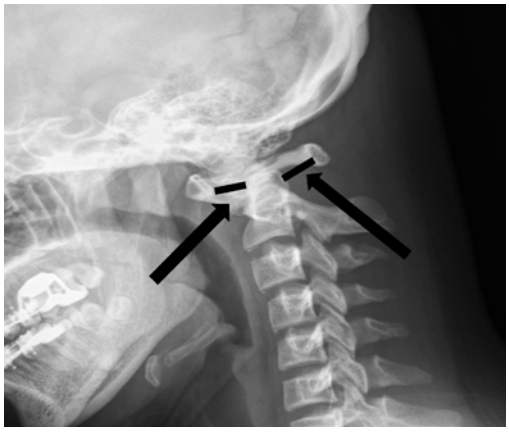


Figure 1 (top): Wiesel-Rothman measure: distance between basion and a line drawn perpendicular to the atlas, intersecting the posterior cortex of the anterior atlas.

Figure 2 (middle): Basion-Axial Interval: Measure from basion to extension of posterior axial line.

Figure 3 (bottom): Patient with AA instability noted on neutral lateral x-ray. Left line shows ADI of >10 mm. Right line shows SAC of 9mm.

Results / Table 1			
	All With Neutral	Those Having Neutral, Flexion and Extension FIlms	
N	84	61	
		Neutral	Flex/ Ext
ADI ≥6mm	2	0	* 2
Also SAC ≤ 14mm	2	0	0
ADI >5.5mm	4	2	** 2
Also SAC ≤ 14mm	2	0	0
Flexion - Neutral ADI Avg			0.2mm
Flexion - Neutral ADI >1mm			14
Flexion - Neutral ADI < (-1)mm			4
Flexion - Neutral ADI >2mm			1
Flexion - Neutral ADI < (-2)mm			2
SAC ≤14mm	7	2	*** 2
Flex - Neut SAC avg			(0.6)
Flex - Neut SAC ≥2mm			**** 10
BAI ≥ 12mm	3	1	10
Also SAC ≤ 14	3		# 1
Also ADI ≥6mm	2		## 1
Weisel -Rothman Translation > 4mm	NA	NA	9
Also SAC ≤14			0
Also BAI ≥12 in flexion			### 2

Table 1: Radiographic Indicators of Upper Cervical Instability or Spinal Cord at Risk.
* 1 had 1.9mm movement between flex and neutral. Both had Flex SAC >19mm
** All had Flex and neutral SAC >19mm
***These were same patients with < 14 mm SAC on neutral
**** None had SAC ≤17mm
# the 1 patient with flexion BAI >12 and SAC ≤ 14 was had neutral BAI > 12 and SAC <14 also
SAC was >19 mm in the 1 patient who had flexion ADI≥6, and BAI flexion ≥ 12
Neither of these had SAC < 15mm in flexion, extension or neutral

measure increasing more than 4mm between extension and flexion.

Results

113 studies were read in 106 patients, 43 females and 63 males. Age ranged from 1.5 to 18.7 years with average age being 8.6 years. 29 studies did not include a readable neutral lateral x-ray and were excluded. 84 studies included a readable neutral lateral cervical spine x-ray. 61 included measureable neutral, flexion and extension x-rays. 43 studies included an AP x-ray and 14 an open mouth view.

OS Odontoideum

2 patients had Os Odontoideum visible on neutral lateral film. (1 of which had ADI of 11.54mm in neutral, the other did not manifest any other criteria for instability).

SAC ≤ 14mm, ADI ≥ 6mm, BAI of >12mm, WR measure increasing ≥4mm on Flex/ext

See Table 1.

All patients (2) with SAC ≤ 14, ADI of ≥6mm and BAI of ≥12mm showed these abnormalities on the neutral lateral x-ray.

SAC ≤14mm

7 patients were found to have a SAC ≤14mm. No studies showed SAC ≤ 14 mm on flexion or extension views that did not have SAC ≤14mm on the neutral lateral film. These 2 patients met all criteria for Atlantoaxial instability as noted above.

ADI ≥6mm

2 patients showed ADI ≥6mm on the neutral lateral x-ray.

Of the patients with an ADI ≥ 6mm only on flexion views(2), none were found to have a SAC ≤14mm, or BAI ≥12mm

Only 1 patient had ADI more than 2mm greater on flexion (2.11mm) compared to the neutral lateral.

BAI ≥12mm

3 patient studies showed a BAI ≥12mm and SAC ≤14mm on the neutral view, 2 of which also had ADI >=6mm.

In 9 patients the BAI was found to be ≥12mm in flexion only. None of these showed SAC ≤14mm, or ADI ≥6mm

Weisel-Rothman Measure ≥4mm

9 studies showed ≥ 4mm of posterior translation in extension using the WR measurement.

None of these images demonstrated a SAC ≤14mm or ADI ≥6mm. 2 patients, however, had a BAI ≥12mm in flexion.

AP and Open Mouth

No information relevant to the assessment of stability was obtained from any AP or Open Mouth View. Os Odontoideum was visible on Lateral X-ray, and there were no segmentation anomalies or significant lower cervical abnormalities noted.

Summary

All patients who met more than one criteria for Atlanto-axial instability were identified on neutral lateral x-rays. No additional information of value for Atlantoaxial instability assessment was obtained from flexion-extension views.

Flexion extension views identify translational movement at the Atlanto-Occipital Joint, but the clinical significance of this motion is not clear, and did not appear to be associated with radiographic Atlanto-Axial instability or evidence of spinal canal narrowing.

We recommend that if screening x-rays are obtained for Down Syndrome patients, only a simple single upright lateral cervical spine x-ray is needed. Additional evidence of instability is not likely to be obtained from flexion-extension views, AP or Open-Mouth Odontoid views. Correlation with clinical symptoms and if needed advanced neuroimaging such as MRI would be helpful next steps.

Do Bone Cells Recognize Rest Intervals?

Ronald Y. Kwon, Ph.D., Leah E. Worton, Ph.D., Sundar Srinivasan, Ph.D., and Ted S. Gross, Ph.D.

Abstract

This study begins to elucidate novel molecular mechanisms by which brief rest-intervals enhance the response of bone to mechanical loading.

Introduction

During signal transduction, increased extracellular stimuli are generally associated with greater intracellular responses. Contrary to this paradigm, we previously showed that selectively removing mechanical signals to enable 10 s of rest between each load cycle transforms low magnitude, non-osteogenic stimuli into a potent anabolic signal [1,2,3]. The capacity zero load rest intervals to give rise to such osteogenic adaptation suggests that rest-inserted loading may be regulated by distinct (and as of yet unidentified) signaling mechanisms that are not elicited by continuous mechanical stimuli. In this study, we tested the hypothesis that rest-inserted and continuous stimuli activate distinct early signaling events and downstream transcriptional targets in bone cells exposed to dynamic fluid flow in vitro.

Materials and Methods

- MC3T3-E1 osteoblast cells were cultured in α-MEM containing 10% FBS at 37°C and 5% CO_2. For flow experiments, cells were cultured in 6-well plates (2 ml media per well) and placed on an orbital shaker resulting in fluid flow characterized by 2.2 Hz waveform and ~0.1 Pa shear stress.
- Cells were exposed to one of the following regimens for 60 min: a) no flow, b) continuous flow, or c) rest-inserted flow (four 15 min loading bouts), with each bout consisting of 5 min of flow followed by 10 min of rest). RNA levels were quantified using real time RT-PCR.
- We first screened a panel of 22 genes selected based on their previous implication in regulating mechanosensation (e.g., c-fos, COX-2, etc.) and/or bone function (e.g., ALP, OSX, etc.) and performed hierarchical clustering. Follow up studies were performed to assess the time course of cluster expression. For analysis of early signaling events, levels of p-ERK1/2 and ERK1/2 were assessed via Western blot.

Results

- We were able to identify gene clusters with differential responses to rest-inserted or continuous fluid flow that extended well past the cessation of flow at 1 hr (Figure 1).
- Given previous studies implicating MAPK signaling in the regulation of these clusters, we assessed whether ERK1/2 was differentially activated by rest-inserted flow. We found that rest-inserted flow uniquely enable serially spiking of ERK1/2 phosphorylation (Figure 2).

Discussion

We hypothesized that intracellular responses to rest-inserted fluid flow may be regulated by signaling phenomena distinct from those elicited during continuous flow. We found that rest-

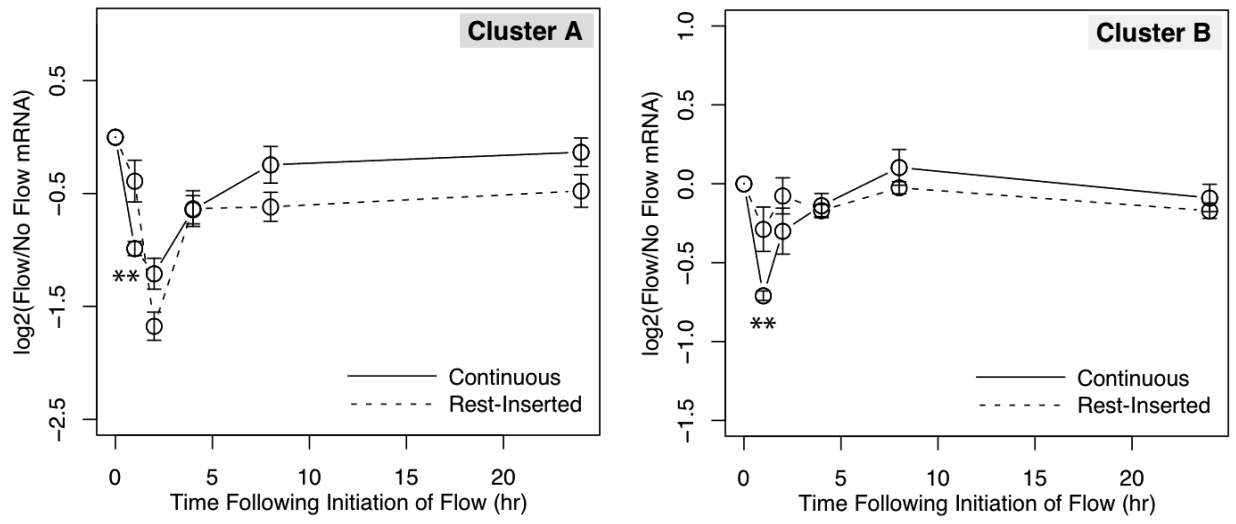


Figure 1: Time course of expression for cluster A (left) and cluster B (right). In cluster A, rest enhanced flow-induced decreased in expression. In cluster B, acute decreases in expression under continuous stimulation were mitigated by rest. **: $p<0.01$

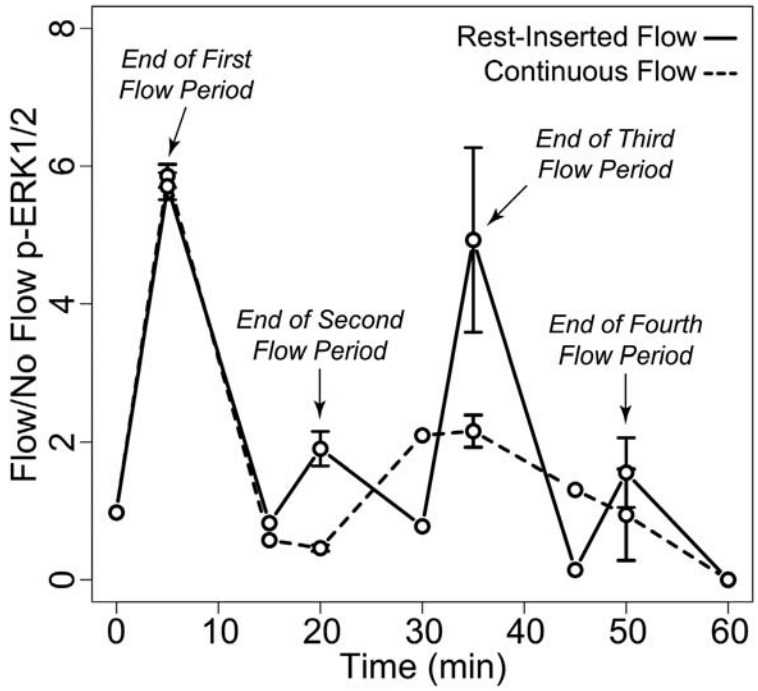


Figure 2: Continuous flow stimulation (CF) resulted in a single spike in activation with a peak at 5min, whereas rest-inserted flow (RF) resulted in recurring increases in p-ERK1/2 levels immediately following each successive period of flow.

inserted flow equivalently activated a number of flow-sensitive genes, despite a four-fold decrease in the number of cycles of flow. Additionally, we found that flow with rest intervals and continuous flow differentially activated specific transcriptional clusters via two distinct mechanisms. In the first cluster (A), down-regulation of expression by continuous flow was further amplified (both in terms of magnitude and duration) by the insertion of rest intervals. In contrast, in the second cluster (B), down-regulation of expression by continuous stimulation was mitigated by rest. With regard to early signaling events, rest-inserted flow resulted in a unique signature of acute ERK1/2 activation with multiple spikes in phosphorylation (one following each loading bout). This recurring activation was in direct contrast to the single spike in phosphorylation that occurred during continuous stimulation. Taken together, these data suggest three potential mechanisms by which the insertion of rest intervals may enhance aspects of cellular mechanotransduction: 1) inducing recurring bouts of acute ERK1/2 activation, 2) enhancing osteogenic transcriptional alterations initiated by mechanical stimuli, and 3) minimizing transcriptional alterations that may otherwise serve to antagonize the adaptive process.

References

1. Srinivasan, et al., J Bone Miner Res 17:1613-20, 2002.

2. Srinivasan, et al., J Appl Physiol, 102(5): 1945-52, 2007.

3. Poliachik, et al., Bone, 42(4): 653-9, 2008.

Acknowledgements

LEW and RYK contributed equally to this work. This work was supported by NIH grants AR056652 (TSG) and AR056235 (SS) and the Sigvard T. Hansen, Jr. Endowed Chair (TSG).

Bone Loss Following Peripheral Nerve Injury in Mice is Rapid and Profound

Steven D. Bain, Ph.D., Brandon J. Ausk, M.S., and Ted S. Gross, Ph.D.

Abstract

Peripheral nerve damage is a frequent complication of orthopaedic trauma that can lead to muscle atrophy, sensory impairment and chronic pain (1). The purpose of this study was to investigate the skeletal effects of peripheral nerve injury (PNI) in a mouse model using microCT and dynamic bone histomorphometry.

Introduction

Bone loss has also been associated with nerve damage and has generally been attributed to reductions in mechanical loading due to paralysis, immobilization, and/or inactivity. However, as bone is abundantly innervated, even modest interruption of neuronal signaling has potential to directly influence skeletal homeostasis. Indeed, studies that have quantified the skeletal response to chronic neuropathy have demonstrated significant bone loss (2,3), which has been attributed to the activation of osteoclastic bone resorption. Given that neuropeptides and neurotransmitters also modulate osteoblast activity (4,5), investigations to elucidate the osteoblastic response to nerve injury have potential to increase our understanding of the pathogenesis underlying neuropathy-induced bone loss.

Material and Methods

Nerve Injury Model

- Twelve (12) week old C57B1/6 female mice were randomized to PNI or sham surgeries (n = 5/group).
- The mice were anesthetized with an IP injection of ketamine/xylazine, after which the right sciatic nerve was exposed dorsally through a gluteal-splitting approach; Figure 1 (6). Following mobilization of the nerve, a 3 mm length of silastic tubing slit longitudinally was placed atraumatically around the nerve. The nerve was then returned to the host bed and the incision was closed with either 5.0 or 6.0 sterile suture as needed.
- To create a Sham nerve injury (SNI) animals underwent an identical dissection isolating and manipulating the nerve but omitting the placement of the silastic tubing.

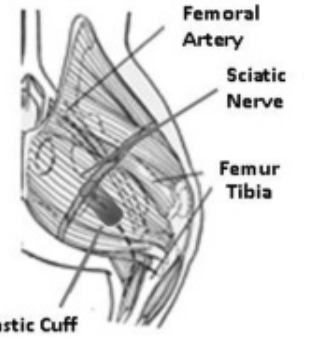


Figure 1: Exposure of sciatic nerve.

MicroCT Imaging

- *In vivo* micro-CT scans (Scanco *viva*CT 40) spanning the proximal tibia and the tibial mid-shaft were performed on Day 0, 14 and 28. User guided subroutines were used to isolate trabecular bone of the proximal tibia, while automated subroutines were used to define cortical bone.
- Standard image analysis algorithms were used to determine trabecular tissue volume (TV; mm^3), bone volume (BV; mm^3), bone volume/tissue volume (BV/TV; %), trabecular number (Tb.N; #/mm), thickness (Tb.Th; mm), and spacing (Tb.Sp; mm). The cortical shell was analyzed to determine periosteal, endosteal, and cortical bone volumes (mm^3) and average cortical thickness.
- Calf muscle volumes were also measured at each time point.

Bone Histomorphometry

- Nine and 2 days before sacrifice the animals received an IP injection of calcein green (10 mg/kg), to label mineralizing bone surfaces.
- Following euthanasia, the right and left tibiae were excised, fixed in NBF for 24 h, dehydrated in EtOH, and embedded with Low Viscosity Epoxy Resin (Polysciences, Inc.)
- Diaphyseal cross sections 150 μm thick were made using a diamond wheel saw and then hand ground to 70 μm
- Single-labeled (s.LS) and double-labeled (d.LS) surfaces, and interlabel thickness (Ir.L.Th) were measured using fluorescent microscope and used to calculate mineral apposition rate (MAR), mineralizing surface (MS), and bone formation rate (BFR = MS/100*MAR).

Statistics

- The effect of PNI on were based on comparisons with SNI using a two-way ANOVA with treatment and time as main effects. A P value of < 0.05 was considered significant.

Results

Both PNI and SNI led to significant declines in BV/TV (Figure 2) and a corresponding decline in Tb.N and an increase in Tb.SP (data not shown) in the proximal tibia. In cortical bone, there were no significant changes in midshaft BV/TV or cortical thickness at any time point (data not shown), nor were there any significant changes in calf volumes. Comparisons of dynamic histomorphometry did not reveal any differences between the PNI or SNI treatment, however, comparison of PNI and SNI treated limbs with contralateral control limbs demonstrated significant reductions in periosteal BFR of 51% and 82%, respectively ($P < 0.05$).

Discussion

This study confirms previous work demonstrating rapid and profound alterations in trabecular bone architecture in response to PNI. In addition, the observation

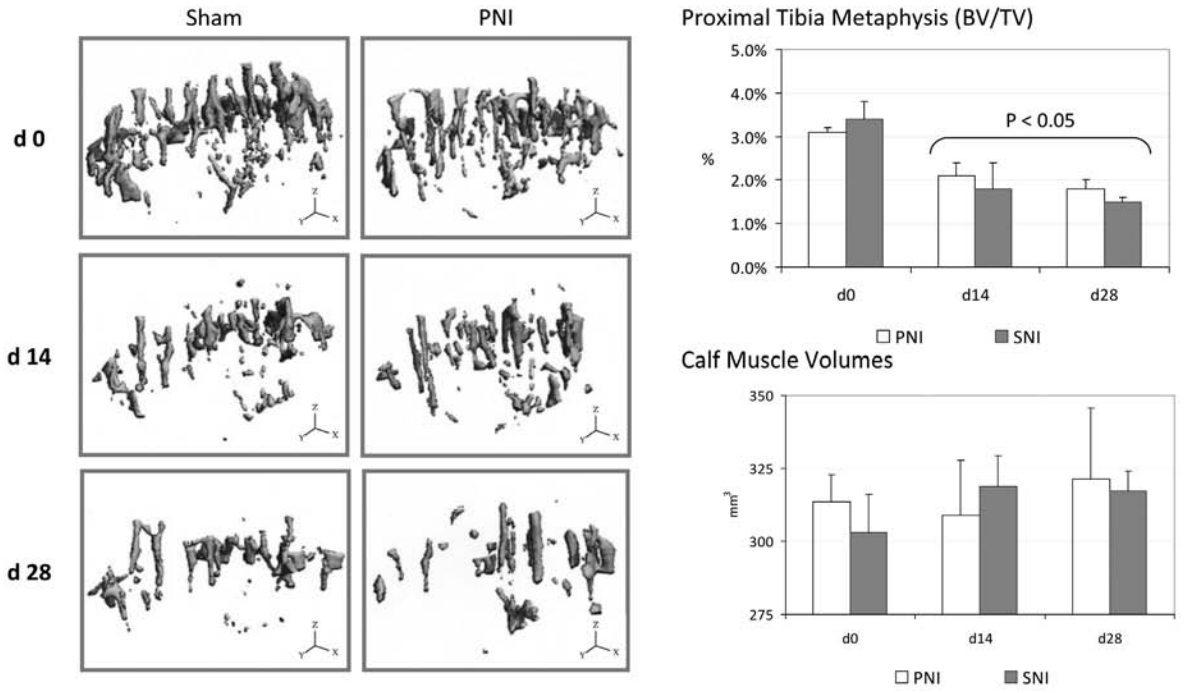


Figure 2: MicroCT images of the proximal tibia metaphysis (left) from sham and PNI treated mice demonstrated significant decreases in BV/TV compared to d0 at both d14 and d28 (right). Surprisingly, bone loss following Sham injury and PNI were no different. There was no effect of either injury on calf volumes.

that SNI leads to a nearly identical bone loss pattern was a new and unexpected finding, although similar results were recently reported in a study comparing bone loss following unilateral sciatic neurectomy vs. sham-operated controls (7). Decreased bone formation in response to nerve injury also implicates neuronal signaling as a key modulator of osteoblastic function. The sensitivity of osteoblasts to this signaling is exemplified by the fact that even sham injury leads to declines in bone formation without evidence of muscle atrophy or disuse. In conclusion, peripheral and sham nerve injuries have deleterious effects on trabecular bone architecture and cortical bone formation. The sensitivity of bone tissues to these effects points to a central role for neuronal pathways in the regulation of skeletal homeostasis.

Acknowledgements

This project was supported by the Julia H. Lane Foundation Fellowship Scholarship and the UW Medical Student Research Training Program.

References

1. Noble J, Munro CA, Prasad VS, Midha R 1998 Analysis of upper and lower extremity peripheral nerve injuries in a population of patients with multiple injuries. J Trauma 45(1):116-22.

2. Suyama H, Moriwaki K, Niida S, Maehara Y, Kawamoto M, Yuge O 2002 Osteoporosis following chronic constriction injury of sciatic nerve in rats. J Bone Miner Metab 20(2):91-7.

3. Whiteside GT, Boulet JM, Sellers R, Bunton TE, Walker K 2006 Neuropathy-induced osteopenia in rats is not due to a reduction in weight born on the affected limb. Bone 38(3):387-93.

4. Imai S, Matsusue Y 2002 Neuronal regulation of bone metabolism and anabolism: calcitonin gene-related peptide-, substance P-, and tyrosine hydroxylase-containing nerves and the bone. Microsc Res Tech 58(2):61-9.

5. Lerner UH 2006 Deletions of genes encoding calcitonin/alpha-CGRP, amylin and calcitonin receptor have given new and unexpected insights into the function of calcitonin receptors and calcitonin receptor-like receptors in bone. J Musculoskelet Neuronal Interact 6(1):87-95.

6. Mosconi T, Kruger L 1996 Fixed-diameter polyethylene cuffs applied to the rat sciatic nerve induce a painful neuropathy: ultrastructural morphometric analysis of axonal alterations. Pain 64(1):37-57.

7. Brouwers JE, Lambers FM, van Rietbergen B, Ito K, Huiskes R 2009 Comparison of bone loss induced by ovariectomy and neurectomy in rats analyzed by in vivo micro-CT. J Orthop Res 27(11):1521-7.

A Fragment-Specific Approach to Type IID Monteggia Elbow Fracture-Dislocations

Daphne M. Beingessner, M.D., Sean E. Nork, M.D., Julie Agel, M.A., and Darius Viskontas, M.D.

Abstract

Adult Monteggia fracture-dislocations can be difficult injuries to treat. In particular, a subset of adult Monteggia fractures exists that include a complex ulna fracture extending from the olecranon to the diaphysis and is often associated with radial head fracture and ligament disruptions. These injuries are known as Type IID Monteggia fractures. In the original series describing adult Monteggia fractures, only one patient had a Type IID injury making guidelines for treatment limited. The objective of our study was to describe the pattern of injury, surgical technique and outcomes of Monteggia type IID fracture dislocations in a series of sixteen patients with this injury. We found that this type of injury usually has fragments that follow a typical pattern and that a systematic fragment-specific approach to fixation can lead to a good outcome in these challenging injuries.

Introduction

In 1814, Monteggia described one elbow fracture-dislocation pattern as a "traumatic lesion distinguished by a fracture of the proximal third of the ulna and an anterior dislocation of the proximal epiphysis of the radius." In 1967, Bado suggested that the Monteggia lesion be divided into four groups based on the direction of dislocation. Bado type II lesions involve a fracture of the ulna with a posterior dislocation of the radial head and are the most common variant seen in adults. In 1991, Jupiter further classified the posterior Bado type II lesion. The Jupiter type IID (complex ulna fracture extending from the olecranon to the diaphysis) is the most rare and in the original article, only one out of 13 Monteggia lesions followed this specific fracture pattern. Such limited experience with this complex pattern could lead to suboptimal outcomes. At our center, we have experience with a relatively large number of these patients with this unusual fracture pattern. The purposes of this study were to describe the injury pattern in Monteggia type IID fracture-dislocations, outline a fragment-specific surgical technique for their management, and to report the outcome in a series of patients with this injury.

Figure 1 A, B, C: Anteroposterior (a) (above), lateral (b) (upper right), and traction (c) (lower right) radiographs of a typical Monteggia IID injury. Note the multifragmentary coronoid fracture with displacement posterior to the olecranon, the anterior oblique fragment, and a comminuted radial head fracture.

Patients and Methods

- Sixteen patients with a Monteggia type IID fracture-dislocation were identified in a five year period.
- Records were reviewed for demographic data, mechanism of injury and associated musculoskeletal and systemic injuries.
- The pattern of bone and soft tissue injury around the elbow was identified on the pre-operative imaging and from the operative notes.
- Clinical outcome, including elbow range of motion, union, quality of fracture reduction, secondary surgical procedures and complications, were assessed.

Surgical Technique

- Lateral decubitus position with the injured extremity supported on a padded radiolucent arm board.
- The following fracture fragments were typically present: radial head fracture, shaft component, anterior oblique cortical fragment with or without the base of the coronoid, coronoid fragment, avulsion fragments of the ulnar ligament insertions both medially and laterally, olecranon fragment, and humeral origin avulsion of the lateral collateral ligament.
- The proximal ulna and

Figure 2: Anteroposterior (a) and lateral (b) fluoroscopy images showing a provisional reduction of the ulna with the trial for the radial head arthroplasty in place.

the olecranon process are identified between the flexor and extensor carpi ulnaris muscles.

- The fractured olecranon fragment and attached triceps insertion is reflected to expose the elbow joint. The coronoid, collateral ligament insertions and radial head are then visualized.
- The order of fixation is as follows:
  1. repair or replacement of the radial head
  2. reduction of the ulnar shaft including the anterior oblique cortical fragment
  3. reduction and stabilization of the coronoid process
  4. reduction and fixation of the olecranon process to the ulnar shaft and definitive fixation of the ulnar shaft component of the injury
  5. repair of osseous ulnar insertion of the medial collateral ligament and/or lateral collateral ligament
  6. repair of the humeral origin of the lateral ulnar collateral ligament.
- The stability of the elbow, range of motion and fracture fixation is tested clinically and fluoroscopically to confirm that motion is unrestricted and that immediate post-operative range of motion can be initiated.
- The arm is splinted for 24 to 48 hours and then motion is started. Active and active assisted motion is encouraged with the arm at the side with avoidance of varus stress.

Results

- 15 patients had fractures of the radial head
  - 6 underwent ORIF
  - 8 underwent radial head arthroplasty
  - 1 did not require fixation
- 14 patients had coronoid fractures
  - 5 were fixed with suture
  - 9 were fixed with screws and mini-fragment plates
- 2 patients required lateral ulnar collateral ligament insertion repairs with suture anchors.
- Average clinical follow-up was 37 weeks (range 9-82 weeks)
- Average range of motion was from 18 to 119 degrees of flexion; 11 out of 16 patients had greater than a 100 degree arc of flexion and extension. Average pronation was 69 degrees and average supination was 70 degrees.
- All articular reductions had less than 1 mm gap or step and all patients united their fractures without secondary procedures at an average time of 14 weeks.
- There were 6 complications in 6 patients. 3 patients developed elbow stiffness with heterotopic ossification but none of them opted for release. 1 patient developed pronator syndrome and radial nerve compression at the elbow 13 months post-operatively but did not want any further surgery. 1 patient had collapse of the radial head but did not want a revision procedure. 1 patient required coronoid hardware removal due to development of resorption and fragmentation of the coronoid with the potential associated risk of hardware impingement.

Discussion

Type IID Monteggia fracture dislocations are rare and their fracture patterns are not well understood making the surgical approach demanding. To our knowledge, our study reports on the largest series of these patients to date.

The mechanism of injury in this study population was most commonly a fall from a height. Despite the high energy mechanism, only one third of patients had associated systemic

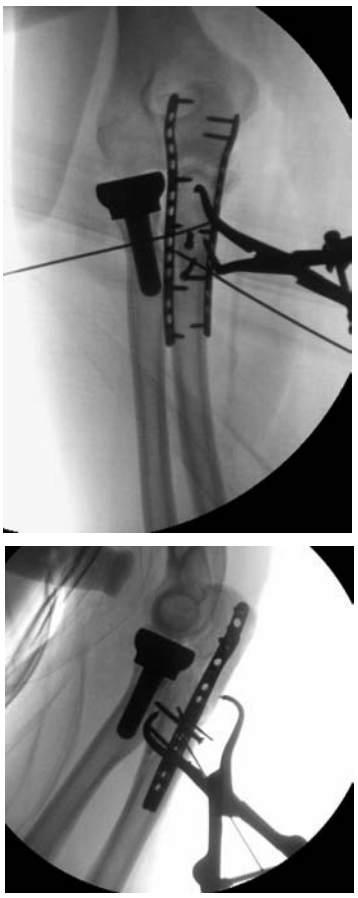


Figure 3: Anteroposterior (a) and lateral (b) fluoroscopy images showing fixation of the anterior cortical fragment and shaft components with minifragment plates to hold reduction.

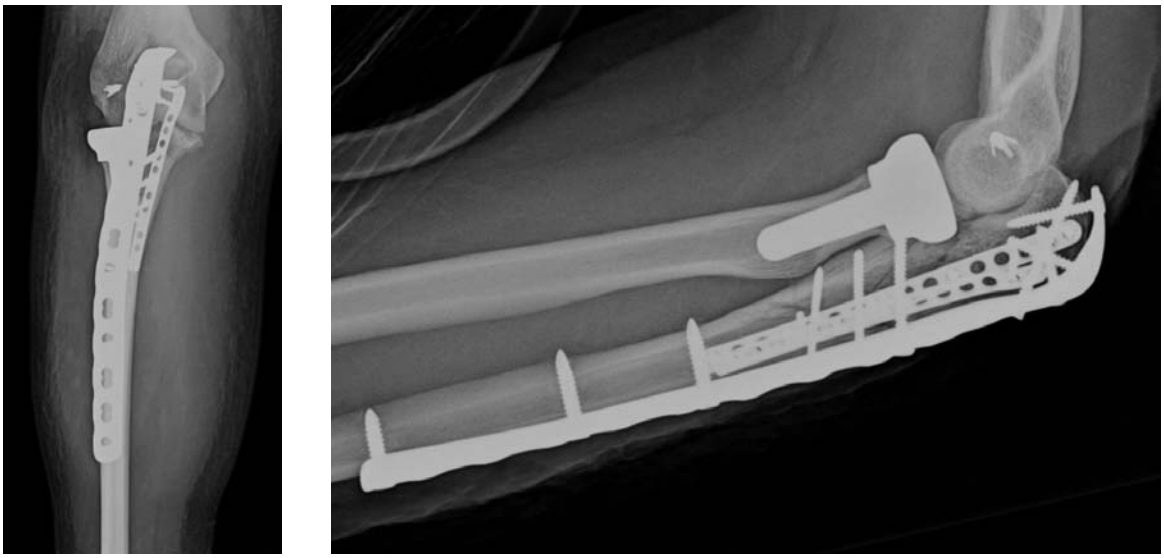


Figure 4: Anteroposterior (a) and lateral (b) radiographs a periarticular proximal ulna plate (3.5 mm thickness) spanning the olecranon and shaft component of the injury. Suture anchors have been placed to repair the lateral collateral ligament injury. The elbow is congruently reduced.

and musculoskeletal injuries and these were quite minor. Most of the energy at the time of the trauma was likely absorbed by the elbow leading to the highly comminuted elbow fracture-dislocations. Although there was significant soft tissue disruption, there were no nonunions in this series. Nonunion rates requiring further intervention in other publications varies from 3% to 15% of all Monteggia types.

Associated radial head fractures are commonly seen in posterior Monteggia fracture dislocations and were seen in all except one of the patients in this study. It has been shown that re-establishing the radial head as a lateral support, whether through repair or arthroplasty, is important for elbow stability and function. In this study group, 14 of the 16 patients required either ORIF or a radial head arthroplasty. It is important to test elbow stability after reconstruction of the joint. If the radio-capitellar joint remains unstable, the lateral ligaments should be inspected and repaired if torn. If radial head fixation remains questionable, a radial head arthroplasty should be performed.

Complications following fixation of Monteggia fracture-dislocations have been shown to be correlated with poor outcomes. Three patients required contracture releases and developed heterotopic ossification which is similar to other studies on Monteggia fractures. Other complications included one patient who developed pronator syndrome and radial tunnel symptoms of unclear origin but did not pursue nerve releases. In this series, nerve injuries are rare despite the magnitude of trauma to the elbow.

Eleven patients had a final flexion arc of greater than 100 degrees and nine of those were within a functional range of motion (30 – 130 degrees). Nearly all had full rotation. After carefully examining a relatively large series of patients with this injury, we have advanced the understanding of this injury pattern and therefore have been able to pursue a more sound surgical approach. Despite the complexity of these injuries, Monteggia type IID fracture dislocations can have a good outcome with a detailed understanding of the fracture pattern and a fragment specific approach to appropriate fixation. We recommend sound fixation of all fracture components, lateral ligament repair when necessary and early range of motion.

References

1. Bado JL. The Monteggia lesion. Clin Orthop Rel Res. 1967;50:71-86.

2. Konrad GG, Kundel K, Kreuz PC, et al. Monteggia fractures in adults: Long-term results and prognostic factors. J Bone Joint Surg Br. 2007;89:354-360.

3. Jupiter JB, Leibovic SJ, Ribbans W, et al. The posterior Monteggia lesion. J Orthop Trauma. 1991;5:395-402.

4. Ring D, Jupiter JB, Simpson NS. Monteggia fractures in adults. J Bone Joint Surg Am. 1998;80:1733-1744.

5. Beingessner DM. Monteggia fractures in adults. Curr Orthop Practice. 2009;20:499-505.

Impact at Foot Strike in Women Distance Runners

Peter R. Cavanagh, Ph.D. and Molly D. Glauberman, M.S.

Abstract

- Our analysis of 32 long distance women runners demonstrated that leg shock in this group of runners varied over a 2.6-fold range.
- While the ground reaction force characteristics of forefoot strikers were distinct from rearfoot strikers, we found no reduction in tibial shock during forefoot running and thus the benefits of the forefoot striking may have been overstated.

Introduction

- Each time the foot strikes the ground in running, the collision transmits a shock wave to the leg that is considered by some authorities to be a potential cause of overuse injuries such as stress fractures.
- We have developed a system to monitor the "leg shock" in running and have assessed foot strike patterns in a group of 32 female recreational runners who were running 20 miles per week or more.

Methods

- Our subjects were between the ages of 18 and 40. They all had either run a race in the past few months or were training for a race in the near future. None of them were barefoot or minimal shoe runners, and they all had been injury-free for at least a month prior to testing.
- Each subject visited the laboratory on two separate occasions. Subjects ran on a force-measuring treadmill at 3.13 m/s with a wearable sensor that was attached to their ankles in a standardized manner using a Velcro strap (Figure 1). The antero-medial border of the tibia—about 5cm above the medial malleolus—is an excellent location for such measurement since there is very little subcutaneous soft tissue at this site.
- The sensor measured three components of acceleration and three components of angular velocity. In this report we will concentrate on the acceleration component along the long axis of the tibia and the vertical component of the ground reaction force (Fz) measured from the treadmill.
- Data from approximately 90 successive foot strikes from each subject were averaged to generate the results described below.

Figure 1: Wearable sensor.

Results

- A comparison of the peak axial accelerations from the two separate visits showed that this is a highly reliable measure with an R^2 of 0.92. Remarkably, the tibial shock in this group of women running at the same speed varied over a 2.6-fold range from a minimum of 4.0g to a maximum of 10.6g.
- Twenty-seven subjects exhibited Fz patterns characteristic of rearfoot strikers (Figure 2A) with an initial spike (Fz peak 1) at approximately 35 milliseconds after foot strike followed by a larger peak (Fz peak 2) at approximately 125 milliseconds.
- No Fz peak 1 was present in the remaining 5 subjects, a pattern which has been previously described for forefoot strikers. However, all subjects demonstrated a peak in the vertical component of ground reaction forces shortly after foot strike regardless of their foot strike pattern (Figure 2B).
- Regardless of footstrike pattern, an early peak in tibial acceleration (shock) was always present (Figures 2C and D).
- A multiple regression analysis was used to assess the relationship between tibial shock and other variables in the rearfoot stikers. A combination of the rate of change of Fz (dFz/dt - highly significant: $p<0.00005$), body mass (significant: $p=0.0320$), and Fz peak 1 (significant $p=0.0135$) together accounted for 58% of the variance in peak tibial acceleration.

Discussion

- There is, as yet, no prospective study in the literature that relates tibial shock to the risk of injury in distance runners. However, the notion that impact at footstrike could be a contributing factor to injury risk is intuitively attractive and tibial acceleration has been the target of a previous intervention study.
- A novel finding in the present study is the presence of tibial acceleration peaks even in runners who exhibit a forefoot strike pattern in which there is no initial peak in the ground reaction force. There has been considerable debate in the literature on the merits of forefoot running and barefoot running both of which have been said to reduce impact

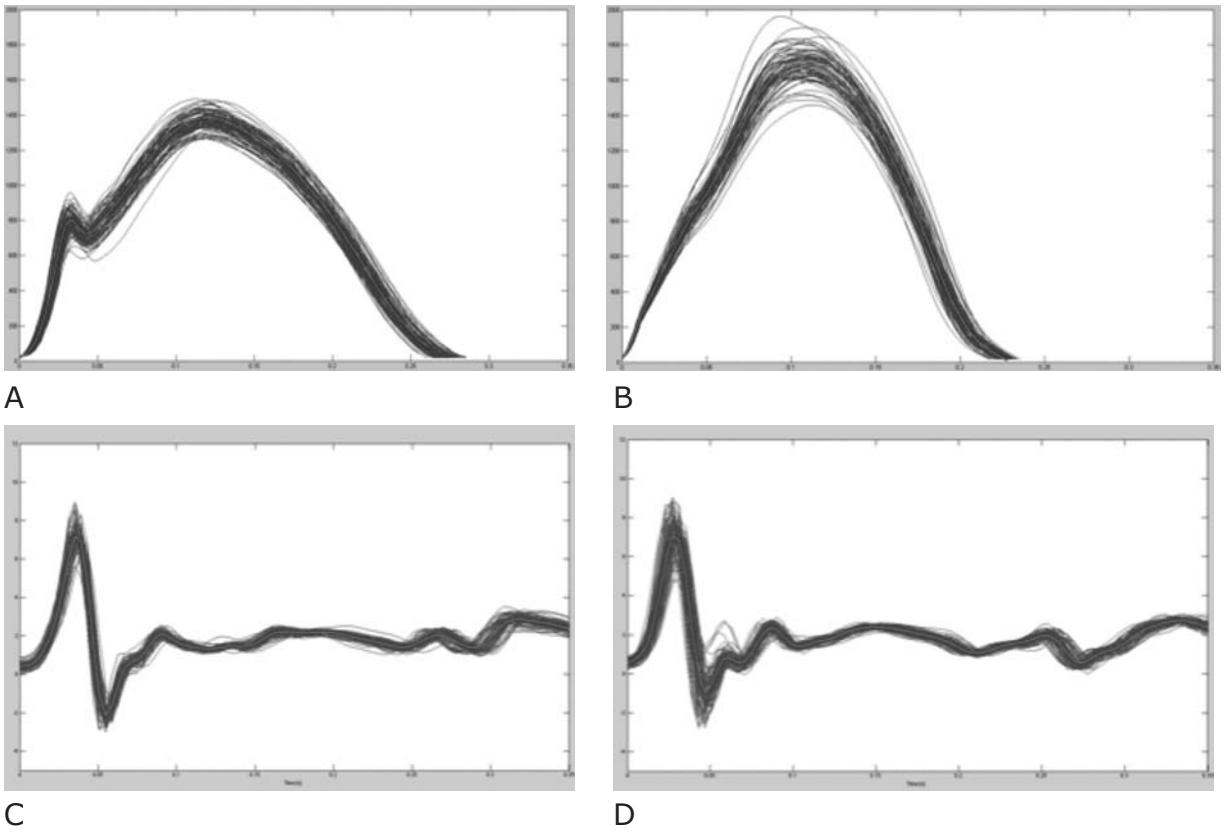


Figure 2: Force vs. time and acceleration vs. time for the contact phase of a rearfoot striker (2A and 2C respectively) and a forefoot striker (2B and 2D respectively). Note the difference in ground reaction force but the similarity in tibial shock. Force scales are 0 to 2000 Newtons; acceleration scales are -4g to +10g; time scales are 0 to 0.35 seconds.

loading based on observations of ground reactions forces.

- Our study demonstrates that there is no reduction in tibial shock during forefoot running and thus the benefits of the forefoot striking may have been overstated.
- The sensor used in these studies has a Bluetooth radio which transmits data to a Smartphone. Using this configuration, we plan to go outside the laboratory in order to study runners during actual training and racing sessions on a variety of surfaces and gradients.
- A satisfactory explanation of the different tibial acceleration patterns requires a mathematical model. Several spring-mass-damper models of the ground reaction forces have appeared in the literature and we are in the process of exploring more parsimonious models of tibial shock.

References

1. Matheson G, et al. American Journal of Sports Medicine,15, 46-58, 1987.

2. Iwamoto J, et al. Journal of Orthopaedic Science: Official Journal of the Japanese Orthopaedic Association, 8, 273-278, 2003.

3. Bennell K, et al. American Journal of Sports Medicine, 24, 211-217, 1996.

4. Hreljac A, et al. Medicine and Science in Sports and Exercise, 32, 1635-1641, 2000.

5. Milner C, et al., Medicine and Science in Sports and Exercise, 38, 323-328, 2006.

Technique Paper: Pediatric Scaphoid Waist Nonunion, a Novel Technique

Adam Bakker, M.D. and Douglas P. Hanel, M.D.

Background

Pediatric scaphoid fractures are the most common fractured carpal bone in children [1]. Although scaphoid nonunions are relatively uncommon they appear to be increasing in nature as the fracture patterns in children are shifting to adult type patterns involving primarily the scaphoid waist [2]. Currently there is no consensus on the treatment of pediatric scaphoid waist nonunions. Others have described techniques requiring the use of iliac crest bone autograft [2], leading to an additional surgical site in the pediatric population.

Methods

Study Design: Retrospective review from 1999 to 2010 of 29 cases of pediatric scaphoid nonunions performed by senior author DPH.

Technique

- Single incision in the distal radius along the flexor carpi radialis tendon with a 120 degree turn toward the thumb at the distal wrist crease over the scaphoid.
- Excision of the scaphoid waist nonunion site.
- Autograft harvest along the volar distal radius (in the same surgical incision site).
- Placement of the bone autograft within the scaphoid.
- Compression and rigid fixation of bone autograft in the scaphoid with a compression screw.

Results

27/29 patients (93%) achieved union with a single operation for their scaphoid waist nonunion using a single surgical site. 2 patients required an additional surgery to achieve full union. There was no reported complication in harvesting the bone autograft from the volar distal radius.

Discussion

It been previously thought that the majority of pediatric fractures occurred in the distal pole of the scaphoid, where the blood supply is robust, and where therefore high union rates could be expected. However a recent study demonstrated a shift in the location of common pediatric fracture sites towards a proximal injury pattern similar to those found typically in adults [2], where the blood supply and thus healing ability is not as robust as the distal scaphoid pole [3].

One clear advantage to this described technique is that it eliminates the need for an additional surgical site to obtain bone autograft from other regions such as the iliac crest. This prevents common surgical complication associated with Iliac bone graft surgical donor sites such as infection or pain [4].

In summary we believe this novel surgical technique for the treatment of pediatric scaphoid waist nonunions is a reliable method of obtaining union. In addition, it obviates the need for an addition surgical in the harvesting of bone autograft and its potential complications in the pediatric population.

References

1. Christodoulou, AG, Colton CL. Scaphoid fractures in children. J Pediatr Orthop 1986;6:37-39

2. Gholson JJ, Bae DS, Zurakowski D, Waters PM. Scaphoid fractures in children and adolescents: contemporary injury patters and factors influencing time to union. J Bone Joint Surg 2011;93(13):1210-1219

3. Mintzer CM, Waters PM, Simmons BP. Nonunion of the scaphoid in children treated by Herbert screw fixation and bone grafting. A report of five cases. J Bone Joint Surg 1995;77B:98-100

4. Younger EM, Chapman MW. Morbidity at bone graft donor sites. J OrthopTrauma. 1989;3:192-5

Figure 1: (Top) PA view L-wrist. Scaphoid nonunion marked by single arrow. (Middle) AP view L-wrist. Immediately post op after compression screw. Distal radius bone autograft donor site marked by double arrow. (Bottom) PA view L-wrist. 5 months post op. Distal radius autograft site as filled in with bone.

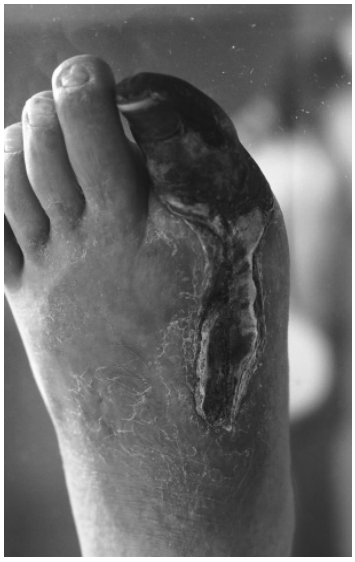
Foot and Ankle Observations:
Elevation Ischemia and Commercial Continuous Cold Pac: A "Frostbite Prescription"

Sigvard T. Hansen, Jr., M.D.

In Dr. Matsen's superb monograph on compartmental syndromes from 1980, the basic vascular dynamics in the leg, with and without elevation, were clearly described (the hydraulics basics were not new, clearly demonstrated by Leonardo Da Vinci in his pressure studies on a column of water).

Dr. Matsen showed that "limb elevation reduced local arterial pressure by an amount equal to the pressure produced by the column of blood from the limb to the heart." He also noted that local venous pressure cannot be significantly below local tissue pressure and that (of course) elevation of the foot above the heart level reduced the local arteriovenous gradient (proportionately).

In my book[1] on Functional Reconstruction of the Foot & Ankle I referred to Matsen's work[2] in discussing the effect of elevation on the postoperative foot, which can be 6 – 10 inches more elevated than the compartment of the leg when elevated in the given position. When the pulse pressure in the toes was significantly reduced we called this "elevation ischemia" and recommended that the foot not be elevated more than 8-12 inches above the heart postop as the venous return is little helped by more elevation but the arterial pressure and thus arteriovenous gradient continues to drop putting circulation to the toes at increased risk.



After two months in a walking boot waiting for maturation and demarcation to save maximum length, sesamoids.

Subsequently a new player has been added to the problem, the continuous cooling device made primarily for the knee – the one I'm aware of is called "Polar Care." Our first case where a confluence of all the dangerous factors came together was 15 years ago.

A then 14-year-old-girl came to the foot clinic with a history of a "bunionectomy" a month earlier and a "black" great toe plus the necrotic blackened edges of her incision up the first metatarsal which looked exactly like frostbite.

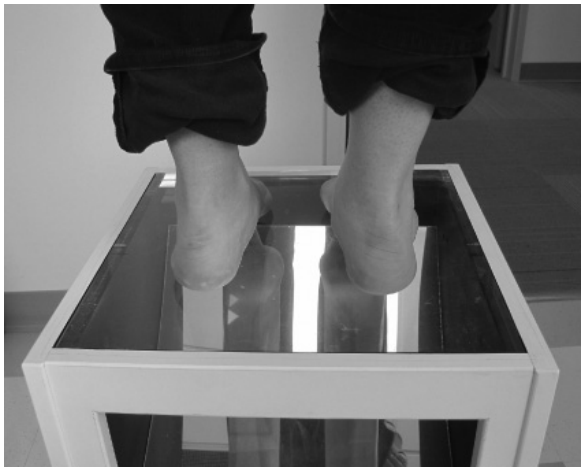
She was a tall, slender girl with a low ~90/60 blood pressure. She had been kept in a quite markedly elevated position postop at home after no more than a day. She was visited there by the Polar Care representative as they had applied a cooling device with circulating ice water all with the idea of preventing this nice young girl from having to experience pain and swelling.

When the toe was noted to be persisting in a cold bluish state and had been very painful, frequently with a feeling of being hot (this is a symptom

Presentation three weeks after bunion surgery, cold application and elevation.

Intra op, amputation

15 years post amputation, negligible disability.



Note that amputated side, in spite of loss of great toe has better hindfoot alignment.

known as *caumesthesia*, a condition in which with a low temperature the patient experiences a burning heat). Eventually the cold was removed but the toe went on to mummification.

We treated this as a frostbite problem, leaving her in a walking boot for six to eight weeks to let the necrotic area demarcate as distally as possible and as completely as possible in an attempt to save the proximal half of the proximal phalanx and the sesamoid mechanism. We eventually carried out a quite standard great toe amputation.

Some time later she had problems with pain under the second metatarsal and extensor claw toes, with forefoot overload and further reconstruction included a gastroc slide, extensor substitution, and girdlestone procedures and second metatarsal shortening. Eventually she became nearly normally functional and has done very well.

She was called in and examined very recently, nearly 15 years out. She is now a 30-year-old teacher with essentially no disability. She shows a foot and leg that is quite normal aside from missing the great toe.

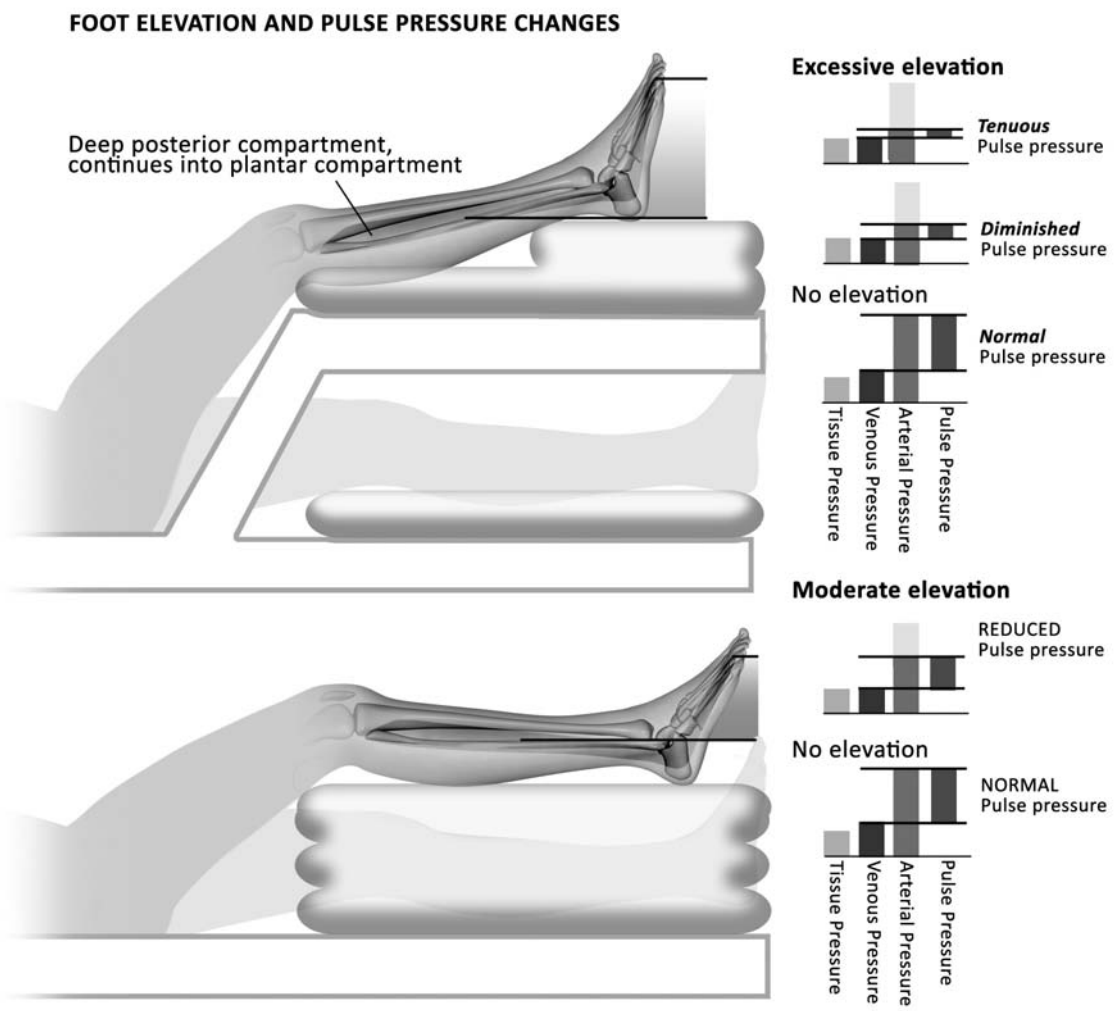
She was briefly examined in the vascular lab to reproduce her initial elevation only and measure her foot blood pressure and pulse waves in the toes.

Elevation at 52 centimeters as against zero elevation showed about the expected loss of pressure in the toes on the left especially, a little less on the right, and the anterior tibia only. The most obvious difference was in the pulse pressures on the great toe on the right, the affected side of course.

Very importantly and pertinent here, Matsen's work indicated and it seems obvious in this case, that elevation of a normal leg may not show significant circulatory problems but it becomes much more sensitive to other factors such as soft tissue swelling, occlusive dressings, and cold application assumedly.

Subsequent to this initial case we have seen another one of these cases of almost identical story almost every two to three years. Most are young patients with low blood pressure, and a history of excessive elevation and the Polar Care device. Some have lost the whole forefoot, not just a toe. The most recent, still under treatment, is a mid-50's heavier woman, and a smoker, who had an ankle fusion

Note healed scars of extensor substitution and flexor to extensor (Girdlestone) transfers…



Illustration, redrawn from Matsen, to show elevation at toes, compared to leg compartments.

takedown and a total ankle arthroplasty with an InBone prosthesis. Otherwise she had the same scenario of enforced elevation and Polar Care device, eventual frostbite-like necrosis of the lateral forefoot and of the operative wound site, and a breakdown of her total ankle arthroplasty and infection.

To me it is very interesting that we see a large number of postop cases, a few with wound problems, some that have been left elevated too much, but we have never seen a case with this quite typical frostbite-like necrosis in a patient without the history of application of continuous cold in the elevated position.

The message is clear, excess elevation is not only not helpful but strongly contraindicated and the addition of a continuous cooling device below the knee, as in this situation, is extremely dangerous.

References

1. Hansen, ST Jr. Functional Reconstruction of the Foot and Ankle. Lippincott, Williams and Wilkins, p 37-38, 2000.

2. Matsen III, F.A. "Tolerance of Tissue for Increased Pressure" Chapter 4 (p45-64) *In*: Compartmental Syndromes. Grune & Stratton, New York, 1980.

Minimally Invasive Total Knee Arthroplasty Offers Similar Clinical Results to Traditional TKA at Intermediate Term

Brian K. Daines, M.D., Daniel L. Stamper, PA-C, Douglas C. Schaad, Ph.D, and Seth S. Leopold, M.D.

Abstract

Background: Studies disagree as to whether so-called minimally-invasive surgery (MIS) approaches to total knee arthroplasty (TKA) improve clinical outcomes beyond the immediate post-operative period. This study evaluates whether the MIS approach results in a higher risk of re-operation or revision at intermediate term, and whether there are differences in Knee Society Scores between patients whose TKAs were inserted using the MIS approach and those whose TKAs were inserted using a "traditional" medial parapatellar approach.

Methods: We compared the same surgeon's last 50 traditional medial parapatellar approach TKA patients to his first 100 MIS TKA patients. Similar anesthesia, implants, and aftercare approaches were used in both groups. Patients completed a Knee Society Score at a mean follow-up of over four years. Complications, reoperations, revisions and the risk of fair/poor knee scores were compared between groups.

Results: Pre-operatively, there were no significant differences in KSS between the MIS and traditional TKA patients. At a mean of four years (MIS) and five years (traditional), the average Knee Society Score was excellent in both groups, but not different between the MIS and traditional TKA cohorts (85.8 vs. 85.6, respectively, p=n.s.). There have been three reoperations in the MIS TKA group and two in the traditional TKA cohort (p=n.s.). There was no difference in the likelihood of a patient having a fair or poor knee score between the two groups (two of 50 in the traditional TKA group, one fair, one poor; four of 100 in the MIS group, two fair, two poor, p=n.s.).

Conclusion: Excellent knee scores and a low risk of reoperation and revision were observed both in MIS and traditional-approach TKA patients in this controlled series. The risk of a fair or poor outcome was not different between approaches. The MIS approach did not improve or worsen outcomes compared to the traditional approach at intermediate-term follow up. In light of the observed improvements in early recovery following surgery, our ability to achieve accurate implant alignment without an increase in short-term complications, and the durability of these reconstructions at intermediate term, we continue to use the MIS approach in our primary TKA patients.

Figure 1: Patellae in MIS TKAs are tipped up rather than everted 180° during patellar resections.

Introduction

Minimally invasive surgical approaches to total knee replacements were developed to reduce the demanding and lengthy recuperative periods encountered with traditional approaches.[1] Potential advantages of less-invasive approaches to total knee arthroplasty (TKA) have included faster recovery times, shorter hospital stays, and improved short-term functional outcomes[2,3] without compromise to implant alignment or soft tissue healing.[4]

However, some series have suggested that implant alignment can be compromised when MIS approaches are used,[5,6] and that this can result in an increased risk of early failure.[7] Our own earlier work has identified a learning curve that may be prohibitively lengthy for low-volume arthroplasty surgeons.[2]

We previously published a controlled series comparing the senior author's first 100 MIS TKAs (as defined by Coon and Tria[3]) with his last 50 "traditional" (medial parapatellar) surgical approaches.[2] The present study seeks to evaluate these patients, now 4-5 years out from surgery, to determine whether this MIS approach to TKA results in a higher risk of re-operation or revision at intermediate term, and whether there are differences in Knee Society Scores at intermediate term (either in terms of mean score or number of fair/poor results) between patients whose TKAs were inserted using the MIS approach and those whose TKAs were inserted using a traditional medial parapatellar approach.

Materials and Methods

We reviewed a cohort of consecutive TKA patients (50 who had a traditional medial-parapatellar approach, followed

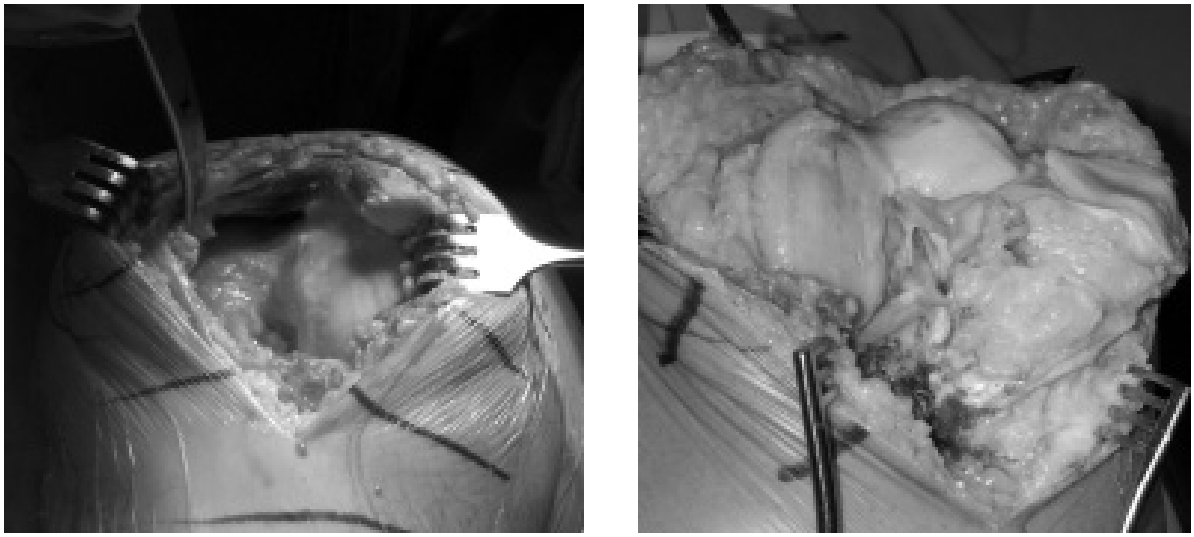


Figure 2: In MIS TKA (left) the patella is gently subluxated laterally to gain tibiofemoral exposure, using a "mobile window" approach; in traditional TKA, the patella is everted 180° and the knee is hyperflexed to obtain tibiofemoral exposure.

by 100 MIS TKAs), previously reported on in *The Journal of Bone and Joint Surgery*[2]. All procedures were performed by the senior author at a high-volume arthroplasty hospital. The surgeon's pre-training and other elements of anesthesia, surgical technique, analgesia, and aftercare are covered extensively in that report. The present study evaluated those groups of patients at a minimum of 4 years after surgery.

The MIS approach was used as defined by Tria and Coon[3], and included the following key elements:

(1) no patellar eversion; patellae were tilted up (Figure 1), cut freehand, and subluxated laterally rather than everted (Figure 2) ;

(2) no dislocation of the of the tibiofemoral joint during bone preparation;

(3) no knee flexion beyond 90 degrees (Figure 3) until trial components were in place and range of motion testing was performed; and

(4) a shorter, anteromedially placed incision was used, rather than a longer anterior midline incision.

Traditional TKA patients received a medial parapatellar approach with an anterior midline incision, patellar eversion during preparation of the patella, and tibiofemoral subluxation with deep flexion during the tibial resection.

The Knee Society Score was administered, and records were reviewed for complications, reoperations, and revisions at a mean of four years. As the procedures were performed at the regional referral medical center for a five-state area, not all patients were able to return for in-person evaluation. Mean KSS scores and the risk of fair/poor knee scores were compared between groups.

Results

Pre-operative demographics and patient factors were similar between the two groups. In both groups, the primary diagnosis was osteoarthritis with the remainder having various forms of inflammatory arthritis. Pre-operative KSS between the MIS and traditional TKA patients were not significantly different (35.6 vs. 34.2 out of 100, p=n.s.)

At a mean of four years (MIS) and five years (traditional), the average Knee Society Score was excellent in both groups, but not different between the MIS and traditional TKA cohorts (85.8 vs. 85.6, respectively, p=n.s.).

No radiographic loosening was seen in either group.

Three of the 100 MIS TKA patients have had re-operation or revision, two for infection and one for knee stiffness. Two of the 50 in traditional TKA cohort were revised, one for a flexion contracture the other for knee stiffness. The difference was not statistically significant.

Four of 100 MIS TKA patients had a fair or poor KSS at final follow-up (two fair, two poor). Two of 50 traditional TKA patients had a fair or poor KSS (one each; p=n.s.).

Discussion

Potential benefits of minimally invasive surgical approaches include less surgical dissection, decreased blood loss, less post-operative pain, earlier return to function, and a smaller incision.[1-4] While several studies have suggested a higher rate of component malposition with the minimally invasive approach[5,6], other studies[8-10] have not found component malposition to be a problem. Component malalignment can be a cause of TKA failure.

In our previous study, we saw an improvement in patellar alignment as the primary surgeon worked through the early part of the learning curve.[2] Although patellar alignment was within the range of that reported in studies with the use of traditional approaches,[14] we wondered whether the differences noted would affect intermediate-term performance of the arthroplasties (in terms of later patellofemoral complications, inferior knee scores, or excess revisions).

This did not appear to be the case. The mean Knee Society Score in both the traditional and MIS groups was in the excellent range; with the numbers available, there were no significant differences noted between the groups. The risk of a fair or poor outcome, likewise, was not different between approaches. There was no radiographic loosening noted in either group of

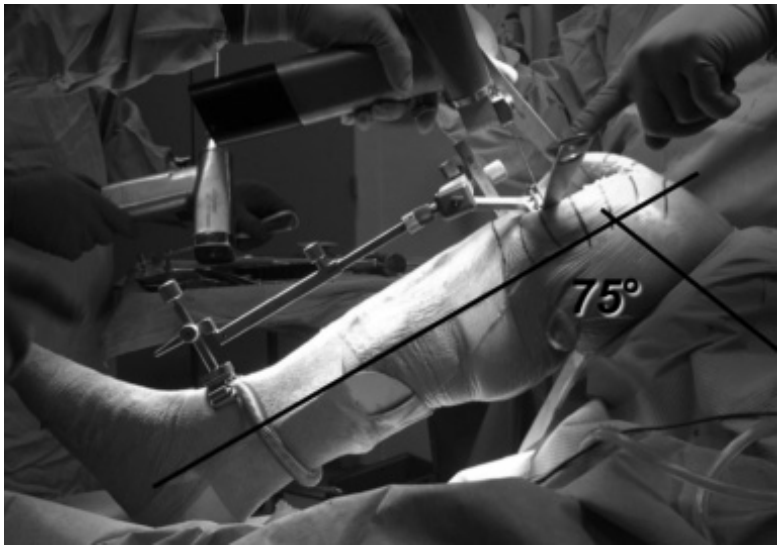


Figure 3: In MIS TKA, the tibiofemoral joint is not placed in hyperflexion nor is it dislocated during the procedure; rather, gentle flexion is maintained, while the tibia and femur are cut *in situ* from the medial or anteromedial side.

patients, and no patients were revised for loosening. The overall risk of re-operation and revision was similarly low in both groups, and within range of that reported in other TKA series.

In light of the observed improvements in early recovery following surgery[1, 3, 4], our ability to achieve accurate implant alignment without an increase in short-term complications[2], and the durability of these reconstructions at intermediate term demonstrated here, which appears comparable to that of the traditional approach to TKA, we continue to use the MIS approach in our primary TKA patients. However, because of the learning curve involved,[2] we remain uncertain about whether the approach is generalizable to low-volume arthroplasty surgeons.

References

1. Anderson JG, Wixson RL, Tsai D, Stulberg SD, Chang RW. Functional outcome and patient satisfaction in total knee patients over the age of 75. *J Arthroplasty.* Oct 1996;11(7):831-840.

2. King J, Stamper DL, Schaad DC, Leopold SS. Minimally invasive total knee arthroplasty compared with traditional total knee arthroplasty. Assessment of the learning curve and the postoperative recuperative period. *J Bone Joint Surg Am.* Jul 2007;89(7):1497-1503.

3. McAllister CM, Stepanian JD. The impact of minimally invasive surgical techniques on early range of motion after primary total knee arthroplasty. *J Arthroplasty.* Jan 2008;23(1):10-18.

4. Tria AJ, Jr., Coon TM. Minimal incision total knee arthroplasty: early experience. *Clin Orthop Relat Res.* Nov 2003(416):185-190.

5. Chin PL, Foo LS, Yang KY, Yeo SJ, Lo NN. Randomized controlled trial comparing the radiologic outcomes of conventional and minimally invasive techniques for total knee arthroplasty. *J Arthroplasty.* Sep 2007;22(6):800-806.

6. Dalury DF, Dennis DA. Mini-incision total knee arthroplasty can increase risk of component malalignment. *Clin Orthop Relat Res.* Nov 2005;440:77-81.

7. Barrack RL, Barnes CL, Burnett RS, Miller D, Clohisy JC, Maloney WJ. Minimal incision surgery as a risk factor for early failure of total knee arthroplasty. *J Arthroplasty.* Jun 2009;24(4):489-498.

8. Bonutti PM, Mont MA, McMahon M, Ragland PS, Kester M. Minimally invasive total knee arthroplasty. *J Bone Joint Surg Am.* 2004;86-A Suppl 2:26-32.

9. Haas SB, Cook S, Beksac B. Minimally invasive total knee replacement through a mini midvastus approach: a comparative study. *Clin Orthop Relat Res.* Nov 2004(428):68-73.

10. Laskin RS, Beksac B, Phongjunakorn A, et al. Minimally invasive total knee replacement through a mini-midvastus incision: an outcome study. *Clin Orthop Relat Res.* Nov 2004(428):74-81.

11. Sharkey PF, Hozack WJ, Rothman RH, Shastri S, Jacoby SM. Insall Award paper. Why are total knee arthroplasties failing today? *Clin Orthop Relat Res.* Nov 2002(404):7-13.

12. Ritter MA, Faris PM, Keating EM, Meding JB. Postoperative alignment of total knee replacement. Its effect on survival. *Clin Orthop Relat Res.* Feb 1994(299):153-156.

13. Fehring TK, Odum S, Griffin WL, Mason JB, Nadaud M. Early failures in total knee arthroplasty. *Clin Orthop Relat Res.* Nov 2001(392):315-318.

14. Barrack RL, Wolfe MW. Patellar resurfacing in total knee arthroplasty. *J Am Acad Orthop Surg.* Mar-Apr 2000;8(2):75-82.

Injuries in Seattle Area Female Club Gymnasts

John W. O'Kane, M.D., Marni R. Levy, Kristin E. Pietila, M.S., Dennis J. Caine, Ph.D., and Melissa A. Schiff, M.D., M.P.H.

Abstract

In this cross-sectional survey we evaluate the incidence, distribution, and contributing factors to injury in club gymnastics. Ninety-six club gymnasts from competitive levels 4-10 completed a questionnaire regarding demographics, injuries and contributing factors, and exposure time in the last competitive season. Acute injury rate was 1.3 per 1000 hours and was 3.6-fold greater (95% CI, 1.6-9.1) among 10-12 year olds and 3.1-fold greater (95% CI 1.3-8.0) among 13-17 year olds compared to 7-9 year olds. The most common acutely injured body parts were foot (21.0%), ankle (19.3%), knee (14.0%), and wrist (8.8%). The overuse injury rate was 1.8 per 1000 hrs primarily affecting the same body parts and low back. Most injuries occurred on floor exercise (32.1%), beam (20.7%), and bars (17.0). Injury was most common during landing (49%). During their gymnastics careers, concussions occurred in 30.2% and stress fractures affecting mostly low back and foot occurred in 16.7% of the gymnasts.

Study Rationale and Context

Artistic gymnastics is popular with 90,000 competitive gymnasts in the United States. Few epidemiological studies of injuries affecting female gymnasts have been conducted since 2000[1,2] and these focused mostly on older gymnasts.

Objective

Describe the incidence and types of gymnastics injury at different ages and levels of competition and evaluate factors associated with injury.

Methods

- Cross-sectional survey of 5 randomly selected gyms.
- A questionnaire was completed by 96 gymnasts ranging from competitive level 4 (least experienced with easiest skills) to level 10 (highest degree of difficulty)
- The questionnaire requested information on demographics, gymnastics level, acute and overuse injuries, injury type and circumstances of injury, and practice and competition exposure time (see O'Kane et al '12 for full description of survey and statistical analysis).[3]
- We also questioned each gymnast about lifetime occurrence of concussion symptoms following a blow to the head (a list was provided) and stress fractures resulting from gymnastics.
- We analyzed our data using descriptive statistics, comparing gymnasts with and without injuries, using chi-square testing.
- Regarding acute and overuse injuries, we calculated cumulative incidence (number of gymnasts injured divided by the total number of gymnasts) and incidence rates (number of injuries divided by number of hours training or competing) along with 95% confidence intervals. We also calculated injury incidence rates stratified by practice and competition; age categories 7-9, 10-12, and 13-17 years; and by level 4, 5, 6, 7-10. We compared these rates by age and level using relative risks and 95% confidence intervals.
- UW Institutional Review Board approved the study.

Variable	Acute Injury* N=40 Number (%)	No Acute Injury* N=56 Number (%)
Age(years) [a]		
7-9	8 (20)	29 (51.8)
10-12	14 (35.0)	20 (35.7)
13-17	18 (45.0)	7 (12.5)
Level [a]		
4	2 (5.0)	17 (30.4)
5	11 (27.5)	19 (33.9)
6	4 (10.0)	8 (14.3)
7-10	23 (57.5)	12 (21.4)
Body Mass Index for age (percentiles)		
<10	2 (5.3)	8 (15.1)
10-50	14 (36.8)	17 (32.1)
51-90	22 (57.9)	26 (49.0)
>90	0	2 (3.8)
Post-Menarchal [b]	14 (35.0)	7 (13.0)
Time doing competitive gymnastics (years) [a]		
1-2	9 (22.5)	27 (48.2)
3-4	9 (22.5)	20 (35.7)
5-7	14 (35.0)	8 (14.3)
8-10	8 (20.0)	1 (1.8)
Number of practice hours / week [a]		
2-9	3 (7.5)	15 (26.8)
10-13.5	11 (27.5)	26 (46.4)
14-18	8 (20.0)	9 (16.1)
19-25	18 (45.0)	6 (10.7)
Plays other sports	23(62.2)	24 (46.2)

Table 1: Demographic and gymnastics characteristics for level 4-10 gymnasts comparing acute injury and no acute injury, Seattle 2010.

*Totals may not add to overall total due to missing data
a=p<0.011
b=p<0.05
c=p=0.07

	Number Injuries	AE Hours	Rate (95% CI)	RR (95% CI)
Age (years)				
7-9	8	15497	0.5 (0.2-1.0)	1.0 (ref)
10-12	26	14159	1.8 (1.2-2.7)	3.6 (1.6-9.1)*
13-17	24	15043	1.6 (1.0-2.4)	3.1 (1.3-8.0)*
Level				
4	5	5771	0.9 (0.3-2.0)	1.0 (ref)
5	13	11827	1.1 (0.6-1.9)	1.3 (0.4-4.5)
6	8	5950	1.3 (0.6-2.6)	1.6 (0.4-6.0)
7-10	32	21148	1.5 (1.0-2.1)	1.7 (0.7-5.7)

Table 2: Comparison of acute injury rates by age and by level for level 4-10 gymnasts, Seattle 2010.

*Statistically significantly different

Results

- The gymnasts reported a 57.6% lifetime cumulative incidence of acute injury and 43.5% reported an injury in the study season. The acute injury rate was 1.3 per 1000 hours (95% Confidence Interval (CI) 1.0-1.7).
- Table 1 lists demographic and gymnastics characteristics comparing those acutely injured and non-injured. High or low BMI and playing other sports were not associated with more acute injuries.
- Table 2 compares acute injury rates by age and level revealing more acute injuries with age but not competitive level.
- The most common acutely injured body parts were foot (21.0%), ankle (19.3%), knee (14.0%), and wrist (8.8%).
- The gymnasts reported a 52.7% lifetime cumulative incidence of overuse injury and 40.7% reported an overuse injury in the study season. The percentage of gymnasts reporting an overuse injury increased with age and increasing level of participation but the overuse injury rate, 1.8 per 1000 hours (95% CI 1.5-2.2), did not vary significantly.
- The most common overuse injuries were low back (18.4%), foot (17.2%), knee (15.9%), ankle (13.2%), and wrist (9.2%).
- During their career, concussion symptoms following a hit to the head were reported by 29 (30.2%) of the gymnasts. Stress fractures were reported by 16 (16.7%) of the gymnasts, 50% of which involved the low back.
- Floor exercise was associated with the greatest percentage of acute injuries (32.1%) followed by beam (20.7%), and bars (17.0). Landings accounted for 49% of all injuries.
- Most injuries occurred in practice (84%).

Discussion

- Our acute injury rate, 1.3 per 1000hrs, compares favorably with other sports such as youth soccer, (3.0 per 1000hrs)[4] although a significant proportion of gymnasts surveyed had been injured, likely a function of the high number of hours spent training.
- Prior studies have found that older gymnasts are more likely to be injured, with periods of rapid growth one established risk factor.[2] We found that increasing age was a risk factor but increasing level of competition was not, suggesting growth and other post-pubertal physiologic changes are more responsible for injury than the increasing difficulty of skills attempted at higher levels.
- Prior studies have not asked about symptoms of concussion and have reported very low rates of head injury.[2] By specifically asking about concussion symptoms, we found a 30% lifetime incidence of concussion. This finding is surprising and concerning suggesting club gymnasts need to be made aware of concussion symptoms and instructed to report them to coaches so they can be referred to physicians experienced in their management.
- Nearly half of all acute injuries occur with landing a skill. Injury prevention efforts should focus on appropriate spotting and other protection (mats and landing pits) during landings.
- This study is limited by the retrospective data collection and future studies with prospective assessment of injuries and risk factors are needed in this high risk population of athletes.

References

1. Marshall SW, Covassin T, Dick R, et al. Descriptive epidemiology of collegiate women's gymnastics injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. J Athl Train. 2007;42:234-240.

2. Caine DJ, Nassar L. Gymnastics injuries. In: Caine DJ, Maffulli N (eds.) Epidemiology of Pediatric Sports Injuries. Individual Sports. Med Sport Sci. Basel, Karger, 2005;48:18-58.

3. O'Kane JW, Levy MR, Pietila KE, Caine DJ, Schiff MA. Survey of Injuries in Seattle Area Level 4-10 Female Club Gymnasts, Clin J Sport Med 2011;21(6): 486-492.

4. Schiff MA, Mack CD, Polissar NL, Levy MR, Dow SP, O'Kane JW. Soccer injuries in female youth players: Comparison of injury surveillance by certified athletic trainers and internet. J Athl Train. 2010 May-Jun;45(3):238-42.

Jump Biomechanical Properties and Injuries in Female Youth Soccer Players

Allan F. Tencer, Ph.D., John W. O'Kane, M.D., Nayak Polissar, Ph.D., Lori Sabado, P.T., B.S., Marni Levy, Christopher Mack, M.S., and Melissa A. Schiff, M.D., M.P.H.

Abstract

Soccer is the fifth most popular sport in the United States, (1) with an estimated 8.6 million players from 6-11 years old and 5 million from 12-17 years old (2). The injury rate is high, with lower extremity injuries predominating. Several studies have addressed some aspects of soccer injuries (3, 4). The focus of this five year study has been to determine whether there is a relation between a comprehensive series of measures including biomechanics of jumping, to injuries recorded in the sample. Though still preliminary, an analysis of jump mechanics showed that significant ankle and knee valgus bending moments and axial torsion occur during landing from a jump. Also a considerable number of subjects (31%) had valgus angulation at the knee of 10 deg or greater. Valgus angulation combined with high valgus moments could be a potential source of knee or ankle trauma.

Acute soccer injuries	no	proportion
Hip (adductor, flexor, rectus femoris strains)	9/228	3.9%
Leg (tibial fracture, contusions, strains)	31/228	13.6%
Knee (ACL, MCL, meniscus tears, sprain, strain	40/228	17.5%
Foot and Ankle (contusion, sprain)	70/228	30.7%
Head and neck (Concussion, contusion)	49/228	21.5%
Upper Extremity (elbow, forearm, hand sprian, contusion)	18/228	7.9%
Back (lumbar spine, rib, muscle strain, contusion)	11/228	4.8%

Table 1: Location and rates of injury for Seattle youth soccer players.

Jump landing forces	mean	sdev	units
anterior shear of shoe against floor	-403.1	155.9	N
compressive impact against floor	2126.3	642.8	N
R foot inversion, L foot eversion	-72.8	53.8	N-m
L foot inversion, R foot eversion	91.9	86.9	N-m
ankle flexion moment	118.3	53.9	N-m
ankle torque, CCW	-30.0	21.7	N-m
ankle torque, CW	32.7	13.8	N-m
no of samples	420		
Knee angles at landing			
Right knee valgus	8.5	7.2	deg
Left knee valgus	7.9	7.3	deg
Right knee flexion	56.7	19.2	deg
Left knee flexion	48.4	10.6	deg
no of samples	329		

Table 2: Summary of jump landing forces and moments as well as angles at the knee during a two legged landing from a jump off a 12" high box.

Introduction

Among the 420 female youth soccer players enrolled in the study, Table 1 shows the proportions and locations of 228 acute injuries. Some players had multiple injuries. These ranged from contusions and sprains to factures and a small number of ligament tears, mostly at the knee and ankle. The focus of this study was to assess a comprehensive set of factors which might relate to the high rate of injury in female youth soccer players.

Materials and Methods

- We randomly selected 33 elite girls' U13 to U15 soccer teams from several Seattle area soccer associations. The participation rate was 83%. Team membership, female gender, and age between 12 and 14 years were the only requirements for inclusion in the study. This study was approved by the University of Washington's Institutional Review Board, and subjects and their parents provided written assent and consent respectively, prior to participation.
- Assessments included dynamic muscle strength, joint flexibility, pre and post jump lower extremity geometries, Figure 1, jump landing joint forces, background information on participation, types of shoes worn, and injury evaluations.
- For this component of the study, the subjects jumped off a 12" high box onto a force plate which recorded impact landing forces and joint moments. Video recordings were made of the jumps from which video frames of the landings were analyzed. Single and double leg jumps were performed.

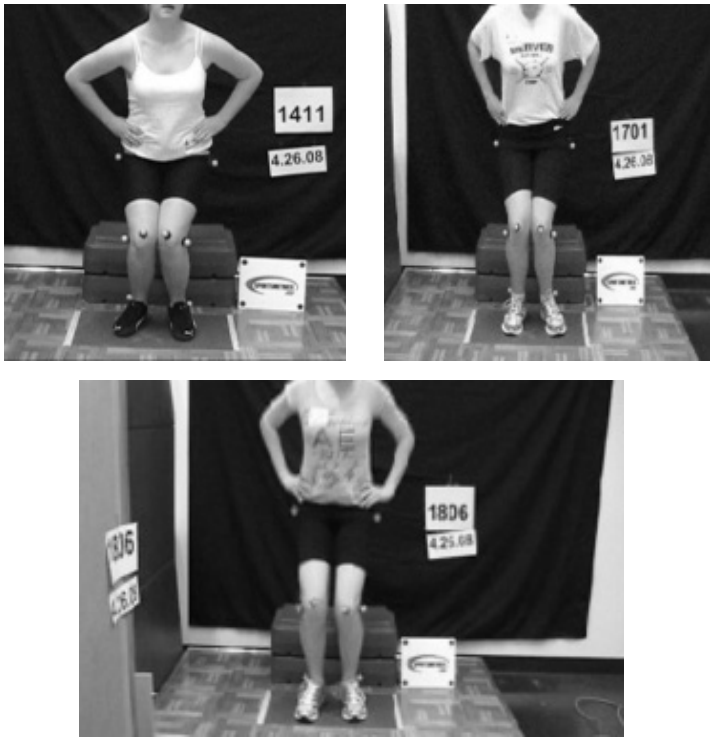


Figure 1: Above left, bilateral knee valgus, above right, unilateral knee valgus, lower, minimal valgus landings after jumping off a box (blue box) onto a force plate (grey area on floor).

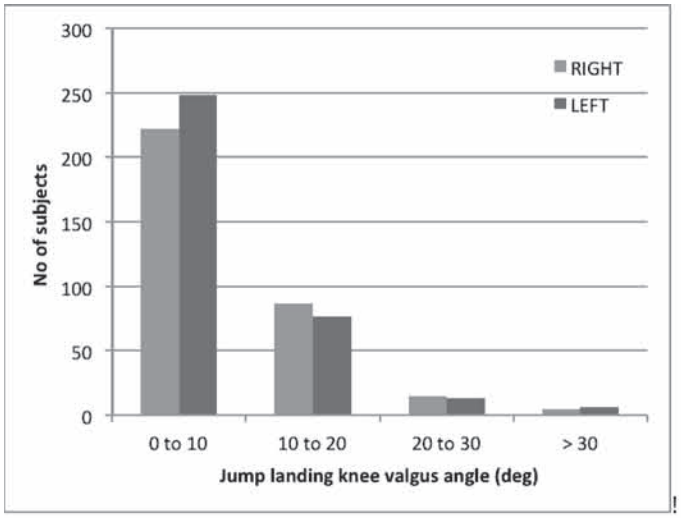


Figure 2: Number of subjects separated by knee valgus angle at landing from a jump.

Results

- As shown in Figure 1, knee landing geometries ranged from symmetrical low knee valgus angles to unilateral valgus to bilateral valgus.
- In landing a jump on both legs, shown in Table 2 and Figure 2, 222/329 (67%) subjects had valgus angles of the right leg of less than 10 deg, while 87 (26%) measured between 10 and 20 deg and 20 (6%) had more than 20 deg of valgus.
- Forces at the knee and ankle were quite high, Table 2. Compressive impact averaged 2126 N (nearly 5 times body weight) while knee and ankle valgus torques (73-92 N-m) and axial torques (30-33 N-m) were high. For a physical comparison of the level of knee moments, the flexion moment averaged 118 N-m but is resisted by the quadriceps. However, the valgus and axial torsional joint moments are resisted only by joints and ligaments as opposed to muscles.

Discussion

Lower extremity injury rates in our random sample of female youth soccer players were high over the course of the study. These injuries varied in severity but all resulted in time loss from soccer. Jump mechanics are but one component of the study, but give insight into both the large forces and moments generated at the joints and also the joint misalignment caused by valgus landings which could be a factor in acute injuries. A separate component of the study also addresses overuse injuries. If the correlations between injury and the factors analyzed here hold, then possible corrective actions, such as shoe insoles that reduce valgus deformity might be a prevention measure to consider.

References

1. National Federation of State High School Associations. High School Athletics Participation Study 2008-9. [database on the Internet] [cited July 27, 2010]. Available from: www.nfhs.org/content.aspx?id=3282&linkidentifier=id&itemid=3282.

2. Sporting Goods Manufacturer's Association. Teens & Sports Participation in America. 2001. Available from: www.sgma.com. Accessed July 29th, 2010.

3. Brink M, Visscher C, Arends S, Zwerver J, Post W, Lemmink K. Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players. Br J Sports Med. 2010 May.

4. Gissis I, Papadopoulos C, Kalapotharakos V, Sotiropoulos A, Komsis G, Manolopoulos E. Strength and speed characteristics of elite, subelite, and recreational young soccer players. Res Sports Med. 2006 2006 Jul-Sep;14(3):205-14.

Open Reduction and Intramedullary Stabilization of Subtrochanteric Femur Fractures

David P. Barei, M.D., Daphne M. Beingessner, M.D., and Sean E. Nork, M.D.

Abstract

The unique anatomy and biomechanical forces in the subtrochanteric region of the femur makes the management of fractures in this location substantially more difficult. With intramedullary (IM) nailing, the combination of the high biomechanical forces that naturally occur in this region, the copious dimensions of the metaphysis relative to the medullary implant and lack of direct cortical fracture support commonly results in a predictable, angular loss of reduction that is poorly tolerated biomechanically as the implant must bear the entire bending load. Clinically, this is manifested as protracted hip and thigh pain, disability, leg length inequality, nonunion, and the need for subsequent procedures. Open reduction and IM nailing of fractures to improve fracture reduction is, however, generally discouraged due to fear of bone devascularization and resultant impaired bone healing capacity. This retrospective study of 56 patients with high-energy subtrochanteric femur fractures demonstrates that careful open reduction of these fractures and IM nail stabilization achieves an excellent reduction with all patients uniting their fractures without the need for subsequent procedures.

Figure 1a: This 48-year old male fell 14 feet from a ladder at his workplace. The AP pelvis and lateral left hip radiographs demonstrate a displaced minimally comminuted subtrochanteric femur fracture.

Introduction

Both lateral plate constructs and IM nails have been used with some success for the treatment of subtrochanteric fractures. Plates have an eccentric location relative to the mechanical axis of the femur, making them biomechanically inferior to nails in bending, but because of their open application, facilitate a direct open reduction. IM nails are advantageous biomechanically due their central location, but are usually performed with closed techniques, thereby relying on radiographic confirmation of reduction. With design modifications that provided fixation into the femoral head, expansion of the indications for IM nailing occurred, allowing surgeons to take advantage of the improved biomechanics of IM nails in more proximal femoral fractures. Plating techniques for proximal femur fractures have also evolved to include the use of indirect fracture reduction techniques, locking screw/plate technology, and the liberal use of bone graft and bone graft substitutes to enhance the biologic fracture healing response. This has resulted in 2 competing philosophical approaches to the subtrochanteric femur fracture: mechanically superior percutaneous IM nailing in a vascular environment limited by the need for good closed fracture reduction with technically challenging nail starting point compared to a mechanically inferior device plate/screw implant requiring an open somewhat devascularizing approach which however allows for anatomic fracture reduction. Suboptimal outcomes have been demonstrated with both of these approaches. The purpose of this study was to evaluate the complications and successes in a consecutive series of patients with closed subtrochanteric femur fractures treated with a combination treatment consisting of open reduction and reamed antegrade statically locked intramedullary nailing.

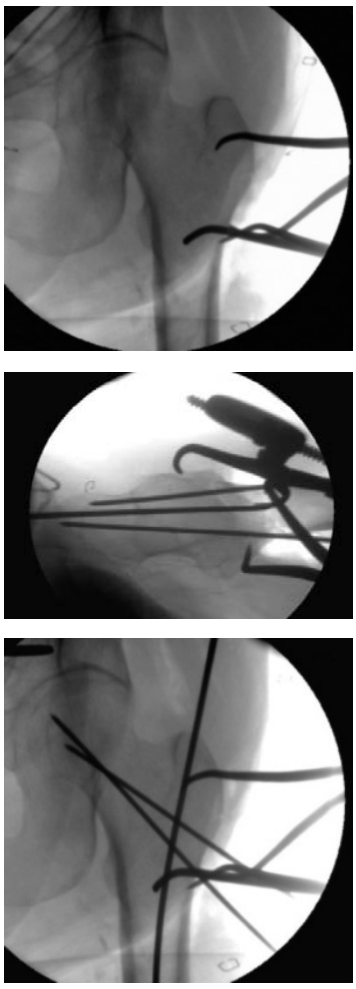


Figure 1b: The intraoperative fluoroscopic views demonstrate an anatomic clamp-assisted open reduction. A medial trochanteric starting point for the anticipated nail position can also be identified.

Materials/Methods

- Over a 7.5-year period, 154 adult patients with a closed subtrochanteric femur fracture treated with reamed statically locked IM nailing were retrospectively reviewed. Fifty-six fractures required an open reduction prior to nailing and formed the study group. All had adequate followup to determine union.

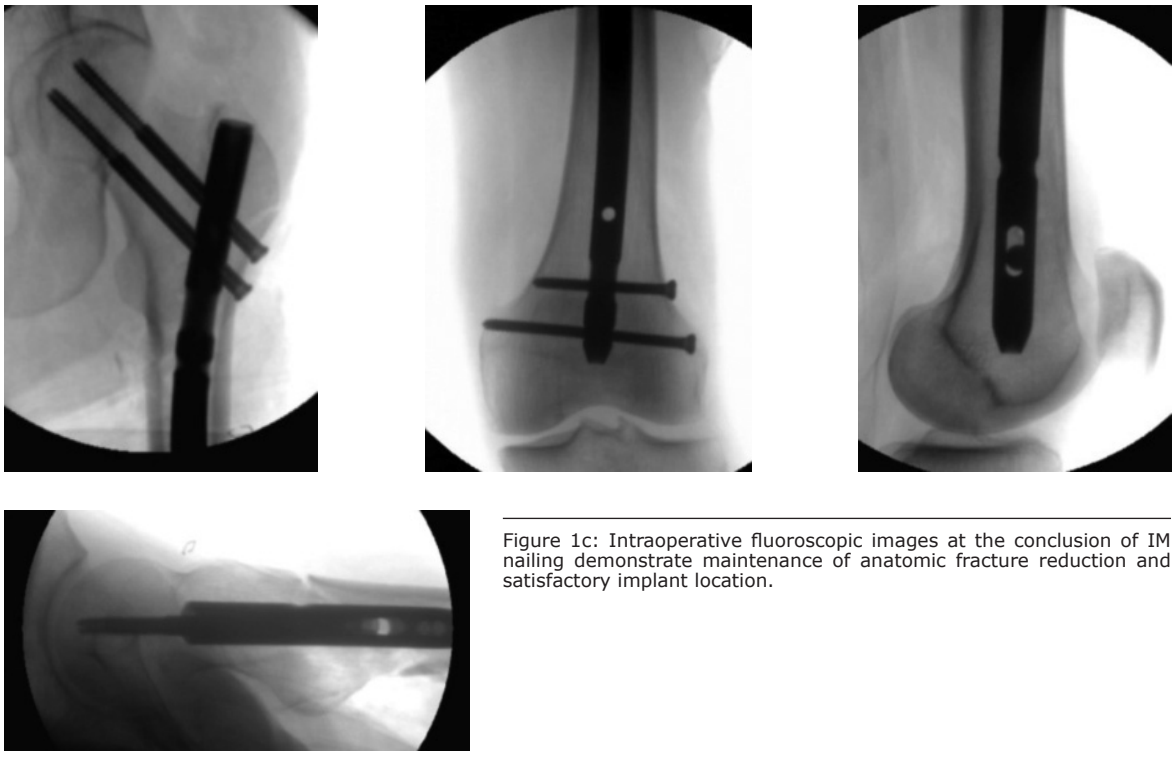


Figure 1c: Intraoperative fluoroscopic images at the conclusion of IM nailing demonstrate maintenance of anatomic fracture reduction and satisfactory implant location.

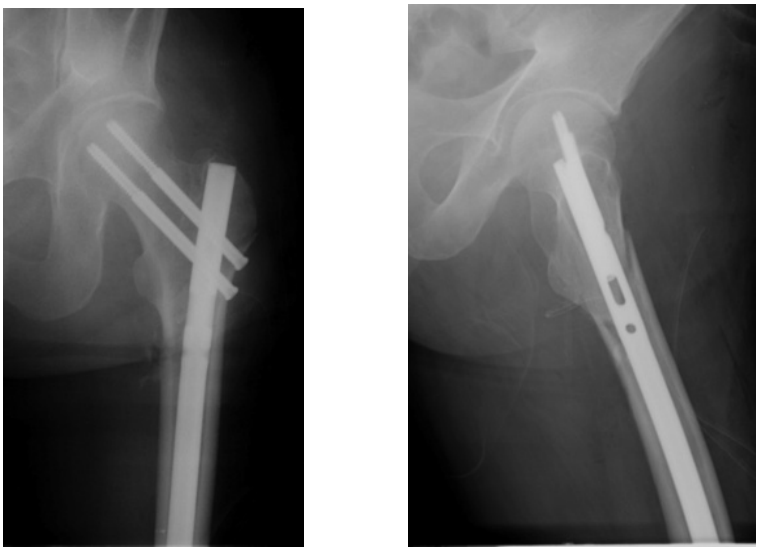


Figure 1d: Immediate post-operative plain radiographs.

- Records were reviewed for demographic data, mechanism of injury, operative technique, adequacy of reduction, and complications, including those affecting union.
- A subtrochanteric fracture was defined as a proximal shaft fracture with the primary fracture line within five centimeters of the lesser trochanter, or a reverse-obliquity pertrochanteric fracture pattern extending into this region. Displaced intertrochanteric fractures with distal extension were excluded, fractures distal to the lesser trochanter with an undisplaced extension proximally into the greater trochanter were included.
- Union was defined clinically and radiographically at a minimum of 12 weeks by a lack of pain with weight bearing and continuous bone on at least three cortices. Nonunion was defined as a lack of progression of healing on successive radiographs at a minimum of 6 months, or the need for a secondary procedure to achieve union.
- Anatomic alignment was defined as lack of measurable or perceptible deviation in either the coronal or sagittal plane based on orthogonal radiographs. Length and rotation were examined clinically. A minor malreduction was defined as measurable but <5 degrees of angulation. A major malreduction was defined as >= 5 degrees of angulation.

Operative Technique

- Supine positioning on a radiolucent operating table with the limb draped freely. Open reduction through a lateral approach was performed if initial closed reduction failed.
- Access via a pre-existing

Figure 1e: Anteroposterior and lateral plain radiographs of the left hip demonstrate a united anatomically-aligned fracture without any change in alignment or implant placement.

muscular rent was utilized wherever available through a lateral skin incision. Additional muscular elevation was minimized and performed extraperiosteally if needed.

- Pointed clamps and 2.5 millimeter cortical drill holes to allow a 'foothold' for the points through muscle were used whenever possible to minimize soft tissue dissection. Other temporary stabilization methods included Kirschner wires and manual manipulation with Schanz pins, hooks and pushers. After reduction, reamed antegrade nailing was performed using a separate incision for starting point identification, reaming, and nail placement.

Results

- In our series, our surgeons preferred treated the majority of fractures with cephalomedullary nails in 91%) compared to conventional interlocking nails in the rest of injuries.
- All 56 fractures treated with an open approach united.
- Radiographic fracture callus appeared in 51 (91%) patients within 60 days, and in all cases by 121 days.
- There were no deep infections and no wound complications.
- 6 patients required removal of proximal or distal interlocking bolts for relief of local symptoms.
- There was no loss of radiographic alignment from the immediate postoperative radiographs to union. The final alignment was anatomic in 82%. Nine patients had a minor malreduction of ≤ 5°. One patient had a 7° varus deformity. Therefore, a final deformity of less than five degrees was observed in 98%.

Discussion

Malreduction, nonunion, and malunion, especially in form of varus and external rotation deformities often complicate the management of subtrochanteric femur fractures. Lateral plate constructs have an eccentric location relative to the mechanical axis of the femur, making them biomechanically inferior to nails under bending load conditions. IM nails are advantageous biomechanically due their central location, particularly with design modifications that provide fixation into the femoral head.

Given previous reports of malunion and nonunion of subtrochanteric femur fractures, we prioritized a quality reduction prior to initiating nailing. Our treatment philosophy emphasized the biomechanical load sharing capacity of an accurately reduced proximal femoral segment, making the final construct less implant-dependent and also facilitating optimal IM nail placement. Our approach to achieve optimal fracture reduction followed a progressive exposure tactic, starting from a closed attempt to percutaneous manipulation and finally open reduction if less-invasive techniques were not successful. The obvious concern of our combined open reduction and reamed IM fixation approach was that of higher rates of infection or nonunion (Figure 1). We suggest limiting this technique to patients without extensive comminution. A direct open reduction is ideally accomplished when there are major reducible fragments.

In conclusion, a careful open reduction with minimal additional soft tissue disruption combined with intramedullary nailing of complex subtrochanteric femur fractures was associated with an anatomic reduction and implant placement, maintenance of alignment, a high rate of union and rare complications.

References

1. Wiss DA, Brien WW. Subtrochanteric fractures of the femur. Results of treatment by interlocking nailing. Clin Orthop Relat Res. 1992:231-236.

2. French BG, Tornetta P, 3rd. Use of an interlocked cephalomedullary nail for subtrochanteric fracture stabilization. Clin Orthop Relat Res. 1998:95-100.

3. Russell TA, Mir HR, Stoneback J, et al. Avoidance of malreduction of proximal femoral shaft fractures with the use of a minimally invasive nail insertion technique (MINIT). J Orthop Trauma. 2008;22:391-398.

4. Afsari A, Liporace F, Lindvall E, et al. Clamp-assisted reduction of high subtrochanteric fractures of the femur. J Bone Joint Surg Am. 2009;91:1913-1918.

5. Kinast C, Bolhofner BR, Mast JW, et al. Subtrochanteric fractures of the femur. Results of treatment with the 95 degrees condylar blade-plate. Clin Orthop Relat Res. 1989:122-130.

A Quantitative Analysis of the Congruity of Hemi-hamate Arthroplasty

Nathan Coleman, M.D., Jerry I. Huang, M.D.,
and Peter R. Cavanagh, Ph.D., D.Sc.

Abstract

- Hemi-hamate arthroplasty is performed for complex PIP fracture-dislocations involving more than 50% of the joint surface that are not amenable to primary fixation.
- The aim of this study was to quantify the goodness of fit of the dorsal hemi-hamate bone graft with the base of the middle phalanx that it is used to replace.
- CT scans of patients with intact proximal inter-phalangeal joints and uninjured hamate bones were converted to point clouds after operator-guided segmentation. The portion of the hamate that is used to replace the phalangeal base was defined though "virtual surgery" and the congruence between the two surfaces was determined by an optimization technique called Iterative Closest Point procedure (ICP).
- The results indicated that portions of the hamate can be a remarkably good substitute for the base of the middle phalanx with typical average residual errors of less than 0.5mm. Different portions of the hamate were identified for the optimal fit in different specimens.
- This approach can be adapted to any joint where a transfer is being contemplated to replace a badly fragmented articular surface.

Introduction

- The hemi-hamate arthroplasty is performed in proximal inter-phalangeal joint injuries of the hand when more than 50% of the articular surface is involved, when the fracture is unstable, or when it is highly comminuted.
- In this procedure, the dorsal portion of the ipsilateral hamate distal articular surface is excised, and transferred to the defect at the volar base of the middle phalanx. The hamate has a prominent ridge (from its articulation with the 4th and 5th metacarpal bones), which mimics the inter-condylar ridge of the native phalangeal base.
- Prior studies of the 'goodness of fit' of the hamate explant with the bone it is replacing have been either subjective in nature or they have used two-dimensional techniques which do not adequately characterize the three-dimensional surfaces involved.
- We have developed a method to quantify the 'goodness of fit' of the procedure in 3D based on segmentation of CT scans, conversion of the articular surfaces to point clouds, and the use of mathematical optimization techniques.

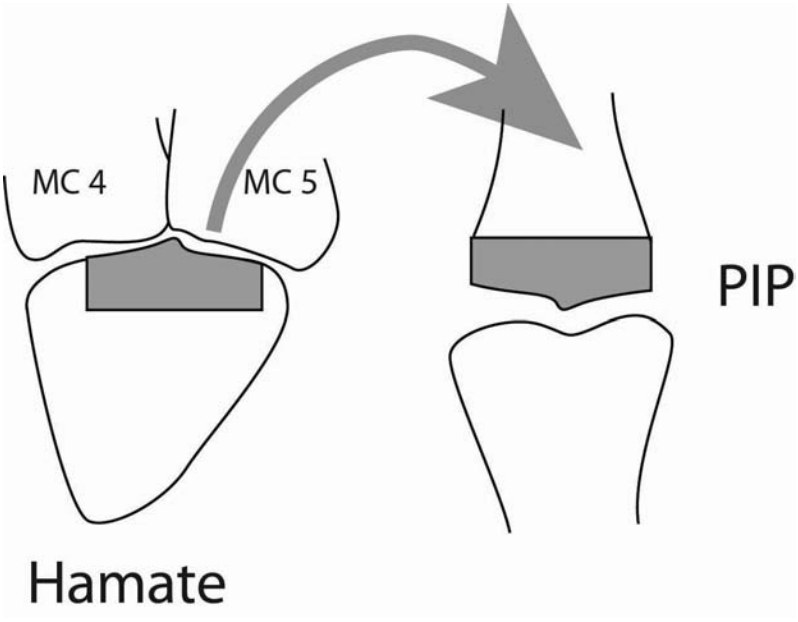


Figure 1: Schematic drawing of the hemi-hamate arthroplasty.

Methods

- CT scans with 0.6mm slices that included the hamate and all PIP joints from 3 patients (2 females, 1 male, mean age 33 years) who had pathology elsewhere in the hand were analyzed.
- The resulting CT slices were imported into ScanIP (Simpleware, Exeter, UK) where voxels representing the bones of interest were segmented from the remaining bone and saved as stereolithography (.STL) files (see Figure 2).
- Custom software was developed in MATLAB (Mathworks, Natick, MA) to perform "virtual surgery" on point clouds extracted from the bones (Figure 3).
- An initial alignment of the two resulting bone segments was performed by collocating the point cloud centroids after a 180 degree rotation of the hamate. This initial alignment

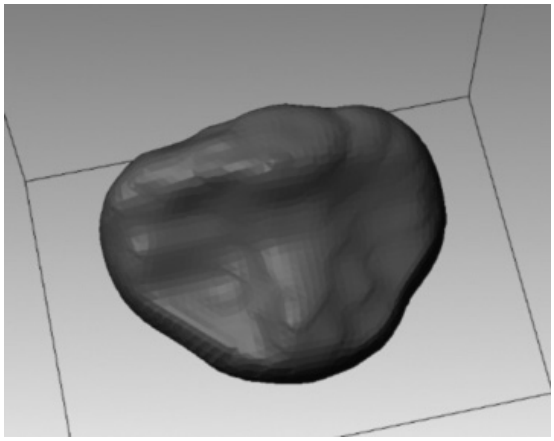


Figure 2A: The base of the middle phalanx seen from a proximal viewpoint (volar lip at the top).

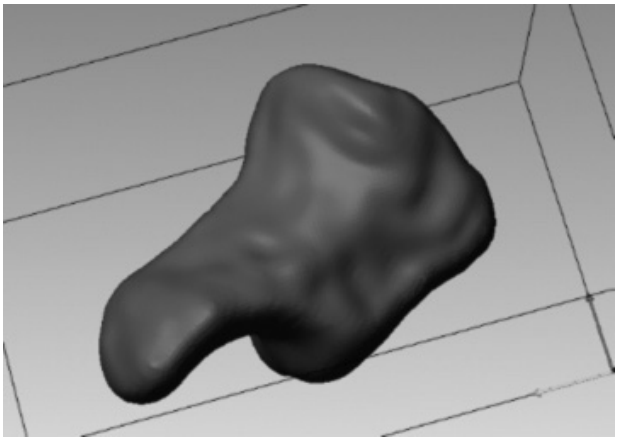


Figure 2B: The segmented hamate bone from the same individual as in Figure 2A (not to the same scale).

increased the probability of finding a global, rather than local, minimum in the subsequent optimization step.

- An optimization technique called Iterative Closest Point procedure was then performed in MATLAB using a cost function that minimized the distance of all points on the extract of the base from their nearest neighbor points on the surface of the hamate. The point cloud representing the base was systematically rotated and translated in relation to the hamate many thousands of times until a minimum residual was found.

Results

- The ICP procedure aligned the volar lip and central ridge of the base with the dorsal lip and central ridge of the hamate. Figure 4A shows an example of the optimal placement of the segments that are presented in Figure 3. The distance from the phalangeal base to the surface of the hamate is shown in Figure 4B. It is apparent that the two surfaces are remarkably congruent with a maximum error of ~0.3 mm. The average nearest neighbor

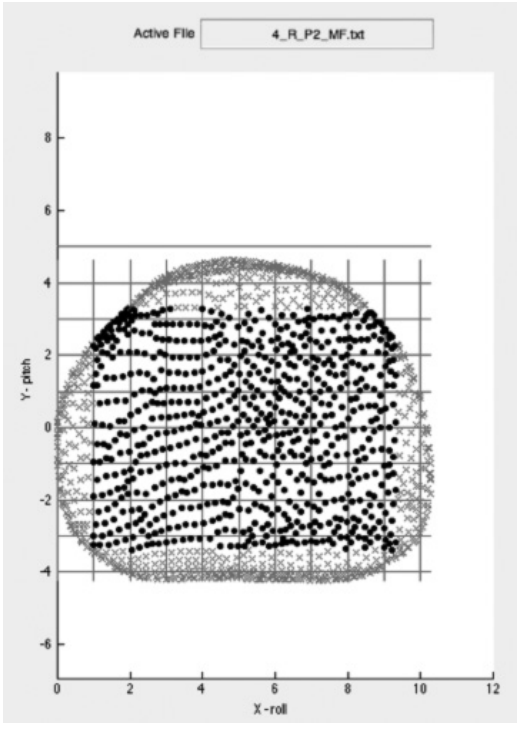


Figure 3A: Point cloud of the extracted articulating surface of the base of the middle phalanx of the middle finger (lighter points deleted).

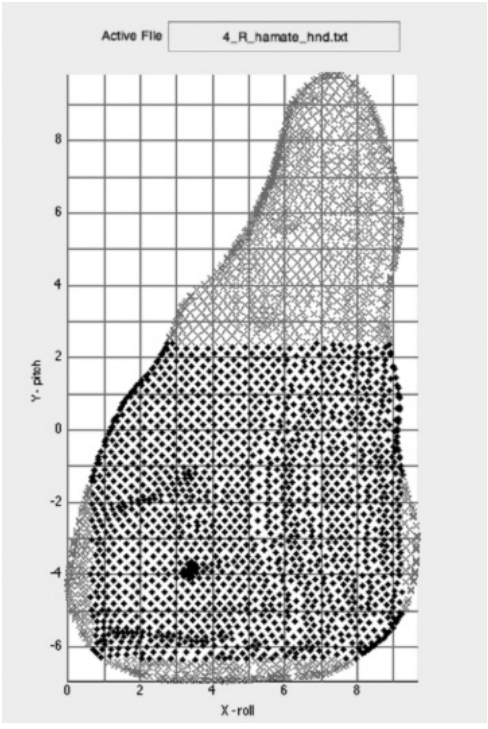


Figure 3B: Point cloud of the portion of the hamate from the same subject as Figure 3A that is available for transfer after virtual surgery (lighter points deleted).

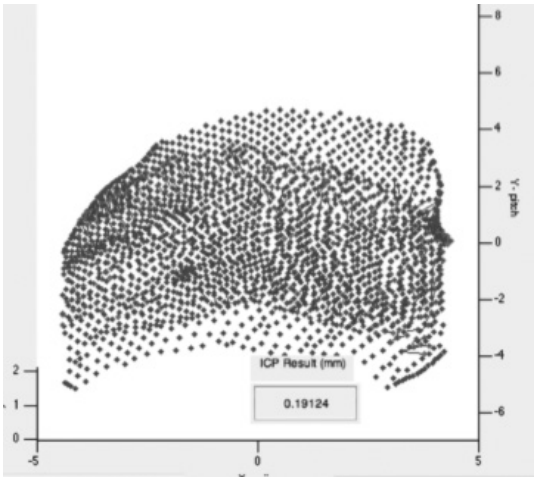


Figure 4A: The optimal alignment of the phalangeal base with the hamate.

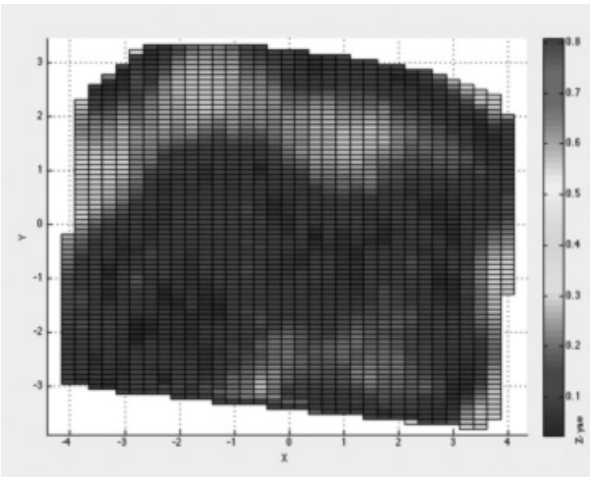


Figure 4B: The distance from each point on the phalangeal base to its nearest neighbor point on the hamate. The average distance was 0.19mm.

distance was only 0.19mm.

- The results for all 4 bases in the three subjects are shown in Table 1.

Discussion

- The method described above is a powerful approach to the analysis of the congruity of the hemi-hamate arthroplasty.
- The results indicate that the dorsal hamate is an excellent donor site for the reconstruction of the base of the middle phalanx.
- The variability in the location of the optimal region on the hamate suggests that the technique could be used in surgical planning to maximize congruity of the reconstruction.
- The approach described could also be used for identification of novel graft donor sites for joint reconstruction of articular defects in other areas of the human body.

References

1. Blazar PE and Steinberg DR Fractures of the Proximal Interphalangeal Joint J Am Acad Orthop Surg 2000;8:383-390

2. Calfee RP, Kiefhaber TR, Sommerkamp TG, Stern PJ. Hemi-hamate arthroplasty provides functional reconstruction of acute and chronic proximal interphalangeal fracture-dislocations. J Hand Surg Am. 2009 Sep;34(7):1232-41.

3. Capo JT, Hastings H 2nd, Choung E, Kinchelow T, Rossy W, Steinberg B. Hemicondylar hamate replacement arthroplasty for proximal interphalangeal joint fracture dislocations: an assessment of graft suitability. J Hand Surg Am. 2008 May-Jun;33(5):733-9.

4. McAuliffe JA. Hemi-hamate autograft for the treatment of unstable dorsal fracture dislocation of the proximal interphalangeal joint. J Hand Surg Am. 2009 Dec;34(10):1890-4.

5. Williams RM, Kiefhaber TR, Sommerkamp TG, Stern PJ. Treatment of unstable dorsal proximal interphalangeal fracture/dislocations using a hemi-hamate autograft. J Hand Surg Am. 2003 Sep;28(5):856-65.

6. Williams RM, Hastings H, Kiefhaber TR. PIP Fracture/Dislocation Treatment Technique: Use of a Hemi-Hamate Resurfacing Arthroplasty Techniques in Hand and Upper Extremity Surgery 6(4):185–192, 2002.

Middle Phalanx Base	Index	Middle	Ring	Small
Subject 3	0.27	0.28	0.25	0.23
Subject 4	0.21	0.19	0.18	0.24
Subject 12	0.28	0.32	0.29	0.28

Table 1: Average distance (in mm) of each point on the phalangeal base point cloud from its nearest neighbor point on the hamate surface after optimal alignment.

Patient Reported Outcome Measures in Clinical Research: Making the Subjective Objective

Amy M. Cizik, M.P.H. and Darin Davidson, M.D., M.H.Sc.

Abstract

Determination of a primary outcome measure is necessary for clinical research. Traditionally, measures have been objective mortality- or morbidity-based measures, such as death or disease-specific measures like measuring knee flexion or extension. However, more short-term or subjective measures have been used, and are gaining more favor. These subjective measures, have been labeled patient-reported, clinician-reported or observer-reported outcomes. When explicit non-disease related measures are used they are typically thought of a health-related quality of life measures. The use of validated subjective measures such as patient reported outcomes can provide a comprehensive assessment of outcome from the patient's perspective, which can complement evidence obtained from traditional measures.

Introduction

Clinical research studies require use of a primary outcome measure. These measures may be objective, for example occurrence of a discrete event such as death, or subjective, such as a patient reported outcome (PRO) of pain experienced over a specific time. There are varying categories of these measures (Figure 1). Disease and joint specific measures provide information regarding a particular disease process or anatomic area, respectively. Though informative, these measures do not provide an indication of outcome patients quality of life. Such an assessment is of importance, given the primary objective of medical care is to make patients feel better[1].

Generic measures are categorized as either non-preference based or preference based. Non-preference based measures are what are typically seen in current orthopaedic literature, such as rating scales like the Visual Analogue Scale for pain or other measures that ask about general quality of life. Preference – based measures elicit a patient's response about a particular health state and are conducted using either a time trade-off method or a standard gamble method. These measures provide a health state utility score between 0, representing death, and 1, representing perfect health. These scores can be compared across all patient populations and provide measurement of health related quality of life (HRQL). As an illustrative example of a time trade-off method, a score of 0.8 is interpreted as representing an indifference to two treatments; one with an 80% chance of being in perfect health and a 20% chance of death or another treatment with a 100% chance of maintaining the current health state.

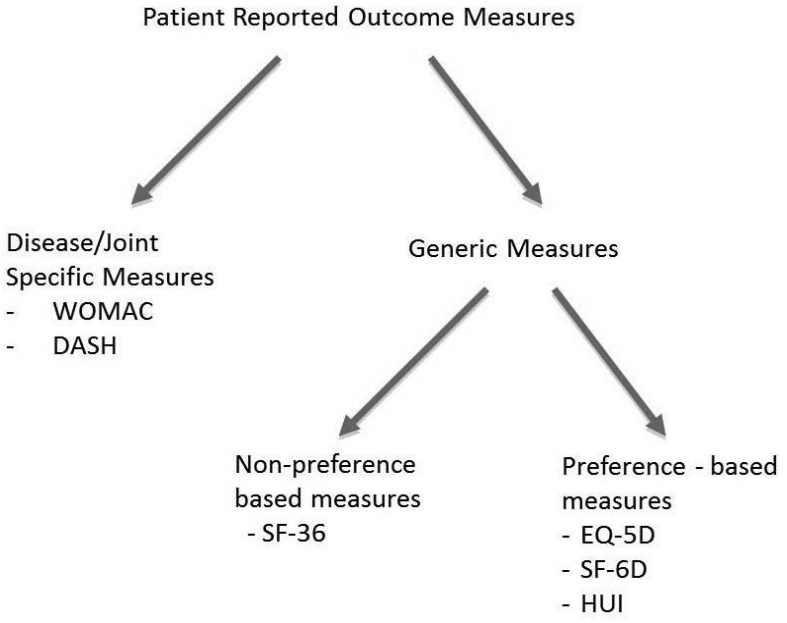


Figure 1: Depiction of categories of Patient Reported Outcome Measures

Legend:
WOMAC: Western Ontario and McMaster University Osteoarthritis Index
DASH: Disabilities of the Arm, Shoulder, Hand
SF-36: Short Form 36
EQ-5D: European Quality of Life group health state utility score
SF-6D: Short Form 6D health state utility score
HUI: Health Utilities Index health state utility score

The Dilemma

Patient assessment of outcome is, by definition, subjective. As this form of outcome assessment provides a comprehensive determination of outcome from the patient's perspective, it is highly valued but, in order to have confidence in the evidence provided by the PRO, must be made to be objective. In order to accomplish this, several psychometric properties of the measure are studied and assessed, which provide an estimation of the objectiveness of these measures[2]. These properties are used both in the creation and development of new measures and in the evaluation of existing measures. There are several such properties (Table 1) and it must be emphasized that these properties are assessed for a given PRO in a specific population. A measure is not validated in and of itself, rather its use in a specific population is validated[2].

Choosing a Measure

If a PRO is to be utilized in a research study, the choice of measure is critical. Once the research question has been established, a PRO should be chosen which has been developed and shown

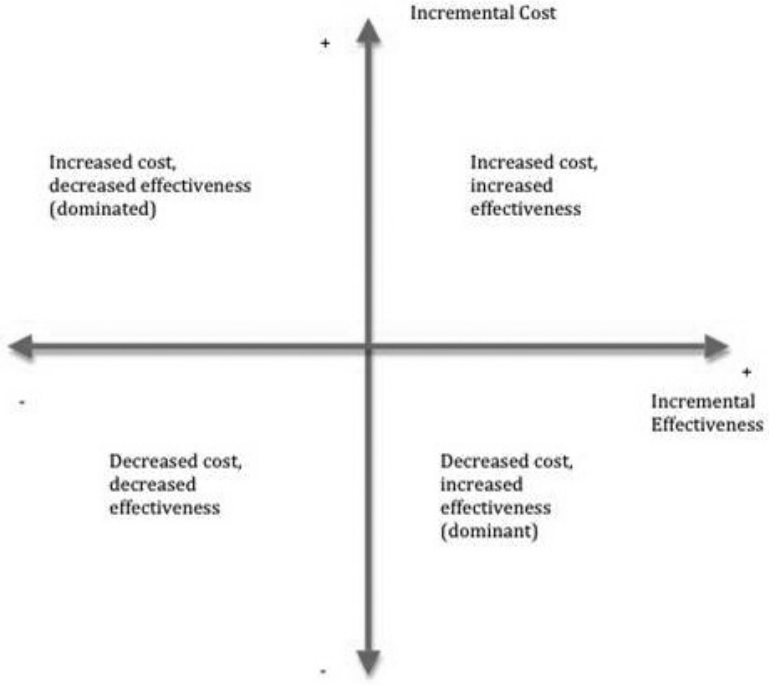


Figure 2: The cost-effectiveness plane demonstrating possible outcomes in comparing the incremental cost-effectiveness of a treatment option.

to be valid in the population being studied. Selection of an inappropriate measure can lead to an inability to fully investigate and answer the research question and may lead to indeterminate results. The chosen PRO should have established psychometric properties (Table 1) appropriate for the research question. If no such measure exists, consideration to first studying the PRO in the population in question should be given.

Research Application of PRO

There are three predominant research applications for PRO measures, and health state utility scores in particular. Regardless of the type of PRO measure used, the utility score derived from the measure can be used as the primary outcome in a clinical study. The use of health state utility scores can provide a more comprehensive assessment of outcome compared to disease or joint specific measures. Quinten et al[3] performed a review of 30 randomized controlled trials from a European Oncology study group (EORTC) and demonstrated that scores, at the time of randomization into a treatment trial, from the quality of life core questionnaire (QLQ-C30) for physical function, pain, and appetite loss were significantly predictive of overall survival. Another example of the application of health state utility scores was reported by Barrera et al[4] who compared the PRO of limb salvage and amputation among survivors of lower extremity bone sarcoma. There was no statistically significant difference in scores between the two groups. In another study of young adults who were survivors of childhood osteosarcoma, the mean health state utility score was 0.8[5]. These studies provide evidence regarding HRQL among survivors of bone sarcoma, which can be used to improve knowledge regarding patient outcome and as the basis for future research.

Health state utility scores can also be used for performing decision and economic analysis. These methodologies are gaining increasing acceptance in the medical and surgical literature and are able to provide assessment of the cost-effectiveness of treatment options, particularly where uncertainty exists, limited resources must be considered, or comparison to other treatment options in situations where traditional study designs are not possible[6]. The comparison of other treatment options is of particular interest in orthopaedic surgery because the gold standard of scientific research, the randomized, double-blinded, controlled trial, is in most cases unethical to do.

In a decision analysis, two or more treatment options are compared by combining the probability of outcomes for each treatment with the patient reported preferences for those outcomes. The treatment options under comparison can then be directly compared with regards to the preferred treatment pathway. In economic analysis, this methodology is used and the costs associated with each pathway in the model are included, providing the cost per quality adjusted life year (QALY) gained for each treatment. The results of a comparison between treatments are discussed in terms of the incremental cost-effectiveness ratio (ICER), with four possible outcomes and plotted on a cost-effectiveness plane (Figure 2).

The cost-effectiveness plane has four quadrants that allow for decisions to be made whether to adopt or reject a treatment. When comparing treatments or deciding whether to incorporate a new treatment, an ICER of $50,000 per QALY is the standard accepted threshold for adopting a new treatment, although in the United States the $50,000 benchmark is not a true measurement criteria.[7] Consideration of the cost-effectiveness plane is important given that the majority of treatments fall into the categories of either increased cost with increased quality or decreased cost with decreased quality. No further consideration is required if there is decreased cost and increased health, referred to as 'dominant', however this is seldom the case. Similarly, no further consideration is required if the treatment is associated with increased cost and decreased health, referred to as 'dominated'.

The use of these decision analyses are increasing and applied to decision-making for adoption of new treatments. In the United Kingdom, the National Institute for Health and Clinical Excellence (NICE), at least in part, recommends new technologies or treatments, including those related to cancer care, on the basis of the impact of the treatment on HRQL and cost-effectiveness[8]. There have also been recent recommendations in North America for the study of

Criterion	Definition
Construct validity	Correct hypothesis of relationship between attributes and function being measured
Criterion validity	Extent to which similar measures provide similar results
Content validity	Measure is representative of what is being assessed
Reliability	Measure is reproducible between and within patients
Responsiveness	Ability to detect change over time
Discrimination	Ability to detect differences between patients at the same point in time
Ceiling effects	Ability to distinguish amongst patients at the upper end of function
Floor effects	Ability to distinguish amongst patients at the lower end of function
Clinically Important Difference	The change in score which is clinically relevant to patients and clinicians

Table 1: Psychometric Properties of Patient Reported Outcome Measures.

HRQL and cost-effectiveness in the decision between amputation and limb salvage surgery for treatment of bone sarcoma[9].

Though HRQL measures are frequently collected on a regular basis as part of clinical care, the predominant use at present is for database collection and some clinical research. There is some literature suggesting a potential clinical utility of these measures for prognostic purposes[3], this has not yet become a widespread reality and requires further investigation.

Summary

PRO measures are being increasingly used in clinical research. In order to answer the research question for a particular study, careful selection and consideration of the psychometric properties of a measure must be performed. There are several applications of these measures, in particular health state utility scores, which can be used to assess HRQL and perform decision analysis and economic analysis.

References

1. Feeny D, Furlong W, Mulhern RK, Barr RD, Hudson M. A framework for assessing health-related quality of life among children with cancer. Int J Cancer Suppl 1999; 12: 2-9.

2. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 3rd ed. Oxford, U.K.: Oxford University Press; 2003.

3. Quinten C, Coens C, Mauer M, et al. Baseline quality of life as a prognostic indicator of survival: a meta-analysis of individual patient data from EORTC clinical trials. Lancet Oncol 2009; 10(9): 865-71.

4. Barrera M, Teall T, Barr R, Silva M, Greenberg M. Health related quality of life in adolescent and young adult survivors of lower extremity bone tumors. Pediatr Blood Cancer 2012; 58(2): 265-73.

5. Shimoda S, Horsman J, Furlong W, Barr R, de Camargo B. Disability and health-related quality of life in long-term survivors of cancer in childhood in Brazil. J Pediatr Hematol Oncol 2008; 30(8): 563-70.

6. Brauer CA, Bozic KJ. Using observational data for decision analysis and economic analysis. J Bone Joint Surg Am 2009; 91 Suppl 3: 73-9.

7. Weinstein MC. How much are Americans willing to pay for a quality-adjusted life year? Med Care 2008; 46(4): 343-5.

8. Trowman R, Chung H, Longson C, Littlejohns P, Clark P. The National Institute for Health and Clinical Excellence and its role in assessing the value of new cancer treatments in England and Wales. Clin Cancer Res 2011; 17(15): 4930-5.

9. Barr RD, Wunder JS. Bone and soft tissue sarcomas are often curable--but at what cost?: a call to arms (and legs). Cancer 2009; 115(18): 4046-54.

Integrative Care in Complex Pediatric Disorders: The Skeletal Health Program at Seattle Children's Hospital

Klane K. White, M.D.

Overview

Advanced insights regarding the human genome and protein physiology have expanded our capacity to to understand and possibly treat a number of genetically mediated 'syndromes' and 'metabolic diseases'. While these molecular level insights are increasing at a rapid pace, clinical medicine is at risk of being left behind simply by being overloaded with information not one specialty can possibly address adequately. To counteract this threat, and create a foundation for unprecedented care delivery, Seattle Children's Hospital has created a new clinical platform consisting of clinicians from multiple different backgrounds to form a new patient-centric endeavor to better serve patients with chromosomal and genetic disorders. Many genetic disorders manifest themselves in a complex array of abnormalities that commonly include the skeleton. This insight and the changing face of molecular based medicine has lead to the formation of the Skeletal Health Program at Seattle Children's Hospital as a multidisciplinary clinic composed of specialists from Orthopedic Surgery, Genetics, Endocrinology, Pulmonology and Radiology. Weekly clinics center around these select patients and provide a wide bandwidth of access to dedicated experts in multiple fields at the same time. This program simplifies the families' life by decreasing the number of appointment visits required for these complex patients, enhances the impact and meaning of each visit dramatically, and allows the free exchange of knowledge among subspecialties in the care of children with genetic and metabolic bone diseases.

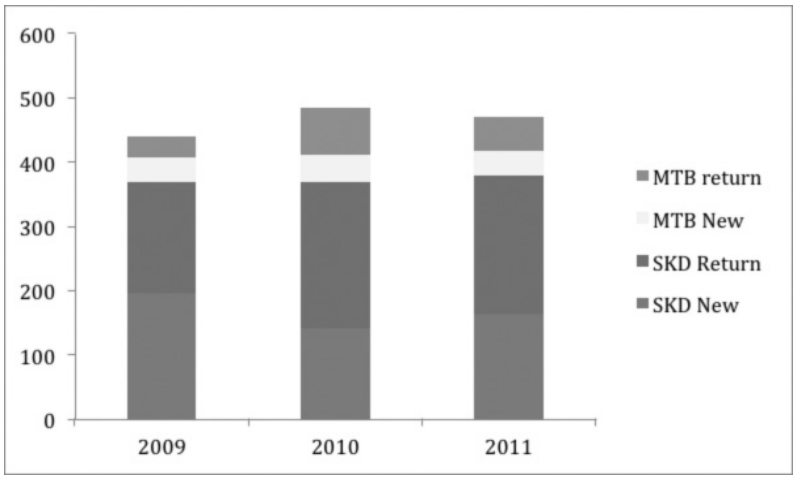
Other speciality services affiliated with our program include Neurosurgery; Otolaryngology and Sleep Medicine. Newly incorporated into the skeletal health program is the group of patients with **'early onset scoliosis'** (EOS). This patient group shares many of the characteristics of the patients that we already care for: Many of these patients have previously underrecognized genetic disorders, and the need for comprehensive care for complex, chronic conditions, for which they have no other "medical home". In addition to comprehensive care of children, teens and young adults, the Skeletal Health Program offers prenatal diagnosis and counseling services as well as care management of adults with dwarfing conditions.

The core mission of this Program is the diagnosis and management of patients with disorders such as the skeletal dysplasias, syndromic and genetic conditions with significant musculoskeletal manifestations, as well as both congenital and acquired bone fragility disorders. As part of management, our mission embraces the prospective collection of functional status tests using patient based health-related quality of life outcomes measures. Our primary tools of choice are the Pediatric Outcomes Data Collection Instrument (PODCI) and the Short Form 36 (SF-36) which we collect systematically in clinic and from afar through internet based access points.

Our group is making a concerted effort to better define the so-called 'rare' conditions, previously mainly published as case reports, that we are increasingly being asked to treat. A significant program goal is to establish the natural history of these disorders as well as explore present state of the art treatment options and 'over-the-horizon' genomic intervention options.

While the direct benefits to patient care are difficult to quantify, many families report substantially increased patient satisfaction. Instead of sitting serially in multiple different doctor's waiting rooms, stretched over many different days and locations, all relevant experts group around one patient and their family and provide a comprehensive assessment and treatment plan. We expect this approach to become the standard of care for complex conditions not only due to patient satisfaction but also from a resource efficiencies perspective. From a health care provider perspective the satisfaction of providing a truly comprehensive and meaningful input to patients, who had previously been 'passed around', cannot be overstated as well.

As the reality of molecular diagnosis of genetic disorders and even treatment interventions are rapidly becoming a reality, the Seattle Children's Hospital Skeletal Health Program is poised to contribute substantially to new research insights for orthopedic manifestations of rare disorders and identification of new genetic mutations through this



Skeletal Health Clinics have maintained high clinic volumes averaging between 400 and 500 patients per year over the last three years.

These xrays are of a 3 year old girl who presented to our department because of a "prominence" in her mid-back. This deformity lead to a diagnosis of Morquio syndrome (mucopolysaccharidosis type IV) in our Skeletal Dysplasia Clinic. She has subsequently required multiple orthopedic surgeries to address her diffuse musculoskeletal disease. Our Skeletal Dysplasia clinic is now her medical home where we coordinate her care by many subspecialists at Seattle Children's Hospital including orthopaedics, neurosurgery, pulmonology, biochemical genetics, cardiology, and otolaryngology. She is now also a participant in phase three trial for enzyme replacement therapy, for which Klane White, M.D., M.Sc. is the site principal investigator.

unparalleled concentration of minds and effort. We look forward to keeping our friends and supporters updated as to our progress. – stay tuned!

Recent Abstracts

Earl DL, Wallace SE, White KK, Glass IA, Goldberg MJ: A Case of Mild Morquio Syndrome IVA Identified with Enzyme Testing. 2012 American College of Medical Genetics Annual Clinical Genetics Meeting in Charlotte, North Carolina. March 2012.

Mendelsohn N, White KK, Hale S, Olson R, Wood, T. The mild side of MPS disorders: Are these cases being missed by urine screening and other common diagnostic methods? Lysosomal Disease Network's 8th Annual WORLD Symposium, San Diego, California. February 2012.

White KK, Hale S Bompadre V. Musculoskeletal Function in Patients with Mucopolysaccharidosis using the Pediatric Outcomes Data Collection Instrument (PODCI) Lysosomal Disease Network's 8th Annual WORLD Symposium, San Diego, California. February 2012.

White KK, Harmatz P, Hendriksz CJ, Thacker MM, Theroux M, Mackenzie W, Jester A, Gravance C, Bache E. Mucopolysaccharidosis IVA: Considerations for Pediatric Orthopedic Surgery. Lysosomal Disease Network's 8th Annual WORLD Symposium, San Diego, California. February 2012.

White KK, Ted Sousa T, Bompadre V. Musculoskeletal Functional Outcomes in Children with Osteogenesis Imperfecta: Pamidronate Improves Function. Denver, Colorado. May 2012

Recent Publications

White KK, Hale S, Goldberg MJ. Musculoskeletal health in Hunter disease (MPS II): ERT improves functional outcomes. Journal of Pediatric Rehabilitation Medicine, 2010, 3 : 101-107.

White KK, Frost N, Daines BK, Song KM. VEPTR Growing Rods for Early-onset Neuromuscular Scoliosis: Feasible and Effective. Clin Orthop Relat Res, 2011, Jan 7. [Epub ahead of print]

White KK, Karol LA, White DR, Hale S. Musculoskeletal manifestations of Sanfilippo Syndrome (MPS III). J Ped. Orthop, 2011,3 1:594-598.

Vining NC, Done S, Glass IA, Parnell SE, Sternen DL, Leppig KA, Mosca VS, Goldberg MJ. EXT2-positive multiple hereditary osteochondromas with some features suggestive of metachondromatosis. Skeletal Radiol. 2012 May;41(5):607-10.

Global Health

A Global Perspective On UW Orthopaedics

Helping People Around The World Lead Longer, Healthier And Happier Lives

The mission of UW Medicine is to support the health of the public. It is only fitting that the many renowned clinicians and researchers of our Department have taken their strong sense of dedication and musculoskeletal expertise towards helping people in need around our State of Washington, the WWAMI area or even globally – all working on a volunteer basis in their time off, and under some form of personal sacrifice in effort, money and time away from family. Our faculty are driven by the awareness of the tremendous adverse impact musculoskeletal conditions have on affected fellow humans, and the profound impact such conditions will have on entire families and surrounding communities if left un- or undertreated. They also know of the power of orthopaedics, and how it can - if well delivered – return crippled or injured individuals to function and free their families to pursue other tasks while also raising the levels of the local medical environment by raising the bar of the care-environment from ground up.

We very much hope that you will find the following section on education outside of the traditional UW venues to be both interesting and inspirational. The following pages show the many different ways in which our faculty is reaching out and provide support directly where it is needed most – through direct help and through education, always striving to improve local expertise as well as self-reliance.

A logical first path to support medical care in countries with emerging economies is to provide some education to surgeons locally in our facilities here in Seattle. This history of local education of far away surgeons dates back to the likes of Drs. D.K. Clawson, Victor Frankel, Sigvard T. Hansen and further encouraged by Dr. F.A. Matsen III and has seen a steady stream of visitors from around the world over decades now. Just over the last year we had 37 visitors (25 of whom were international visitors from the following countries: Spain, Argentina, Germany, Philippines, Ireland, United Kingdom, Canada, Brazil, Switzerland, India, China, Italy, Taiwan, Nigeria, and Indonesia). Some were able to stay days, others weeks – all were grateful for their experience.

These next pages of Discoveries 2012 will take you around the world – the Horn of Africa, Central America, Haiti, the Indian subcontinent, Indonesia and East Africa through largely individual efforts to orchestrated global efforts through organizations like AO International, NGO's, the AAOS and the impressive homegrown effort of SIGN.

Through their exposure to our dedicated faculty the next generation of orthopaedic surgeons – our residents and fellows - have become increasingly interested in serving people in need abroad. For the vision of a formal away rotation to become reality we will need to obtain outside funding sources to address the necessary bureaucracy, address infrastructural needs and provide salary support for our trainees while away. Hopefully reading these next pages will inspire you - our readers - to become engaged and perhaps even support us in our aspiration to create a more formal exposure to global orthopaedic needs for our trainees and allow UW Orthopaedics and our expertise to reach a greater global presence. In doing so we change the lives for the better of many more patients with musculoskeletal problems in areas of need and train the next generation of surgeons to be sensitive to the global needs of mankind while practicing the most noble lesson of medicine: to serve fellow mankind.

Such is the power of modern orthopaedics; with your help we can make this happen – here and in many places around the world. Please let me know if you are interested in learning more about our mission.

Here are some more contacts for information on supporting organized UW Medicine global health efforts:

jenschap@uw.edu

www.globalhealth.washington.edu

WWAMI Outreach - education on site. L-R: ML'Chip'Routt, Eileen Bulger, General Surgery, M. Copass, ER Medicine and Neurology, Saman Arbabi General Surgery and Graham Nichols, ER Medicine; not pictured: Ben Starnes, Vascular Surgery.

Global Orthopaedic Teaching and Training Opportunities

Theodore A. Wagner, M.D.

Yes, the planet seems to be shifting each day, juxtaposing neighborhoods of wealth and influence with poverty and its associated illnesses. Musculoskeletal acute and chronic conditions may be our most common worldwide affliction. The "larger consciousness" of the Orthopaedic training centers is shifting toward a desire to be more involved in global outreach.

A recent survey of Orthopaedic residents here at the University of Washington, conducted by Dr. Chris Howe, indicated that 90% of the residents desired an overseas global rotation. In less formal questioning of 2007 Orthopaedic resident applicants to our program, four out of five expressed a sincere interest in an overseas global experience, and were interviewing with specific programs where such an experience is offered.

Theodore A. Wagner, M.D. (left) and Dr. Hague in Bangladesh.

Since a "global experience" implies a rotation visit to an "emerging country" with some degree of poverty and where the population is medically underserved, it behooves us to review some of the staggering statistics. There are 6.4 billion people on this earth and 3 billion live without basic health care. 3 billion live making less than two dollars a day, 1.3 billion make less than one dollar a day. Four million health workers are needed (one million in Africa alone). In 2006 Colin Mathers and Dejan Loncar reviewed global mortality and burden of disease (GBD). The World Health Organization (WHO) has accepted certain metrics for health conditions. The GBD is defined in terms of DALY's (disability adjustment life years). GBD is also measured in individual countries where the gross domestic product (GDP), the "human capital" (average years of schooling), and relationship of technological change to health status are measured. In attempting to make projections to 2015 and to 2030, these three factors become critical and have been applied to HIV/AIDS, smoking, ischemic heart disease, and diabetes. All projections are based on the assumption that the GBD in poor countries will have the same relationship to economic and social development that has occurred in high-income countries over the last fifty years.

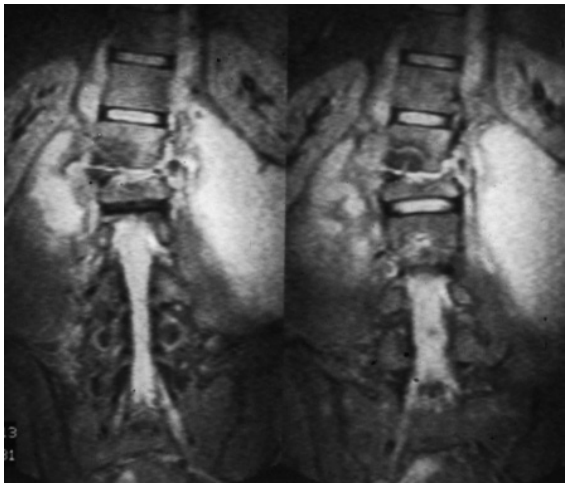
All projections are based on pessimistic or optimistic PACE, and often result in paradoxical or unexpected outcomes. For example, the DALY's are optimistically projected if 80% of all AIDS patients receive anti-retroviral medication. On the other hand, the incidence of diabetes may increase if obesity is linked to improving economic conditions. However, tobacco-attributable diseases in an optimistic analysis predict 5.4 million people affected in 2005, 6.4 million in 2015 and 8.3 million in 2030. Therefore, tobacco-related deaths will kill 50% more people in 2015 than HIV.

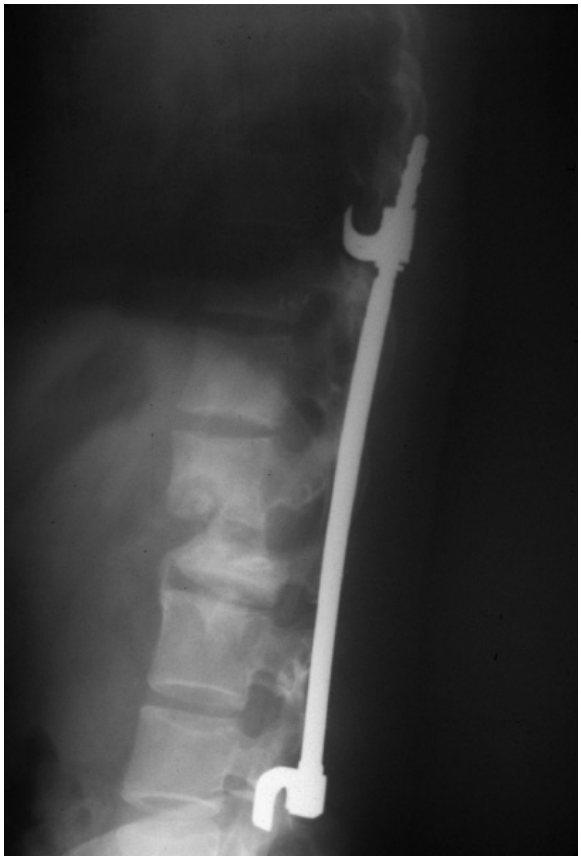
Of special interest to the Department of Orthopaedics and Sports Medicine are the leading causes of burden of disease: (1) depression, (2) vascular diseases, and as of 2010 (3) motor vehicle accidents. There are some estimates that the number of motorcycles, cars and trucks will double in five years. The proportions of upper extremity, lower extremity and spine disabilities are not known.

Dr. Richard Coughlin, Associate Professor of Orthopaedic Surgery at UC San Francisco and the President of Health Volunteers Overseas (HVO), was an invited speaker in 2009 and reviewed his experience of sending fifteen residents to South Africa. He states that the residents reported 100% positive experiences, and 9 out of 15 had already gone back to South Africa or other developing counties after finishing their residency. As President of HVO he emphasized their mission statement, "to teach and to learn."

My personal experiences with medical education overseas began as a medical student, working in Athens, Greece on a thalassemia ward and with G-6-PD deficiency. During my internship in Montreal, I conducted a breast cancer survey in the far north, on Baffin Island. These glancing encounters elevated my antenna for more global sojourns.

My fellowship in Hong Kong was an awakening to Pott's disease and the ravaging disability of TB. In 1974 one in 100 persons in Hong Kong had active TB and we operated on about five cases per day. The British research team was formulating a comparison study on antibiotic treatment -- with vs. without spine surgery. The debate



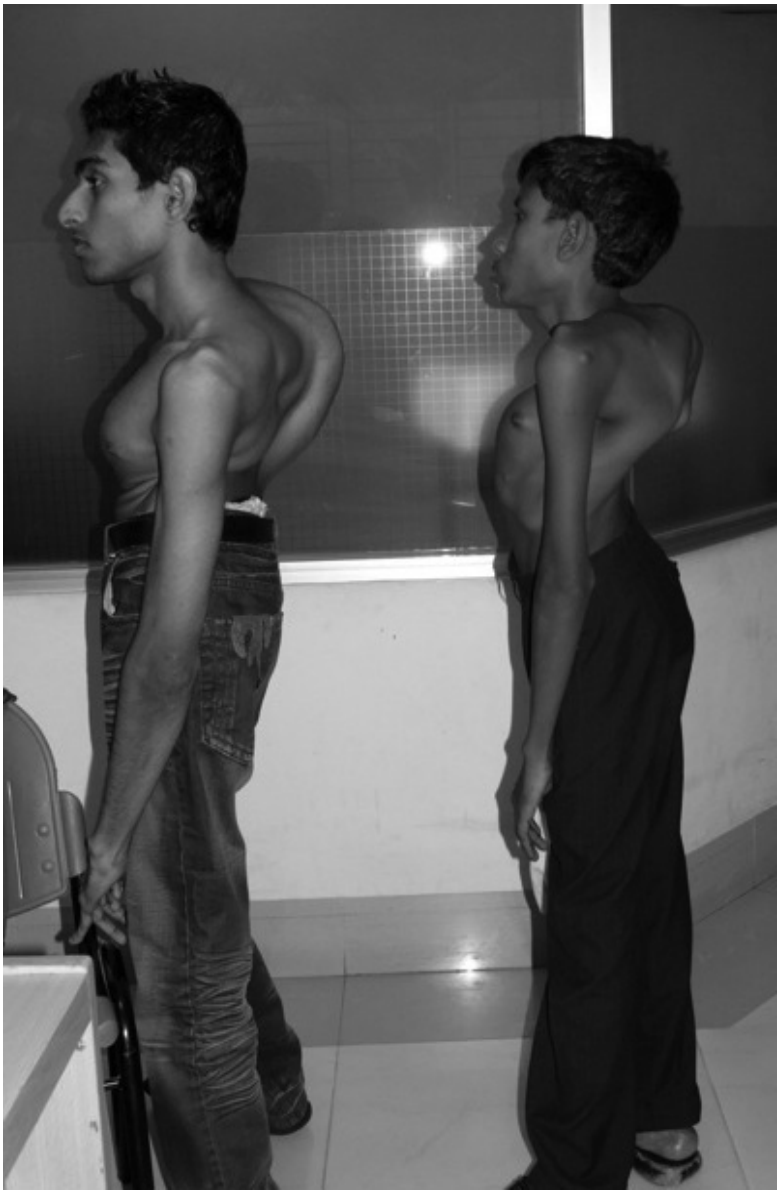


This is a young patient from Hong Kong with acute T.B. spinal abcess (Pott's Disease).

has never ended, but the diagnosis is suspected earlier with MRI.

In 1980, on a six-month sabbatical in Tanzania, I became aware of the logistics of caring for a population of 18 million with minimal access to any medical care. For example, if club foot deformity occurs in one in 500 persons, there are 36,000 untreated cases! Such was true for all congenital disease. Polio, TB, and osteomyelitis filled the orthopaedic clinics. A fascinating public health investigation led to the discovery of that hyperfloridosis was affecting growing children and leading to severe varus and valgus lower extremity deformities. AIDS would be discovered that same year, and would occupy 20% of the hospital beds within ten years of my visit.

In the past ten years I have worked mainly in Indonesia and Bangladesh; the medical conditions in these countries can be sharply contrasted. Poverty is the consistent denominator of disease and wellness. For instance, Indonesia has 250 orthopaedists for 300 million people, and has a well-established university training center and about eighty residents. In Jakarta a visiting surgeon can be housed with a driver and domestic services for a month; one lectures and teaches in



Untreated cases of severe scoliosis in Indonesia.

the operating rooms for three weeks, followed by a one-week vacation to an outlying island such as Bali. Such visits could be a combination of orthopaedic faculty and residents on a continuous basis, and by different subspecialties. Motorcycle trauma in Southeast Asia requires intensive orthopaedic service.

Finally, as Chair of the Global Outreach Committee of the Scoliosis Research Society, I visited Syria last year as its crisis was evolving. The medical community in Aleppo was quite sophisticated but very isolated, and there was great opportunity for teaching. The country is now a war zone and will soon need a cadre of trauma orthopaedists (spine, hand, and foot/ankle). The early NGO's will be MSF and other international teams.

Global exchange that can be sustained must work in concert with global organizations that will fund data collection to update the occurrence and prevalence of disease. These organizations must include both international government-funded groups like WHO, and privately funded ones like the Gates Foundation and Clinton Foundation. Also, multiple NGO's such as the MSF (Doctors Without Borders) and religious missions.

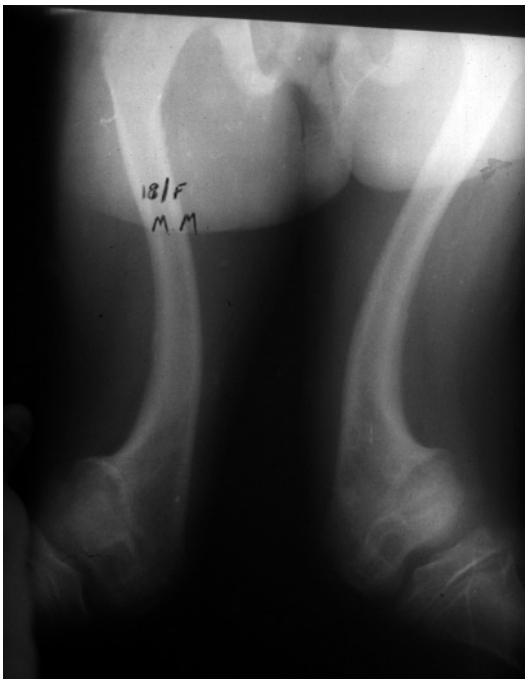
It is very important to capture the "doctor to doctor" communication that occurs "on the ground". In the poorest of countries, many very dedicated bright physician/surgeon teams (with a nursing team) have been in place for many years, and may include expatriates who have been present for many years. Only by working shoulder to shoulder with such teams can long-range trust and communication be established.

Behind any reasonable response is education. In the field of orthopaedics, the training centers (university resident programs) must find opportunities for international exchange of faculty & residents into environments where they might learn the presenting problems and traditional treatments. Having listened to the local caregivers and evaluated local treatment, they would have the opportunity to lecture and teach procedures being conducted in our "First World Orthopaedic hospitals". The exchange is not limited to orthopaedic surgery; its purpose is also to become friends with smart people who have invented clever ways or adopted "outside" methods practical for their available resources. One example is the Ilizaoff procedure for fractures. The procedure was developed in Eastern Siberia using only bicycle spokes and rims to create an external fixation. In Bangladesh, in the Trauma Hospital, the system is built onsite and recycled, and cost less then $100/case (simple frame in the US starts at $3,000 for single use and can go much higher).

The exchanges need to have the support of the American Academy of Orthopaedic Surgeons for accreditation, plus malpractice insurance for faculty and residents. Those two issues have been satisfied and approved here at the University of Washington and several other centers in the United States. Perhaps the most stable and efficient exchanges might be between U.S. training centers and academic centers.

In closing, some quotes from Dr. Jeffrey D. Sachs, a Columbia University economist, come to mind: "70% of medical problems are the result of poverty, ignorance, supplies." And finally: "All serious poverty could be eliminated in twenty years."

The philosophy behind exchanges is that if young minds have an opportunity to enjoy the challenges of international poverty and disease, there is a real chance they will return and infect their



Young Tanzanian patient with severe genuvalgasm secondary to hyperfloridosis - pre and post operative xrays.

families and friends with the same spirit. The excitement lies in seeing young bright surgeons find solutions for the rampant orthopaedic disease around the globe.

Here at the University of Washington, there is an opportunity to work with Dr. Greg Schmale in Nicaragua, Dr. Rick Bransford in Kenya, or with myself in Indonesia and Bangladesh. We are very fortunate to have a large Department of Global Medicine, funded by the Gates Foundation. Finally, our Chairman of the Department of Orthopaedics and Sports Medicine Jens R. Chapman, M.D. is deeply committed to enhancing ties across the world through organizations like the AO Foundation and the Scoliosis Research Society. We hope that we can formalize our Orthopaedic education abroad in the not too distant future with enlightened help and provide Orthopaedic expertise from the University to places in need around the world.

Orthopaedic Care in an Area of Civil Unrest: The Somaliland Experience

Richard J. Bransford, M.D.

Background

I have had the privilege of going to Borama, Somaliland about once a year with a group of doctors/clinicians from Kijabe Medical Center in Kijabe, Kenya for the last four years. Somaliland is truly a needy place and is light years away from joining the modern era. Somaliland and Somalia used to be one country but since the Somali war in the 90's, Somaliland, which historically was a British colony, has developed its own government and is trying to be recognized worldwide as a country separate from Somalia. Somaliland's main export is goats, which are sent to the Middle East primarily for the Hajj – the Islamic pilgrimage. I am told that about 2/3 of all finances in the country come from family members in the Western world sending money home to relatives. The land mainly consists of a desert with minimal agriculture and other than a few spices and myrrh, the main agricultural output seems to consist of Khat (which is chewed by almost all the men and some of the women and is the equivalent to marijuana).

The inspiration for going to Somaliland comes from my father, originally a General surgeon by training, who has been my mentor and teacher - and is my hero. My Dad first went to Africa as a medical student in 1966 and has spent the last 35-40 years of his life in East Africa working as a surgeon. He is capable of doing general surgery, orthopaedics, plastics, obstetrics/gynecology, urology, and really has done just about everything. He has spent the last decade primarily functioning as a pediatric neurosurgeon. Having grown up mostly in East Africa from age 5 to 18, I had a first-hand chance to learn from him how to manage burn contractures and cleft lips among many other conditions from early on as his first assistant.

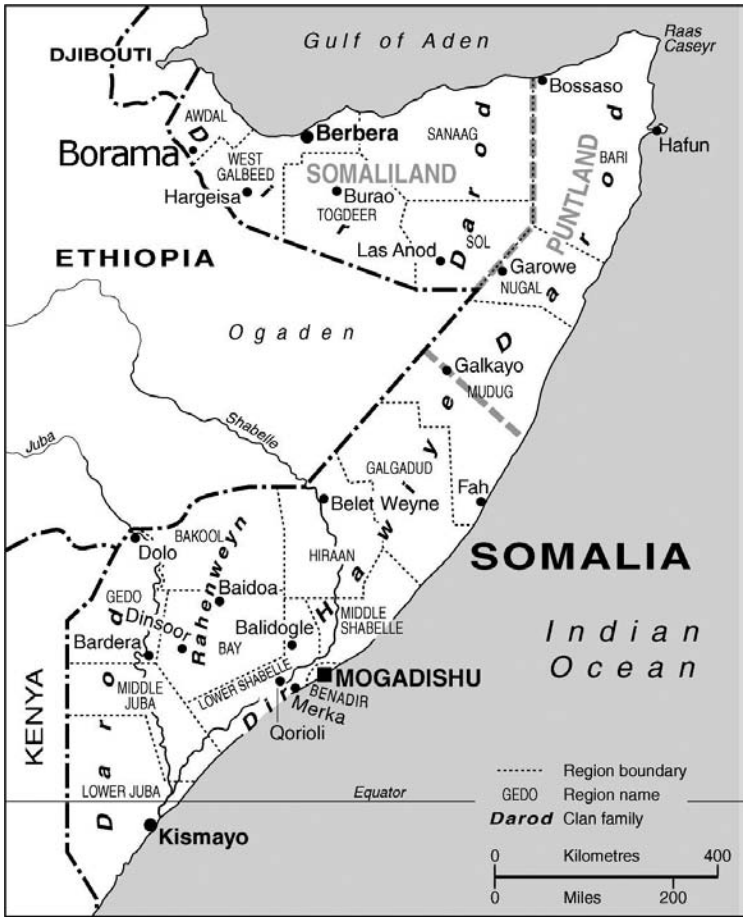


Figure 1: Map of the horn of Africa showing Somaliland. Most maps today do not show the separation of Somaliland from Somalia. We currently fly into Hargeisa and then drive to Borama which is just a few miles from the Ethiopian border. Many of our patients actually live in Ethiopia.

How we get there

Our trips are in part self-funded and in part supported by Samaritan's purse, a faith based-NGO and other mission/church organizations. Our target facility is located in Borama, in the western area of Somaliland (Figures 1 and 2). Our trips usually last for 7 days on the ground in Borama with a total of about 10-11 days being away from Seattle due to the travel time. It takes about 40 hours from the time I leave my home in Seattle until I arrive at the place we stay in Borama and involves a number of small charter aircraft and a cross-desert drive of several hours. On each trip there are about 7-8 of us on the team with usually 2 anesthetists, a general surgeon, my Dad (who truly can operate on about anything), a couple of primary care doctors, a nurse or two, and myself representing orthopedics . . . and plastic surgery (Figure 3).

Figure 2: Entrance to Amoud University in Borama. Photo courtesy of www.world66.com.

Figure 3: Me operating on a femoral non-union with my medical student assistant Rhoda. This man was hanging decorations for his wedding and fell fracturing his femur. He was able to go somewhere and have it nailed with a Kuntscher nail but developed a nonunion. His fiancé refused to marry him until he was "normal." With no C-arm, I had to get the nail out and then plate and bone graft his femur.

Figure 4 a/b: This 11 year old girl had Osteogenesis Imperfecta with tibial deformities. I osteotomized her right tibia and took a piece of fibula and stuck it up her tibial canal. I placed her in cast with a pretty reasonable correction.

Figure 5: This is a burn contracture of the hand. The population commonly uses watered-down kerosene, which apparently is prone to explode leaving lots of hand, arm, chest, and facial burns. The second most common procedure I do is burn contracture releases with skin grafting. We use a lot of full thickness graft taken from the groin.

What we do

The region in question has been subject to prolonged military conflict and its people suffer from extreme neglect. Many of our patients have personally been victimized by a particularly cruel form of modern military campaigning – so called 'social warfare', in which its victims are injured and maimed in such enduring fashion by the enemies as to instill prolonged care needs to its host population – thus detracting important resources away from the host society. The other main source of patients are the product of a lack of social infrastructure – untreated birth defects, dysplasias, environemtnal injuries and infections (Figure 4). Our hosts at Amoud University in Borama (see Figure 2), are concerned about our safety so we have an armed guard go everywhere with us, including on rounds. It is a little odd having someone with an AK-47 along with you to see patients or even follow you to the bathroom. When we drive from place to place, there is a similar "police" escort with four individuals with AK-47s leading our van. None of us ever feel very safe as we share the fear that we are much more likely to be injured by our guards with their care-free handling of their automatic weapons than from anyone we have ever come across. We have never felt in the least bit like we were potentially

Figure 6 a/b: Here is a young lady with significant contractures of her chest and chin from having kerosene explode. We released her neck and placed split thickness skin grafts from her thighs.

in a dangerous situation.

Our patients will come from as far as 30 hours of public transport away or will literally walk 7 days (!) in order to come see us. It might be of interest to note how patients know that we are coming. How do they know when we are coming? The regional cellular phone company sends out an SMS to everyone with a cellphone announcing when we are coming. Indeed - even in this desperately poor region of the world, almost everyone has a cellphone.

For a patient to have surgery, the local hospital charges a flat fee of about $100, which is a tremendous amount of money in this culture. About a quarter of our patients cannot afford this. Therefore we ask patients who we sign up for surgery if they can pay. If the answer is "no" my Dad will pass an envelope with the prerequisite $100 to one of our reliable medical staff members who then in turn pass the envelope on to the patient so they can pay for their surgery. So not only do we not get paid for what we do, most often we are paying to do what we do. It is all worth it though as the people are incredibly grateful, and for many we are their only hope.

Usually between the three of us surgeons, we are able to do about 90-100 operative cases in six days of operating. Typically we arrive mid-afternoon the first day, have a quick lunch and then start clinic about 3:30 PM that finishes about 9:00 PM. In that time, we will usually sign up about 50 operative orthopedic and plastic surgery cases. The rest of the days, we go to the hospital at 6:30 AM every day to round, operate, and see more patients, and then leave about 8:00 PM after a very full day of work. We usually run two OR beds side by side in one room and then do some minor procedures in a side room. We bring all of our own gloves, sutures, drills, screws, plates, . . . everything. No implants are available beyond what we bring. There is no fluoroscopy or C-arm, just a very rudimentary X-Ray machine. Our operatory is an empty 15' x 25' room featuring two 1950's-style operating tables. Between cases, we heat-sterilize all of our instruments and make sure that we have all we need laid out for the next case. There is really no nurse, scrub tech, or anyone else too reliable to speak of

Figure 7 a: Untreated club feet in Somaliland. The Ponsetti method is unheard of so most of the kids are somewhere between 2 and 18 when they come for treatment.

Figure 7 b: Here I am with a mother and her daughter in the ward the day I left to return to Seattle from one of my trips. I had done bilateral clubfoot releases on her. Interestingly on this trip, my bag never made it so I had to buy the shirt and pants I have on in this picture in Nairobi on my lay-over. I alternated between the clothes I wore out and the clothes I bought in Nairobi for the whole trip.

to make sure everything is set for the next case. It is sort of a self-service surgical lay-out. The bulk of the cases I end up doing consist of residual club feet ranging in age from 2 to 18, osteomyelitis, fracture nonunions, malunions, burn contractures, cleft lips, and tumors. (See Figure 5 and 6 a and b). Clubfoot deformities are probably my most common cases with at least 1-2 posteromedial releases a day. (Figure 7 a-c) Usually I manage to get about 5-6 cases done in a day with essentially no break from start to finish; we are either operating or getting everything together for the next case. Most of the cases are done with spinal anesthesia and regional blocks or a ketamine drip. Intubations or LMAs are very rare. Despite my training as a spine surgeon, I have so far not felt comfortable doing any spine procedures due to the prevailing poor medical climate. As to follow-up, members of our team returns about every six weeks to take care of follow-ups and take care of new problems.

Our evenings are spent lecturing to the medical students and "residents". The local medical school in Amoud University has a faculty of about 5 teachers. Most of the teaching is done through reading and self study. Almost all of the text books are in English which is not the local language - thus making learning that much more

Figure 7 c: Here is a young girl in whom my Dad and I did bilateral clubfoot releases. Typically my Dad will do one side and I will do the other side simultaneously.

Figure 8: My Dad and two of the young doctors with whom we work – Rhoda on the left and Deeqa on the right. These two ladies are the two most reliable doctors we have the privilege to work with. They both were very young medical students when my Dad started these trips.

difficult.

Over the years, we have made some great friends and the medical students have moved on to become resident physician surgeons (Figure 8). These physicians will never be able to practice outside their country due to their informal "credentials," but many are good and they truly care about their people. In the intermediate times, the medical students, "residents", and local doctors take care of the various issues and complications that arise to the best of their abilities.

Summary

For me this experience in Somaliland has been most gratifying from my professional vantage point as an Orthopaedic Surgeon, who is fortunate to practice at one of the foremost medical centers in the world - Harborview Medical Center at the University of Washington. Delivering meaningful musculoskeletal healthcare allows disabled individuals in this war-torn region in the world to return to function as well as gainful activity and hopefully helps in a small way in the rebuilding of a functioning society.

A Taste of the AAOS in India: Orthopaedic Trauma Education in Four Cities in India

Robert P. Dunbar, M.D.

Introduction

This past Fall, I had the opportunity to join a team of orthopaedic trauma colleagues selected by our Academy of Orthopaedic Surgeons going to India. I have always been attracted to providing and improving care abroad. Starting as a Peace Corps Volunteer in Burkina Faso, West Africa (1985-7), where I tought middle school Math and English as a foreign language, I then served overseas in Japan (1998-2001), while on active duty in the US Navy. More recently, I chaired an AAOS international course in Accra, Ghana (December 2008) that focused on the problem of road traffic accidents.

Background

As is well known, India is a vast, rapidly developing country with over a billion people but limited resources in many regions outside the main cities. Surgeons often have limited access to newer technologies. Far fewer still have the resources to travel overseas to attend meetings like the AAOS annual meeting. As such, it was decided to bring a component of an AAOS meeting to India. In order to reach the greatest number of surgeons and to impart the greatest impact in a brief tour, it was decided to concentrate on trauma. While many Indian orthopaedic surgeons have now come to subspecialize in other areas of orthopaedics such as spine surgery and joint replacement, most still have to contend with a constant onslaught of fractures and other traumatic injuries, which are commonly the result of road traffic collisions.

Four one-day courses were given in Mumbai, Delhi, Kolkata & Hyderabad. The course was synthesized from four separate two hour trauma Instructional Course Lectures (ICLs) which had been delivered at the 2011 AAOS annual meeting in San Diego. The course content included topics on soft tissue management, difficult periarticular fractures, treatment of nonunions as well as recognizing and avoiding complications. At each site, leading local (Indian) orthopaedic surgeons joined our AAOS faculty, as speakers and moderators. Our AAOS Faculty consisted of Joseph Cass, M.D., Mayo Clinic, Mike Archdeacon, M.D., Vice Chairman at the University of Cincinnati Department of Orthopaedics, William "Woodie" Cross, M.D., (2009 Harborview Trauma ACE) now at the Mayo Clinic and myself. The courses were packed to the rafters with greater than 500 attending orthopaedic surgeons at each site. The attendees were attentive, bright and engaged, making for healthy discussions in each of the sessions, despite long days and great heat. It was clear that many of the surgeons had significant experience dealing with complex fractures and were thirsty for knowledge. I personally was overwhelmed by what they could accomplish with so fewer resources than I typically have available to me.

50 kph in traffic, side saddle, no helmet, with babe in arms.

The Problem

Road traffic accidents have exploded as a public health crisis in the Third World. It is a veritable perfect storm of conditions that has led to enormous cost, suffering, loss of productivity, and challenges for surgeons. Burgeoning Third World urban areas are commonly overcrowded, with great numbers of people, vehicles (both 2 and 4 wheel and both motorized and not) and animals making their way on small, poorly maintained thoroughfares. Dramatically increased motorization & industrialization exacerbate the problem. Most developing world countries simply do not have the resources to build the infrastructure to keep up with the deluge of vehicles. Many areas have little or no standards for roads or vehicles, or even safety, which accentuates the risk for disaster. While the incidence of road traffic accidents is highest in the blossoming urban areas, injuries also occur in the rural setting, where there may be little or no pre-hospital care and a dearth of resources even once in

Combined AAOS and local Indian faculty for course in Delhi.

a hospital. It may be days or longer before patients with open fractures can reach even any facility, even one marginally prepared to care for such injuries. Concepts of debridement and even sterility may be limited, putting patients at risk for infection and further misery (note, upon a return visit to my Peace Corps home of Burkina Faso in 2008, I was told that patients had to wring out, rinse & reapply dirty (including infected) wound dressings as no others were available). Surgeons are generally in short supply and may be inadequately trained or have dauntingly scarce resources (e.g. few random implants, limited surgical instruments, no fluoroscopy). Patients often live far away from medical facilities and are thus unable to return for follow-up or rehabilitation.

Temporary and permanent disabilities often have significant impact beyond the patient himself. There may be loss of income due to disability of the family's breadwinner. Such loss of earning power in often labor driven societies may affect many members of an extended family. Alternatively, the breadwinner may need to leave work to travel to a regional hospital to care for an injured family member or care for them after they have returned home.

The extent of the problem is staggering. Road traffic injuries are the second leading cause of death in the 5-14 age group, the leading cause of death in those aged 15-29 years and the third leading cause in those aged 30-44 years (2005 report by WHO). Even back in 1996, WHO estimated that by 2020 such injuries would be 1st or 2nd leading cause of healthy years of life lost worldwide (surpassed only by cancer) and that they would be the 5th leading cause of death for all ages combined. The impact may take up 1-2% GDP but as much as 5% in India, Vietnam & Malawi.[1,2]

Full house during question and answer periods during course in Kolkata.

Summary

Information exchange, educational ventures delivered through local site visits are but one of the many ways to improve musculoskeletal care abroad. Fortunately there is an increasing recognition of the profound impact traumatic injuries play in the socioeconomic fabric of developing nations. The actual delivery of health care unfortunately remains largely unstructured and nonsystematic. Efforts are under way to improve implant access abroad through formal donation programs. Another important approach is that of providing high quality implants without the need for major technological infrastructure at a reasonable cost basis.

One of the brightest spots in this arena is our own Lew Zirkle and his Surgical Implant Generation Network (S.I.G.N.). Lew noted long ago that fracture implants were largely inaccessible in the developing world and he set about to change that.

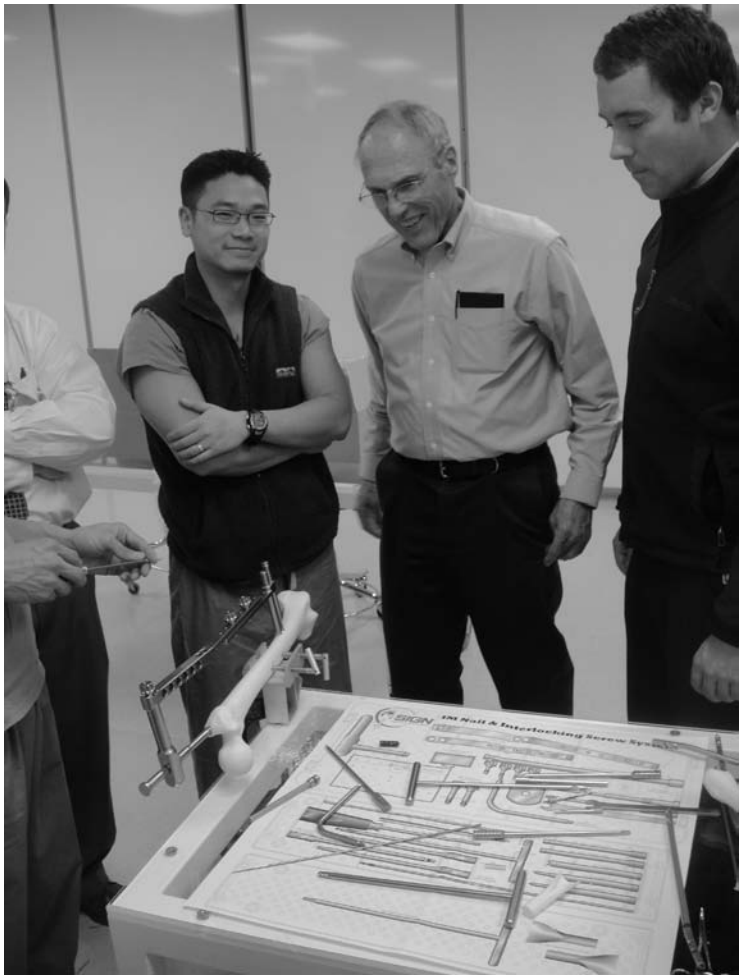
These are all important components of making globalization a winning formula for the health care needs of the Third World. Most importantly the realization of Trauma Care playing a crucial part in improving the quality of life for inhabitants of emerging countries and supporting their fiscal health is an important insight for health care politicians and philanthropists.

Bibliography

1. Friesen, J. Mitigating the Global Burden of Road Traffic Injuries. Should Low and Middle Income Countries Invest in Prehospital Care Systems? TrekMedics International website: trekmedics.org/mitigating-rtis/.

2. World Health Organization. Injuries & Violence: The Facts. http://whqlibdoc.who.int/publications/2010/9789241599375_eng.pdf

SIGN International is the remarkable story of a single man's vision and his wish to make a difference through affordable simple Orthopaedic trauma care brought to any operating theater in the world. Dr. Lew Zirkle Jr,, UW Clinical Professor in Orthopaedics, developed his sense of dedication during his tour of duty in Vietnam as an U.S. Army Orthopaedic Surgeon in 1968. From his practice location in Richland, Washington and initially supported by his family and his practice he developed regular educational programs first in Vietnam and later in other South East Asian countries. In 1999 he formed SIGN to provide a formal platform to create new implants and simple technologies not offered by large implant manufacturers, which can be applied effectively even under the most dire locations devoid of even basic advances of modern medicine. (1) Following the Earthquake catastrophe in Haiti in 2010 it was SIGN and not a governmental or NGO who provided trauma care on the scene. Dr. Zirkle has been a welcome educator of our residents by sponsoring their attendance to his annual SIGN conference in Richland, Washington and providing us with lectures and classes. (2) To date SIGN has trained about 2,000 surgeons in modern fracture care, there are roughly 50,000 patients who have been treated with SIGN implants. One of our researchers, Amy Cizik, Research Scientist / Engineer, has won the Thomas Francis, Jr. Travel Fellowship, awarded by our UW Department of Global Health, to study a novel application of available smart phone technology in 3rd World countries in order to assess outcomes of fracture care. The following article shows the expanding capabilities of SIGN by bringing affordable fracture care to pediatric patients with femur fractures.



Drs. Peter Kim, Lew Zirkle, and Andrew Merritt.

Dr. Lew Zirkle with Dr. Richard Bransford and colleagues.

1. www.signfracturecare.org/corporate_partners.htm

2. www.uwtv.org/video/player.aspx?mediaid=16209983

Design of the SIGN Pediatric Femoral Nail

Lewis Zirkle, M.D.

Abstract

Increasing numbers of families are moving to the city in developing countries. A motorcycle sold for $500 is emerging as the family vehicle. These motorcycles are rented by young men to carry schoolchildren back and forth from school. This combination of gasoline and testosterone has caused a marked increase in the number of pediatric femoral fractures. Surgical supplies and implants must be purchased by the patient prior to surgery. Families cannot afford implants. Cast immobilization, external fixation, plate fixation and Ender's nails have been used with varying success. The plates often break due to poor quality. The SIGN solution is to design a semi-rigid nail which will effectively immobilize pediatric femoral fractures without causing growth disturbances. Forty six surgeries with pre-and post-op x-rays, 24 with follow-up x-rays, have demonstrated excellent results.

Introduction

The treatment of pediatric femoral fractures is suggested based on age and weight. Complications have been reported in patients treated by all modalities.[1,2] Rigid nails have been used with increasing frequency. Lateral trochanteric entry point has not been found to cause osteonecrosis or x-ray changes in patients 9 years of age and older.[3] SIGN has designed a semi-rigid nail for use without C- arm imaging in developing countries (Figure 1).

Material and Method

Design Goals

- Design a nail which is flexible enough to follow the configuration of the femoral canal.
- Use distal fin configuration to avoid need for distal interlocking screws (Figure 1).
- Bench test fatigue strength of the nail using a hip fixture which mimics walking with increasing load (Figure 2).
- Evaluate clinical and radiological healing of the fractures and follow until end of growth by reports on the SIGN surgical database.

Results

- Bench testing reveals the nail is strong enough to withstand fatigue stresses (Figure 2). Using composite made by Pacific Research Laboratory on Vashon Island designed to replicate the human femur with a fracture, the nail can withstand over 120 pounds of force, which is greater than full weight bearing. The composite remained intact for 180,000 strides.
- Clinically the nail is flexible enough to immobilize the fracture and allow some

Figure 1: SIGN pediatric femoral nail.

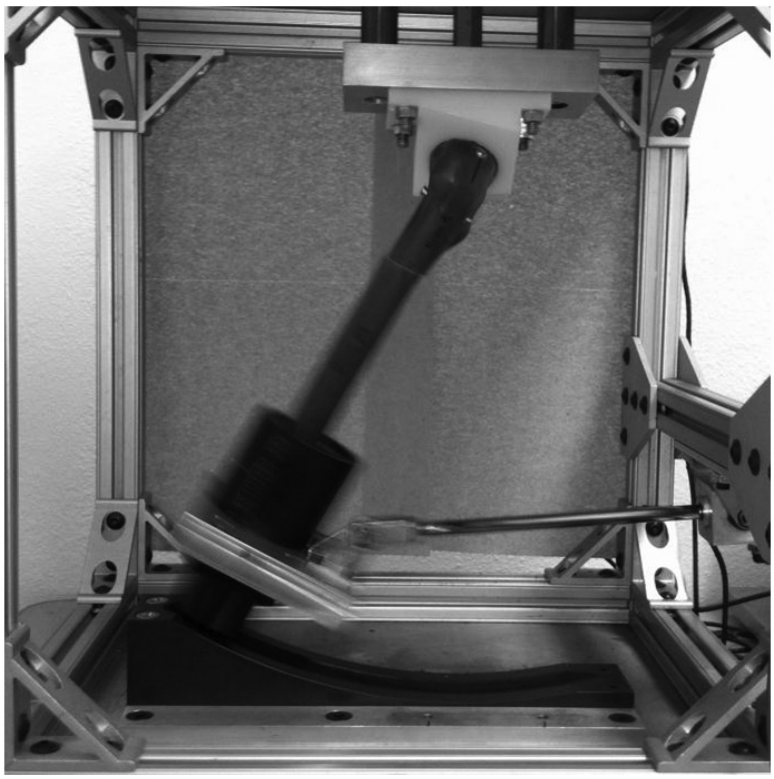


Figure 2: Hip fixture which simulates forces during walking. Designed by David Shearer, M.D., Justin Roth, M.D. and Allan Tencer, Ph.D. at the University of Washington.

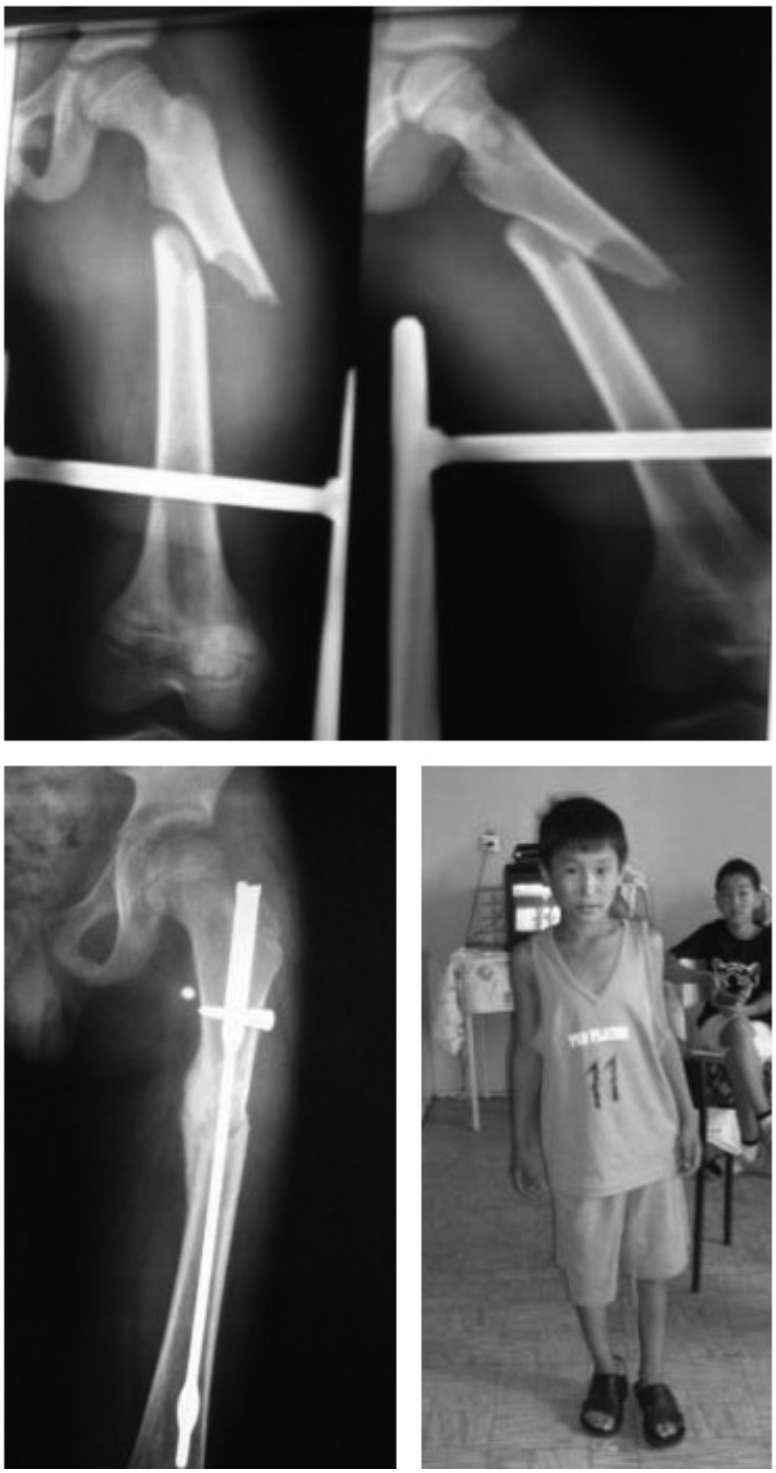


Figure 3: 10-year-old patient from Mongolia treated successfully with SIGN pediatric femoral nail.

telescoping to account for overgrowth.

- Larger diameter shafts are being designed and tested to accommodate the wider canals seen in different countries. As would be expected, preliminary testing indicates these nails will withstand more force pounds and strides.

Discussion

Multiple articles describe the different modalities for treating pediatric femoral fractures. Previous literature describing results of a semi-rigid nail are lacking as we are unaware of semi-rigid nails which are being used to treat pediatric femoral fractures (Figure 3). We chose semi-rigid nails to increase the indications in pediatric femoral fractures compared with rigid nails and other modalities. The canals are larger in different parts of the world and therefore we have increased the size of the shaft from 4mm to 6 mm. This increased shaft diameter will decrease flexibility but more adequately fill the canal in patients with large canal size. Canal fill of flexible nails has been found to be important in comminuted fractures in a pediatric size symptomatic femur model.[4] We are currently bench testing this design. Fatigue testing demonstrates this nail can withstand over 170 pounds of force and remain intact for 240,000 strides. We will begin tension, compression and torsion testing of the nail using an Instron machine. The 8 mm fin nail has been used in 43 patients in Pakistan primarily (Figure 4). Results have been very good. A spectrum of shaft sizes as well as fin sizes are necessary. We will follow the patients until the end of growth.

The SIGN pediatric nail is easy to insert using standard SIGN fin nail technique. Indications are continually being studied. SIGN surgeons have a history of using SIGN nails for expanded indications as they have no other implant to use. External fixation is available in some programs but complications are frequent.[5]

Summary

- SIGN surgeries are reported on the SIGN surgical database. Evaluation of the SIGN pediatric femoral nail reports shows excellent results. We

Figure 4: 9-year-old patient from Pakistan treated successfully with SIGN standard 8 mm fin nail.

recognize the need for follow-up until the end of growth. We are also studying optimum time for removal of the nail. Bench testing is ongoing as is clinical observation.

References

1. Flynn JM, Schwend RM: Management of pediatric femoral shaft fractures. J Am Acad Orthop Surg 2004;12:347-359.

2. Luhmann SJ, Schootman M, Schoenecker PL, Dobbs MB, Gordon JE: Complications of titanium elastic nails for pediatric femoral shaft fractures. J Pediatr Orthop 2003;23:443-447.

3. Gordon JE, Swenning TA, Burd TA, Szymanski DA, Schoenecker PL: Proximal femoral radiographic changes after lateral transtrochanteric intramedullary nail placement in children. J Bone Joint Surg Am 2003;85-A:1295-1301.

4. Mahar A, Sink E, Oka R, Faro F, Newton P: Effects of nail material, nail size and "canal fill" on biomechanical stability of comminuted fractures in a pediatric sized synthetic femur model. J Child Orthop 2007;1(3):211-215.

5. Carmichael K, Bynum J, Goucher N: Rates of refracture associated with external fixation in pediatric femur fractures. Am J Orthop 2005;34(9):439.

Service in Developing Communities Abroad: Leon and Managua, Nicaragua

Gregory A. Schmale, M.D.

I have become a regular visitor to Nicaragua, traveling there annually since 2007 with COAN, Cooperacion Ortopaedica Americana Nicaraguensae, a non-profit organization dedicated to helping people help themselves. COAN travels to Leon, Nicaragua four times a year, with varying numbers of orthopaedists, physiotherapists, anesthesiologists, enthusiasm, and supplies. We routinely bring instruments and implants, sometimes even arthroscopy towers and fluoroscopes. We work with their orthopaedic residents and attendings, teach them a few of our tricks and learn many of theirs. We gain perspective, we learn new and clever approaches to difficult problems, and we are warmly and appreciatively received by them for our dedication in helping them help their community. We are humbled by their routine challenges of dull instruments, unreliable fluoroscopy, floating and not-very-bright-lights, plates without plate benders, screws either way too short or way too long... and, especially, challenging patients with rarely seen and difficult to manage musculoskeletal problems.

Funded by the Seattle Children's Hospital International Education Fund and sponsored by COAN, one of our UW Orthopaedics Residents, Brian Gilmer, who dedicated his vacation time for this trip, and I traveled from Seattle to Nicaragua in late April 2012 for a week of orthopaedic work divided between two sites: Rosales Hospital in the city of Leon, and Hospital Fernando Velez Paiz in the capital city of Managua. There we saw patients in clinics, performed and assisted with surgeries, and taught residents and attendings alike. We brought over $12,000 worth of donated instruments, implants, and general surgical supplies that we left divided between the two sites.

Upon our arrival in Managua, we were greeted by a cadre of orthopaedic residents from Leon who drove us to their hometown. Leon is a University town of about 165,000 in the northwest of the country, close to the Pacific Ocean. We saw 16 complex pediatric orthopaedic patients at the Sunday clinic, and scheduled six cases over the following two days. Of these 16 patients, many were follow-up patients from prior COAN visits and surgeries, including two patients with hip dysplasia who had undergone open reductions as infants or toddlers and were returning to confirm good growth of their hip joints. We saw patients with Sprengel's deformity of the shoulder, Klippel-Feil syndrome, a presumed tethered spinal cord with recurrent foot deformities, and leg-length inequalities amenable to annual follow-up for future epiphysiodeses.

Figure 1: Drs. Schmale and Gilmer with the crew of the Sunday clinic in Leon.

Our surgeries in Leon included a valgus-producing femoral osteotomy for non-union of a femoral osteotomy after slipped capital femoral epiphysis, a patellar realignment in a 13 year old with a long-standing post-traumatic patella dislocation, bilateral femoral osteotomies and hemiepiphysiodeses of the tibias in a child with now medically managed hypophosphatemic rickets, physeal closures of the distal tibia and fibula in a patient with post-traumatic foot and ankle deformities, and open heel cord lengthening in a child with cerebral palsy.

Weekday morning teaching conferences were followed by surgery. Two orthopaedic residents from Leon participated in each surgery, as did at least one of their Attendings. Wednesday morning we traveled to Managua for a clinic at the Velez Paiz Childrens hospital. We saw 20 teenage patients with a variety of primarily sports-related complaints: shoulder pain, hip pain, knee pain, lower limb malalignment and patellar instability, as the Managua orthopaedists had expected us to be bringing arthroscopy equipment from Rosales Hospital in Leon to Managua to help teach the Managua pediatric orthopaedists basic indications for and skills with arthroscopy. Unfortunately, we were unable to deliver arthroscopy equipment to Velez Paiz due to priority needs at Rosales hospital.

At Velez Paiz, we performed three cases over the following two days, including an open Bankart reconstruction of the shoulder in a young active teenager with a history of multiple shoulder dislocations, a patellar realignment in a teenage girl with recurrent patellar instability, and screw removal for presumed

Figure 2: Dr. Gilmer overseeing the final touches on a dynamic compression screw placed after valgus producing osteotomy of a proximal femur.

symptomatic hardware near the hip in a teenage girl who had undergone a prior in-situ screw fixation of a slipped capital femoral epiphysis.

The members of the Orthopaedics Department in Leon were their typical welcoming selves, with Dr. Baldazon hosting the greeting celebration on Sunday and our departure celebration on Tuesday night. In Managua, each evening was spent with our hosts Drs. Mario Sequeira and Gabriel Ramos, and fellow COAN orthopaedists Drs. Ed Campion and Bob Caudle, discussing the challenges of providing orthopaedic care in Nicaragua and how COAN might best serve the cause.

At present, it seems the greatest challenges to orthopaedics in Nicaragua at these two sites are not posed by a dearth of knowledge in general orthopaedic principles and techniques, but rather a dearth of basic orthopaedic instruments and implants: reliable drills and saws, drill bits, saw blades, sharp osteotomes, complete plate and screw sets, plate benders, and K-wires. Both sites now have reliable fluoroscopy, at least part-time, and while the residents in Leon are slowly learning arthroscopy, hopefully in the near future that opportunity will come to the attendings and residents at Velez Paiz as well.

Looking back at how I became involved with Nicaragua, my first visit there came when as a chief resident I invited myself along on one of the first trips that COAN's founders took to Nicaragua. I was so impressed by our Nicaraguan hosts' knowledge, their inventiveness to overcome implant, instrument, and situational challenges, but most of all by their appreciation of our interest in working with them to help their people. Nicaraguans are incredibly open, friendly, and welcoming, making it an easy locale to which to return. That first trip proved to be life changing. I see an opportunity, even an obligation to share the wealth of knowledge that I have gained from my teachers, mentors, and colleagues, and from my experiences as a physician and surgeon. Returning annually is one way to share these great advantages that I have. But perhaps more importantly, I see these trips as an opportunity to offer a similar potentially career-changing experience to our UW orthopaedic surgery residents in the future, similar to the inspiration I received as a resident 13 years ago. In the same way that I enjoy teaching (and learning from) the teaching physicians in Nicaragua, offering a similar opportunity to our residents may spread this interest in and dedication to service in developing nations in their future careers.

Figure 3: An eager patient at the Sunday clinic in Leon, seeking treatment for a chronic patella dislocation.

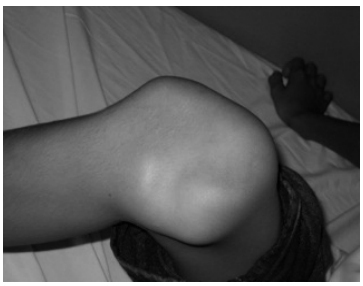


Figure 4: Obligate patella dislocation in our 13 yo when the knee is flexed

Figure 5: Sprengel's deformity in a youth with limited shoulder motion but no complaints.

A New Beginning - Opportunity and Lessons Learned: Virginia Mason Ortho Team in Haiti

Thomas Green, M.D.

There are many opportunities for orthopaedic volunteer work in third world countries. The need is great as there is an enormous discrepancy between what we have in the way of orthopaedic care and what is available to those in underdeveloped countries. My special interest lies in Haiti, which is so close to mainland USA, yet eons away in terms of our living standards and resources.

My friend Rick Frechette, a Catholic Priest and a physician, has worked in Haiti since 1988 when he became the director of an orphanage that is part of Nuestros Pequenos Hermanos. He has spent his life taking care of orphaned and abandoned children, and taking care of the sick and infirm. He gets up in the morning and gives last rights to those who have died and spends the rest of the day caring for the sick. Not long before the infamous earthquake, he opened St. Damien, a 120 bed pediatric hospital just outside of Port au Prince. It gives free care that is evidence based and aims for the same standard of care that we would expect from the best medical centers in the world. This is a daunting mission to carry out with charitable support and volunteers. This hospital happened to take on a special role following the disastrous earthquake that struck Port au Prince on January 12th, 2010. No one knows for sure but as many as 250,000 people may have died immediately surrounding this quake. Almost miraculously St. Damien survived the earthquake with mostly cosmetic damage as the only hospital left standing near and far. It had power and water. Its mostly dormant operating room became a major orthopaedic center for care in the weeks following the disaster. Initially, on site Italian physicians and volunteer US physicians associated with the orphanage organization provided care with very limited equipment and supplies.

Our team visiting the USS Comfort during one of the daily sorties.

In the days after the disaster, Lyle Sorensen, M.D. and I (orthopaedic surgeons), Merry O'Barr, RNFA, Derek Gallichotte, PAC, and Peter Ackerman, M.D. (Anesthesia) felt compelled to help. We did so as individual volunteers, not aligned with any organization. We were able to get on site with a private 12 passenger jet with half-ton of cargo capacity provided by benevolent local corporation. Unlike many other spontaneous volunteers or even formal organizations we had the good fortune of being able to work in an established health care facility. Nevertheless we had to improvise and reinvent almost all aspects of the healthcare delivery chain ourselves due to the desperate absence of any working infrastructure. We became experts at scrounging the area for resources and supplies and slowly became increasingly operational in terms of equipment and supplies. A fellow UW Faculty colleague, Dr. Lew Zirkle from SIGN, came by St. Damien and provided us with implants and training of his devices.

The crew of the USS Comfort also did an amazing job of providing care for complicated cases that we and others could not manage. There was at least one daily visit to St. Damien to pick up and return patients. They also brought many of their post op patients to us for care so that they could make space for new patients. The sights, smells and emotions of this experience will be permanently etched in our memories as much as any experience of our trip.

In the wake of this disaster it became clear that there would be a need for ongoing orthopaedic care for years to come as a result of the injuries sustained in the earthquake. St. Damien is a pediatric hospital and has returned to its mission of taking care of only children. To help meet the need for adult care, St. Luc, an adult hospital has been built from grounds up with

St. Damien Hospital with temporary tent expansion.

Dr. Sorensen with pediatric fracture patient.

With the help of significant donations a new Orthopaedic hospital named St. Luc has opened right next to St. Damien. This is one of the two operating rooms with full equipment from donations. We organize regular return trips there to provide continuity of care, but would invite further support.

two new operating rooms and a focus on Orthpaedic Surgery. There will be ongoing opportunities for volunteer work on a regular basis. The vision is to have the new operating rooms staffed by volunteer teams from the US for at least a week each month of the year. Hopefully this will involve medical students and residents from the US and possibly Haitian orthopaedic residents as well. Together with some of my partners I have been able to return on several occasions and see steady progress in this rebuilding effort.

The experience of providing Orthopaedic care first in a disaster setting and later being involved in an elective facilty that has become a cornerstone of care for the area has taught us some important lessons:

- Little goes a long ways. One doesn't need to open whole sets of instruments to do a simple case. This is especially meaningful when you have limited resources and help. We hand picked a few instruments for each case limited to just what we needed.
- Having a place to go where we were known and wanted was important. We saw many volunteers come to help and they had nothing to do. Such well-meaning people are a burden to the local infrastructure, especially in crisis times, but also in 'normal' periods.
- Having a complete functioning team that could work together in an austere environment is very helpful.
- Staying as long as we did was an important contribution to our impact.
- And finally: you can't help the whole world but you may mean the whole world to someone who you help.

The AO Philosophy: Setting Global Standards in Orthopaedics "Motion is Life, Life is Motion"

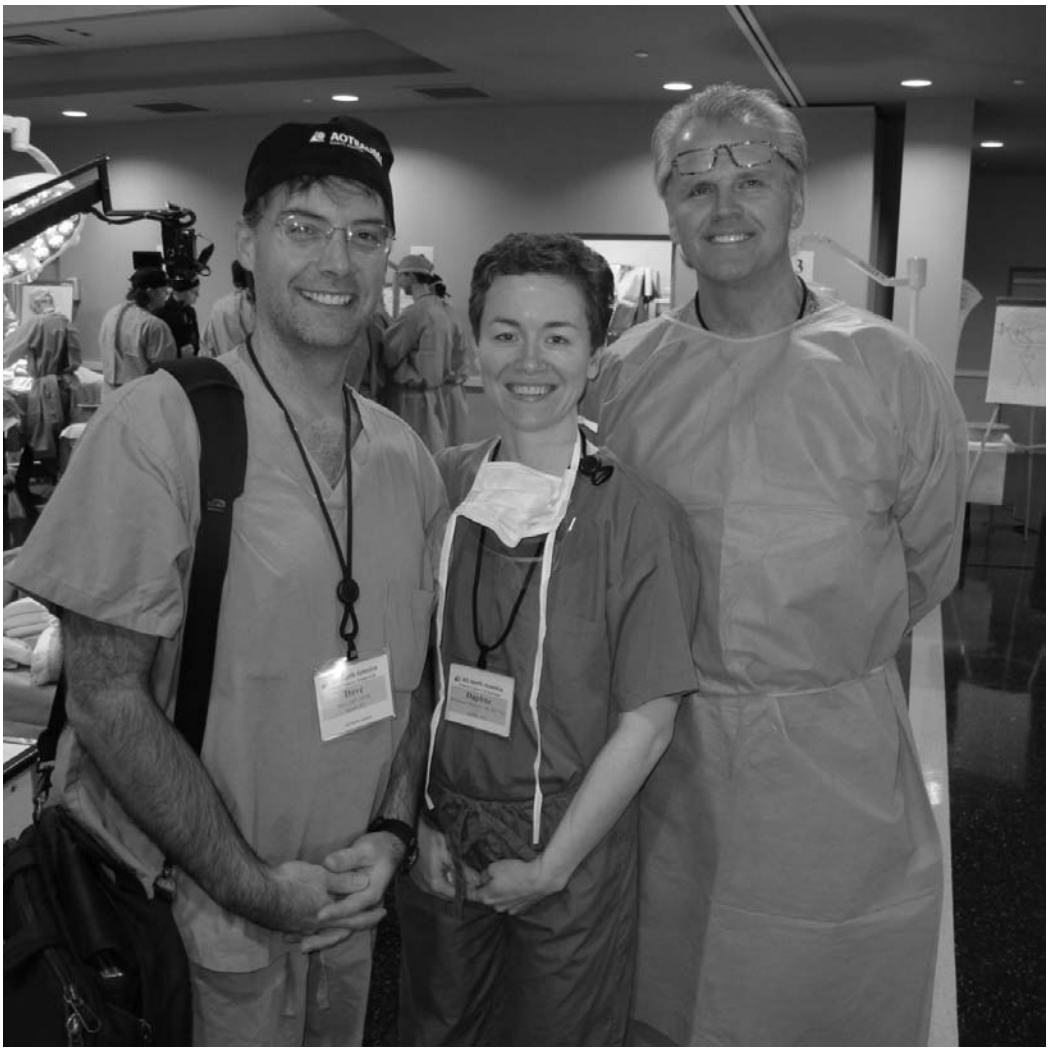
Sean E. Nork, M.D. and Jens R. Chapman, M.D.

There is probably not a more significant and impactful movement in the Orthopaedic domain than that of the AO Foundation. It was created in 1958 by a small group of visionary surgeons in Davos, Switzerland out of a realization that trauma care was in dire need of a revolution through application of modern scientific principles of 'research', 'advanced implant technology', 'documentation' and 'education'. Undoubtedly modern Orthopaedic trauma care owes much of its current level of advancement to the dramatic rise of the AO movement, which since its inception created formal education sessions and surgeon education through academically spirited and surgeon driven courses. Its very name 'Arbeitsgemeinschaft für Osteosynthese Fragen' represents a collegial fellowship of surgeons motivated to voluntarily tackle ongoing issues surrounding musculoskeletal problems – very different from typical professional societies with their traditionally more insular and self-serving approach.

Dr. Bellabarba (left) in with former fellow liyan Zhang at COA meeting in Beijing.

From its beginnings in fracture care, the AO movement has spawned a sound global presence with four clinical specialties – AOCraniomaxillofacial, AOVeterinary, AOSpine and AOTrauma, each functioning with some operational independence but all ascribing to the same ethos: the highest quality education of surgeons through a continuous quest for the best possible treatments, and truth delivered by a unique fellowship of like-minded surgeons around the world free of commercial bias.

Starting with our former Chair Sigvard T. Hansen Jr., we have had a strong association with the AO with literally all of our Foot & Ankle, Hand, Spine, and Trauma faculty having served in AO courses. Through the endowment provided through the AO Foundation and the organizational prowess of its regional bodies such as AO North America, the AO continues to define advanced education of residents, fellows and active surgeons in its subspecialty domains. It now sponsors formally peer selected fellowships to select academic sites like ours (Spine and Trauma) and also supports major multicenter research on projects of major concerns such as cervical myelopathy, geriatric odontoid fractures, outcomes after pilon fractures, and improved fixation of proximal humerus fractures with augmentation. The AO's sustained (and in fact growing) success has brought the admiration and formal collaboration with major specialty societies such as the Orthopaedic Trauma Association (OTA), Scoliosis Research Society (SRS), North American Spine Society (NASS), the American Academy of Neurological Surgeons (AANS) and many others. More recently it has also developed a more political role in using its considerable vantage point in



Drs. Barei, Beingessner and Routt at AO Cadaver course in Las Vegas.

research and education to advocate for ethical access to care in many areas of the world.

We are proud to have many of our Faculty strongly involved with AO, serving on the Board of Trustees (S. Benirschke, ST Hansen Jr, JR Chapman, S Nork), serving in education and research committees (Barei, Beingessner, Bellabarba, Bransford, Chapman, Dunbar, Lee, Nork, Routt) and having headed major multinational research efforts or having chaired courses. Our strong clinical and academic programs here at UW Medicine have made our faculty very sought after participants in courses near and far. For UW Medicine this unique academic partnership has brought benefits through networking, participation in major research collaboratives and increased awareness of the quality of our work here around the world of Orthopaedics. We are very proud of this relationship of UW Orthopaedics with the AO and look forward to making further strides toward the advancement of ethically based, high quality patient care and making our present day care opportunities available to more people in need than ever before.

AO in Numbers:

Global Courses Per Year (All Specialties):	620
Number of Participants:	35,000
Global Membership:	10,000

Some of our faculty and other participants at an AOTrauma course.

Making a World of Difference – Right Here at Home: The Seattle Children's Orthopaedic Outreach Perspective in the WWAMI Region

Carol A. Mowery, M.D.

The motivation to practice global medicine in far away places stems from a number of different emotions, including a sense of mission, a quest for adventure, an interest in exposure to different cultures, exotic landscapes with different languages and overcoming obstacles while making a hopefully huge difference for a population in need. The question, however, begs to be asked, if we truly have to travel abroad to make these differences, or if there is an opportunity or even a need right in our own backyard to provide our expertise on site in order to make a big impact on a local underserved population. The enormous landmass of the WWAMI region (Washington, Wyoming, Alaska, Montana and Idaho), which together hosts the world's (geographically speaking) largest medical school located at the University of Washington, provides plentiful areas of need for inspired Orthopaedic expertise. This article shows the work done by Pediatric Orthopaedic surgeons who travel within our WWAMI region to make a big difference.

General Setup

In addition to staffing orthopaedic/sports medicine clinics in the greater Puget Sound region extending from Everett to Olympia, providers from Seattle Children's Department of Orthopedics and Sports Medicine travel to eastern Washington and Alaska with plans to expand into Montana. "Outreach" services in Yakima, Wenatchee, and Anchorage function in partnership with existing hospitals and clinics. The Tri-Cities clinic is owned and operated by Seattle Children's Hospital and is, therefore, a "regional" clinic along with Everett, Mill Creek, Bellevue, Federal Way, and Olympia. Each practice site is unique in terms of facility and patient population, but the overriding goal is to offer orthopaedic services to children in underserved areas.

Wenatchee

The Wenatchee clinic has existed as a 14-year partnership with Central Washington Hospital and currently offers 10 to 11 orthopedic clinics each year staffed by SCH providers. In 2010 and 2011, Drs. Goldberg and Jinguji saw an average of 85 patients per year, 40% of whom were new visits. Approximately 40% of patients require an interpreter. 33% are covered by private insurance and 66% by DSHS. Most patients come from Chelan and Douglas Counties, but some travel from as far as Moses Lake, Toppenish, Sunnyside, Colville, Twisp, and Winthrop. Central Washington Hospital will continue to operate pediatric specialty clinics through December 2012, probably with slightly reduced hours. Work is underway to plan a Seattle Children's regional clinic beginning in January 2013.

Yakima Children's Village

The Yakima clinic represents a 13-year partnership with the Yakima Valley Farm Worker's Clinic and Yakima Children's Village. In 2010 and 2011, Drs. Jinguji and Song held 12 clinics per year and saw an average of 155 patients, 49% of whom were new visits. Currently, the wait time for an orthopaedic appointment in Yakima approaches nine months, and Yakima has requested an increase to 24 yearly clinics. The Children's Village facility in Yakima is large and well-staffed, offering diverse pediatric services, but it lacks radiology.

Tri-Cities Clinic

In Tri-Cities, Seattle Children's has owned and operated the clinic since 2008. Twelve orthopedic clinics were held in 2011, and this will increase to 18 clinics in 2012 with the addition of Dr. Steinman. For the first time, she will offer pediatric upper extremity clinics in Tri-Cities. In 2011, Drs. Krengel and White saw 201 patients (an increase from 136 in 2010), 40% of whom were new visits. Most patients come from Tri-Cities, Walla Walla, and Spokane with gait issues, spinal deformities, neuromuscular problems, and congenital deformities. Increasingly, the surgeons are scheduling postoperative visits, saving families travel time and expense. The patients represent a diverse economic group, ranging from uninsured to well-insured. In 2012, Children's plans to expand their presence in Tri-Cities by moving to a new, larger space.

Yakima Children's Village

Anchorage

The Anchorage clinic represents a 14-year partnership with Providence Alaska Medical Center and the Alaska Native Medical Center. It is an outgrowth of a consultative clinic started by Drs. William Mills, Sr. and Lynn Staheli more than 30 years ago. In approximately 1995, Dr. Staheli retired and Dr. Vince Mosca was asked to take his place. Dr. Mosca visits twice a year and holds two clinic days during each trip, for a total of four clinics per year. All patients are referred directly from orthopedic surgeons throughout Alaska, and he sees 40-45 patients each trip, of which about 45% are follow-up and postoperative visits. Dr. Michael Geitz, the Anchorage orthopedic surgeon with the largest pediatric practice, attends the clinics along with the orthopaedic surgeons from the Alaska Native Medical Center. Children come from Anchorage and "the bush" as it is called—the tiny rural villages throughout Alaska. Diagnoses include clubfoot, DDH (often neglected or multiply- operated), vertical talus, neuromuscular disorders, tibial pseudarthroses, and many other complex pediatric orthopaedic problems. The deformities and malformations tend to be of higher severity than those seen in Seattle and the other outreach clinics, and each clinic generates four to five surgical cases that are performed at Seattle Children's Hospital.

Tri-Cities Clinic

Anchorage

Missoula

Seattle Children's Hospital and Community Medical Center operate several pediatric specialty clinics in Missoula, Montana. At the request of the local pediatric orthopedist, discussions and planning are currently underway to expand that existing partnership by adding pediatric orthopaedists specializing in tumor and spine diagnosis and treatment. A site visit will take place in the next few months, and arrangements are being made to apply for Montana state licensure. This new and exciting opportunity extends our services into yet another underserved community.

Missoula

Harborview Orthopaedics

Clinical Care

The orthopedic services based at Harborview medical center continue to be clinically and academically productive. Our goal is to be available to referring doctors and injured patients from the Pacific Northwest. We have maintained an open door for these referals. The 2011 year showed a six percent increase in surgical volume ~10 percent increase in total work as measured in relative values. The foot and ankle division has grown with the addition of Michael Brage, M.D. in summer of 2011. Dr. Michael Brage joined the faculty in the summer to increase availability of services to our patients. We are planning for him to take over care of patients served by Dr. Hansen over the years as Dr. Hansen transitions to a nonsurgical practice after 50 years in University of Washington medical system.

The Hand surgery division has also grown slightly in spite of a down economy. The Harborview based faculty also provided nearly $3 million of professional services in charity care to the community. In addition, Dr. Reza Firoozabadi was recruited to expand access on the musculoskeletal trauma service.

Research

During the 2011-12 Academic year the Harborview trauma service entered into additional clinical trials of major extremity trauma, coordinated through a multicenter, research consortium, and network of civilian trauma centers, military medical centers. Major extremity Trauma Research Consortium (METRC) funded by the Department of Defense (DoD) in September 2009 with a goal of solving questions about treatment, healing and rehabilitation of major limb injuries, is run through the coordinating center at Johns Hopkins. The studies planned for this year include a study of bone healing comparing bone graft from the injured person to bone graft substitutes comprised of laboratory-engineered proteins; a registry of the type of injuries; a comparison of strategies for preventing infection; and a comparison of strategies for pain control in severe fractures of the leg and foot.

Harborview surgeons are beginning a multi-center trial funded by the National Institute of Health comparing ankle replacement to ankle fusion for the treatment of end stage ankle arthritis. This study involves 5 medical centers national and is coordinated by University of Washington surgeons and is expected to run through 2016. At Harborview we are proud to continue in our mission to provide the best fracture and trauma care possible while researching for better ways to treat injuries in the future.

Reza Firoozabadi, M.D., M.A. will join the Department in the summer of 2012 as a member of the orthopaedic trauma group based at Harborview Medical Center. Dr. Firoozabadi, was raised in Los Altos, California and obtained his B.A. at UC Berkeley in Cell Biology and cell development. He then spent a year at Boston University where he was awarded a M.A. in Medical Sciences followed by an M.D. in 2005. He returned to California for residency in Orthopedics at UC San Francisco. After completing residency, he spent a year at Harborview for an Advanced Clinical Experience in orthopedic traumatology. Dr Firoozabadi's research interests are in the clinical care of the trauma patient. His wife, Suzette Miranda, M.D. is a 3rd year resident in the department of plastic and reconstructive surgery.

Children's Orthopaedics

The Division of Pediatric Orthopedics has enjoyed its greatest clinical growth in the history of the program. In January of 2011, three new partners were added from Swedish Hospital, Dr. Mark Dales, Dr. Suzanne Steinman, and Dr. Carol Mowery. In October of 2011, Dr. Cordelia Carter was added to the Pediatric Sports service after finishing fellowships in Pediatric Sports and Pediatric Orthopedics in Boston and Los Angeles. Dr. Steinman has partnered with Dr. Hanel to develop the Pediatric Upper Extremity service in collaboration with Plastics Surgery. Dr. Dales brings his strength in General Pediatrics and fracture care, and Dr. Mowery will direct the Outreach program with a practice in general Pediatric Orthopaedics.

New clinical facilities have been opened in Bellevue and Mill Creek, and the Pediatric Sports Medicine program continues to add additional high schools to the ranks of schools supported by the Seattle Children's trainers, directed by Dr. Monique Burton, who was recently appointed as the Medical Director of Pediatric Sports Medicine.

Dr. Antoinette Lindberg is being recruited this year to join the Pediatric Orthopedic department in October 2012, to assist with general pediatric orthopedics, pediatric bone tumors and fracture care. Antoinette completed both the Pediatric Orthopedic and Orthopedic Oncology fellowships at the University of Washington. The Pediatric Orthopaedic Fellowship has been rejuvenated with great success in this years match results for 2013 and plans for a pediatric sports fellowship to begin also in 2013.

Clinical Research in the Division of Pediatrics Orthopedics continues to grow with Dr. Klane White receiving the prestigious 2012 POSNA Traveling Fellowship, and the department presenting five oral presentations at the annual POSNA meeting in May 2012. Dr. Janet Eary, Viviana Bompadre and Rebecca Vest continue to support the research program with good effects. Dr. Michael Goldberg has designed and initiated three "Clinical Pathways" in Pediatric Orthopedics and additional others in the Emergency department and Craniofacial Medicine. Those pathways generate routine clinical metrics for the evaluation of standard work with our three biggest fracture groups, supracondylar elbow, forearm and femur fractures. Efforts with standardized inventories for both spine and trauma implants have been very successful in minimizing costs and improving service.

From an administrative persepctive, Dr. Goldberg has been appointed to the rank of Vice Chief of our section and also serves as Director of our Orthopaedic Quality Assurance program.

Lastly, the Division has benefitted from the extremely competent direction of Patience Peale as our Administrative Director appointed in 2012. Patience succeeded Jennifer Becker who was promoted to Vice President of Outpatient Operations at Seattle Children's.

Dr. Klane White appointed to Associate Professor.

Dr. Conrad hosted Dr. B. Stephens Richards from Texas Scottish Rite Hospital as the Staheli Lecturer 2012 at Seattle Children's Hospital with some of its well known faculty.

University of Washington Medical Center

State of the Union: University of Washington Medical Center & Northwest Hospital

The most profound development in our university based orthopaedic practice was moving our elective adult reconstruction practice to Northwest Hospital, thus taking advantage of the unique inpatient facilities (including the "Easy Street" rehabilitation center) and surgical efficiencies at NWH. This officially occurred on January 3, 2012 but had been preceded by many months of planning with faculty and administration at both the UWMC and NWH. Subsequent to this union with Northwest Hospital, doctors Justin Klimisch and T.J. Tanous joined our department as Clinical Assistant Professors. They will partner with Drs. Leopold, Manner and Chansky to cover the range of adult joint preservation and reconstruction at the UWMC, Puget Sound VAHCS and NWH. The timing of this union was fortuitous in that one of the key members of the adult reconstruction team, Seth Leopold M.D., was just named the next editor-in-chief of Clinical Orthopaedics and Related Research. This prestigious appointment called for Dr. Leopold to scale back his clinical activities.

One other important change is that a valued member of our department, Chris Wahl, M.D., has just announced that he is leaving to become Chief of Sports Medicine at the University of California, San Diego. Dr. Wahl has been a favorite of our residents and in addition to his dedication to the Husky athletes, Chris has also been caring for complex multiligament knee injuries at Harborview Medical Center and the UWMC. We wish Dr. Wahl and his wife Suzanne – a physicians assistant in our sports section and the lead PA in our department - the best of luck in this transition.

We are most excited to have recruited a new sports surgeon, Albert Gee, who trained at the Hospital for Special Surgery and The University of Pennsylvania. Albert will be bringing considerable surgical and research skills to our department and he hopes to continue his scientific research into healing of articular cartilage. Albert's wife Jennifer Gardener is a dermatologist who will also be joining the UWMC faculty.

We have busy outpatient surgical practices at the Roosevelt Bone and Joint Center, the Sports Medicine Clinic, and the Eastside Specialty Center. Jerry Huang, M.D. continues to direct the UWMC Hand Service and works at both the Bone and Joint Center and the Eastside Specialty Clinic. Dan Patzker, PAC assists Jerry in managing this busy service while we are recruiting a partner for Dr. Huang. We anticipate this will happen in the near future. Seth Leopold, M.D. and Paul Manner, M.D. see patients in their total joint clinics at the BJC and the ESC. Soon they will transition from the BJC to NH for their outpatient practice. Pat Maxwell, R.N. is our accomplished manager of the Eastside Clinic and we rely on her experience to help refine processes at all of our outpatient clinics. Similarly, Karin Holmberg manages the Bone and Joint Center in close partnership with Vanessa Lipton and Char Prideaux-Giezler. Howard Chansky, M.D. rounds out the total joint service and also sees general orthopaedic conditions at the

UWMC Leadership group: From Left to Right, Dr. Howard Chansky, VC and Chief UWMC Orthopaedics, Stephen Zieniewicz, Executive Director, Patty O'Leary Crutcher, Director of Sports, Spine and Orthopaedic Health, Grace Parker, Interim Chief Nursing Officer and Associate Administrator, Johnese Spisso, Chief Health System Officer UW Medicine and VP Medical Affairs.

Orthopaedics was well represented at the 2011 UWMC Employees Service Awards Celebration held in March of 2012. From left to right the nurses from 6SE honored that night are: Jennifer Brackensick Grant (staff nurse), Brooke Powers (staff nurse), Sue Theiler (nurse manager) and Stan Shikuma (staff nurse). In the back row from left to right are: Stephen Zieniewicz (Executive Director of UWMC) and Howard Chansky (Chief of Orthopedics & Sports Medicine).

Bone and Joint Clinic. Three extremely experienced physician assistants, Tim Coglon, Pete Hall, and Dan Stamper, support the total joint service by providing excellent and timely care.

Carol Teitz, M.D. leads the Sports Medicine section. Her surgical partners are Roger Larson, M.D. and John "Trey" Green, M.D. John O'Kane, M.D. is the Huskies Head Team physician and primary care doctor. John works in close partnership with the surgeons and also lends his nonoperative musculoskeletal expertise to weekend warriors and high performance athletes from around the region. The sports section could not function without the skills of Nicole Patrick, PAC and Ivory Larry, P.A.. Claudia Happe, R.N. brings years of experience to managing the Sports Medicine Clinic and she has also played a critical role in planning for our new clinic in the rebuilt Husky Stadium.

Dr. Frederick Matsen and Winston Warme constitute our shoulder and elbow service with the assistance of Alex Bertelsen, PAC and Jill Eggers-Knight, PAC. Our Spine Service remains in the capable hands of Michael Lee, M.D., Jens Chapman, M.D. and Ted Wagner, M.D. and Eching V. Bertelsen, PA. Connie Ly, PAC, has become a valuable assistant for Drs. Wagner and Lee. Her skills are in demand so she often helps out in other orthopaedic clinics.

There are a wide variety of research interests at the University of Washington Medical Center and these are strongly reflected in the publication of this year's research report. The Orthopaedic Robotics Laboratory is under the directorship of Peter R. Cavanagh, Ph.D., who is also our Vice Chair of Research. This laboratory is the first of its kind in our department and the lab has become a hub of activity as several faculty members and residents have started collaborative projects with Dr. Cavanagh. Clinical projects under the tutelage of Dr. Cavanagh include fixation of wrist fractures, ACL injuries and tibial anatomy, remote monitoring of total join clinical outcomes and the biomechanics of total knee replacement. Most importantly, Dr. Cavanagh has obtained the first ever "omnibus" arrangement with the university's institutional review board (IRB) that should foster a dramatic expansion of clinical research. While this achievement was no doubt the product of Peter's diligence and persistence, we collectively believe that some sort of divine intervention must have also played a role!

In this new era of measuring seemingly everything that is measurable in medicine, we continue to not only maintain excellent outcomes but in fact continue to improve. The case mix index (CMI), a national measure of complexity of care has risen yet again for our orthopaedic patients while our infection and mortality rates remain lower than expected. This is despite having one of the higher CMIs in University Health Systems Consortium (UHC). Our patient satisfaction scores have also been increasing in absolute terms and when compared to national metrics. These achievements are in no small part due to the hard work of Sue Theiler, the nursing director of 6SE, and her highly professional nursing staff.

In the first fiscal quarter of 2012 the Bone and Joint Center earned a "Likeliness to Recommend" Top Box score (Top Box=Rated as a 9 or 10 out of 10 by those surveyed) of over 93%. This is a considerable improvement over past scores and reflects the excellence and teamwork of all of our nurses, staff, physician assistants and physicians. This score is a direct reflection of patient's willingness to recommend that others receive care at the BJC. For this collective achievement the Bone and Joint Center won the UW Patient Satisfaction Excellence Award and with this comes a plaque that will be displayed at the BJC.

Under our Chairman, Jens Chapman M.D., we are continuing to build capacity at the University of Washington Medical Center as well as at newest practice site, Northwest Hospital. In the upcoming year we anticipate the grand opening of our new sports medicine facility located within the rebuilt Husky Stadium. This will provide nearly 30,000 square feet of space and will be a state-of-the-art clinical and research facility. With these new venues we anticipate an increase in capacity for both inpatient procedures as well as outpatient clinic visits. Recruitment of new faculty will proceed as these opportunities are realized. This will all make for an exciting report in 2013.

Howard A. Chansky, M.D.
Professor, Vice Chair and Chief
Orthopaedics & Sports Medicine

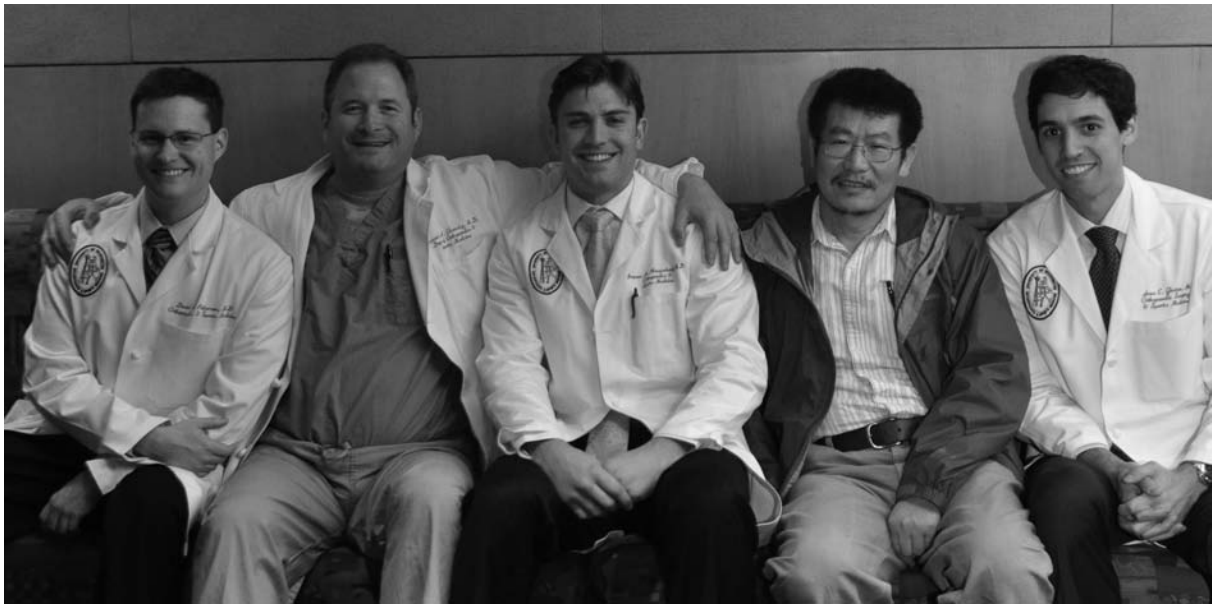
State of the Union: The Puget Sound Veteran's Administration Medical Center

The Puget Sound Veteran's Administration Medical Center (VA) is a popular rotation for the orthopaedic residents. We have a general tertiary care orthopaedic practice at the VA and we see patients from the entire northwest including Alaska as well as states outside of the Northwest. We see a wide variety of both general orthopaedics, as well as complex or revision orthopaedic problems. This past year we performed 761 cases, the vast majority of which were classified as "major" and saw approximately 7000 outpatients in clinic. Despite changes in VA national and local policy that has led to decreased OR efficiency and block time, we remain one of the busiest VA orthopaedic programs in the country. On a positive note, there are plans to build additional operating suites and this should eventually improve patient flow and decrease surgical backlogs.

Our University of Washington residents continue to rate the VA rotation as one of their favorites. While closely supervised, they are given graduated responsibility throughout their training at the VA. Our goal at the VA is to train residents that are dedicated to caring for patients with potentially difficult socioeconomic issues, as well as residents who if they so choose, would be able to graduate from our residency and achieve a high level of expertise in a general orthopaedic practice. Jason Wilcox, a graduate of our program and a fellowship trained sports surgeon has improved the care of veterans with his talent for shoulder and knee arthroscopy. He also performs complex open reconstructions for various shoulder and knee injuries as well as helping out with general orthopaedics. The residents and veterans are both benefitting from Dr. Wilcox's subspecialty training and he has revolutionized arthroscopic teaching and care at our VA. Partnering with Dr. Wilcox in running the long Thursday clinics, Ted Greenlee, M.D. continues to lend us his invaluable experience, particularly his knowledge of the natural history of conservatively treated fractures and his great sixth sense for what is best for the patient and when not to operate.

Cindy Lostoski provides our administrative support and has many roles in assisting patients as well as the physicians. Our physician's assistants Steve Casowitz and Dustin Higbee are the backbone of our surgical service. Dustin briefly tested the waters of private practice but we are incredibly fortunate that he is now returning to the VA orthopaedic service. Sue Grischott, NP has been a long-time member of the service but she has taken a new position in diabetes care. We wish her the best and will be utilizing her skills to manage our preoperative patients with lofty Hgb A1Cs! Monette Manio, R.N. has a new partner in Katherine German, R.N. Monette and Katherine manage all of our surgical scheduling and with a large population of very ill patients of limited means for travel, this can be very challenging. Annette Testa, LPN, assists in our outpatient clinics and has become an accomplished casting technician. Fred Huang, M.D., a former UW resident has a very busy practice at Valley Hospital but still finds time to maintain a presence at the VA. At the VA, Dr. Huang focuses on sports problems while also doing general orthopaedics. The orthopaedic service at the Puget Sound VA could not function without Anne Dinsmore, R.N. Anne is the head of orthopaedic nursing and helps the attendings and residents navigate the elaborate system of rules governing equipment procurement, setting up for cases and sterile processing. Our trusted scrub technicians and friends, Leo Cruz and Amy Arce round out our surgical service.

Operating Room 6 at the Puget Sound Veterans Affairs Healthcare System. From left to right, scrub technician Judy Connery (in window), CRNA Gary Yurina, Jason Wilcox, M.D., Andrew Merritt, PGY5, M.D., Howard Chansky, M.D., Vivian Dollente, R.N. and Amy Arce, scrub technician.



Left to Right: David Patterson, Howard Chansky, Jacques Hacquebord, Liu Yang, Andrew Ghatan

There is an active orthopaedic research program at the VA with extramurally funded programs in sarcoma and cartilage biology (Yang and Chansky) as well as state-of-the-art orthopaedic biomechanics laboratory run by Bruce Sangeorzan, M.D. who is assisted by William Ledoux, Ph.D. Orthopaedic residents participate in research in both laboratories.

The Puget Sound VA Medical Center itself is undergoing a major expansion with the addition of a new research building, as well as extensive additions to the clinical tower and soon the addition of above and underground parking facilities. All of this should improve the quality and quantity of care for our veterans, their families and the quality of the work environment.

Howard A. Chansky, M.D.
Professor, Vice Chair and Chief
Orthopaedics & Sports Medicine

Graduating Residents

Benjamin Amis, M.D.

Following residency, Ben will complete a hand and upper extremity fellowship at St. Luke's Roosevelt in New York City as well as a three-month shoulder and elbow fellowship in Melbourne, Australia. He hopes to practice hand and upper extremity surgery as well as general orthopedics in Texas or Colorado.

Greg Blaisdell, M.D.

Following residency, Greg will complete a fellowship in orthopaedic trauma with the Florida Orthopaedic Institute in Tampa, Florida. He is considering career locations in the Northeast and the West Coast.

Adam Bakker, M.D.

After graduation, Adam will pursue a one-year fellowship in Hand Surgery at the Mayo Clinic in Rochester, Minnesota. Following his fellowship, he plans to practice hand with general orthopaedics.

Josh Lindsey, M.D.

After residency, Josh will complete an Adult Reconstruction Fellowship at The Brigham and Women's Hospital in Boston, Massachusetts. He will then complete a second fellowship at the University of Rochester training in Orthopaedic Sports Medicine. Josh and his family ultimately desire to return to Wisconsin and practice near their families.

Graduating Residents

Grant Lohse, M.D.

Grant and his family will spend the next year in Nashville where he will pursue specialty training in Hand and Upper Extremity Surgery at Vanderbilt University. His wife, Liza, will be employed part-time as a psychiatrist at Vanderbilt. Thereafter, Grant hopes to build a practice where patient care can be the priority despite an increasingly complex healthcare system.

Andrew Merritt, M.D.

After residency, Andrew will move with his wife to New York City and complete a fellowship in Sports Medicine at the Hospital for Special Surgery. Upon completion of his fellowship he plans to return west to begin practice.

Matthew Lyons, M.D.

Following residency, Matt will begin a Sports Medicine Fellowship at the University of Virginia. He plans to complete a second fellowship in Hand surgery. He would ultimately like to establish a practice in the Pacific Northwest.

Nels Sampatacos, M.D.

Following residency, Nels will complete a sports medicine fellowship at the Southern California Orthopedic Institute (SCOI). Following this, he hopes to find a busy practice somewhere in the Western US.

Incoming Residents

Todd Blumberg

Todd Blumberg is from Plano, Texas. He attended college at Rice University and medical school at Baylor College of Medicine. He is interested in pediatric orthopaedics and hand & upper extremity. Away from his residency, he enjoys trail running, skiing, hiking, traveling, photography, and cooking.

Sean Haloman

Sean Haloman, from Gillette, Wyoming, attended the University of Wyoming. He attended medical school at the University of California, San Diego. Sports medicine and shoulder are his areas of interest. In his free time, he enjoys spending time with his wife, fishing, hiking, traveling, jiu jitsu, and all sports.

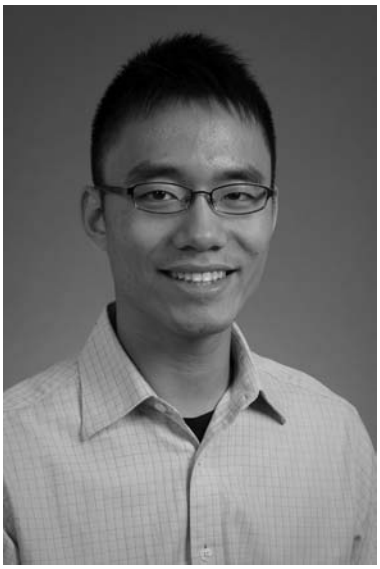
Akash Gupta

Akash Gupta is from Vancouver, B.C., Canada. For his undergraduate and medical education, he attended the University of Southern California. His orthopaedic interests include shoulder and knee biomechanics and rotator cuff repair and healing. He likes to spend his spare time traveling and trying new foods, basketball, golfing, cycling, watching/analyzing/debating college football, NHL, and NBA.

Emily Harnden

Emily Harnden, from San Francisco, California, attended college at Stanford University and medical school at the University of Southern California. When away from the University of Washington, she enjoys skiing, surfing, biking, trail running, good food, college football, SF Giants baseball, being outdoors, and being with her friends, family, and dog.

Incoming Residents



Clifford Hou

Clifford Hou is from Chicago, Illinois. He completed his undergraduate education at Duke and medical training at Washington University in St. Louis. He is most interested in shoulder & elbow and biomechanics. Outside of his clinical interests, he spends time playing basketball and tennis, snowboarding, and eating good food.

Dayne Mickelson

Dayne Mickelson is from Waukesha, Wisconsin. He attended college at Lehigh University and medical school at University of Washington. Sports medicine, trauma, joints, biomechanics, anatomy and orthopaedic education are his areas of medical interest. He enjoys basketball, skiing, movies, reading, cooking, photography, traveling, and spending time with his wife and their dog.

Mithulan Jegapragasan

Mithulan Jegapragasan is from Apple Valley, California. He attended college at Stanford University and medical school at University of Pittsburgh. His major fields of orthopaedic interest are biomechanics and trauma. In his spare time, he enjoys rock climbing, squash, PAC 12 sports, and cooking with his fiancée.

Jessica Telleria

Jessica Telleria is from Boise, Idaho. She attended Western Washington University for her undergraduate degree and Stanford University for medical school. Clinical and translational research in sports, tumor, or trauma and international health are her main areas of medical interest. When away from work, she likes international travel, skiing, biking, and microbrews.

ACEs

Foot/Ankle

Ramces A. Francisco, M.D.

James E. Meeker, M.D.

Spine

Sree Harsha Malempati, M.D.

Amit R. Patel, M.D.

Shoulder/Elbow

Bradley C. Carofino, M.D.

Matthew V. Jenkins, M.D.

Oncology

Antoinette Lindberg, M.D.

ACEs

Trauma

Mark R. Adams, M.D.

Jonathan G. Eastman, M.D.

Reza Firoozabadi, M.D.

Thomas M. Large, M.D.

Jason S. Schneidkraut, M.D.

Fellows

Hand

Stephen A. Kennedy, M.D.

Jason H. Ko, M.D.

Lucie Krenek, M.D.

Andrew J. Watt, M.D.

Research Grants

National Institutes of Health

Aging-Related Degradation in Bone Mechanotransduction
Sundar Srinivasan, Ph.D.
Ted S. Gross, Ph.D.

Brief Rest Intervals Amplify the Response of Bone Mechanical Loading
Ted S. Gross, Ph.D.
Steven D. Bain, Ph.D.
Sundar Srinivasan, Ph.D.

Collagen Assembly in Tissue-Engineered Cartilage
Russell J. Fernandes, Ph.D.
Jiann-Jiu Wu, Ph.D.

Collagen Cross-Linking in Skeletal Aging and Diseases
David R. Eyre, Ph.D.
Jiann-Jiu Wu, Ph.D.

Collagen Diversity and Pathobiology in Skeletal Tissues
David R. Eyre, Ph.D.
Jiann-Jiu Wu, Ph.D.

Design Criteria for Therapeutic Footwear in Diabetes
Peter R. Cavanagh, Ph.D., D.Sc.

Disuse Induced Osteocyte Hypoxia
Ted S. Gross, Ph.D.
Steven D. Bain, Ph.D.
Sundar Srinivasan, Ph.D.

Neuronal Modulation of Focal Bone Homeostasis
Ted S. Gross, Ph.D.
Steven D. Bain, Ph.D.

Skeletal Dysplasias
David R. Eyre, Ph.D.
Russell J. Fernandes, Ph.D.

T-Cell Mediation of Focal Bone Loss Induced by Transient Muscle Paralysis
Ted S. Gross, Ph.D. (Mentor)
Brandon J. Ausk, M.S. (Fellow)

National Aeronautics and Space Administration

A Quantitative Test of On-Orbit Exercise Countermeasures for Bone Demineralization Using a Bedrest Analog
Peter R. Cavanagh, Ph.D., D.Sc

Activity Monitoring During Parabolic Flight
Peter R. Cavanagh, Ph.D., D.Sc

National Space Biomedical Research Institute

Monitoring Bone Health by Daily Load Stimulus Measurement During Lunar Missions
Peter R. Cavanagh, Ph.D., D.Sc

An Integrated Musculoskeletal Countermeasure Battery for Long-Duration Lunar Mission
Peter R. Cavanagh, Ph.D., D.Sc

Enhancing the Efficacy of Musculoskeletal Countermeasures Using Computer Simulation
Peter R. Cavanagh, Ph.D., D.Sc

Extent, Causes, and Countermeasures of Impaired Fracture Healing in Hypogravity
Peter R. Cavanagh, Ph.D., D.Sc

Veterans Affairs Rehabilitation Research and Development Service

Dynamic Foot Bone Motion: Evaluation of Reconstructive Procedures
Bruce J. Sangeorzan, M.D.

Reducing Internal Stresses in Deformed Diabetic Feet
Bruce J. Sangeorzan, M.D.
Peter R. Cavanagh, Ph.D. D.Sc

Surgically Reestablishing Foot Shape in Severely Deformed Flatfeet
Bruce J. Sangeorzan, M.D.

VA Center of Excellence in Amputation Prevention and Prosthetic Engineering
Bruce J. Sangeorzan, M.D.

VA Merit Review Functional Analysis of EWS/FLI-1
Howard A. Chansky, M.D.
Liu Yang, Ph.D.

A.O. Foundation

Quality of fracture reduction and its influence on functional outcome in patients with pilon fractures
Sean E. Nork, M.D.

A.O. North America

An Observational Study Assessment of Surgical Techniques for Treating Cervical Spondylotic Myelopathy (CSM)
Jens R. Chapman, M.D.

An Observational Study Comparing Surgical to Conservative Management in the Treatment of Type II Odontoid Fractures Among the Elderly
Jens R. Chapman, M.D.

AO North America Orthopaedic Trauma Fellowship
David P. Barei, M.D.

AO Spine North America Fellowship
Carlo Bellabarba, M.D.

AO Spine North America Young Investigators Research Grant
Michael J. Lee, M.D.
Randal P. Ching, Ph.D.

A.O. Spine International

Enhancing Pedicle Screw Fixation in the Lumbar Spine Utilizing Allograft Bone Plug Interference Fixation
Michael J. Lee, M.D.

Research Grants

Algos Preclinical Services, Inc.

Development of a Fracture Pain Model
Steven D. Bain, Ph.D.

American Society for Surgery of the Hand

The Use of Vibration Anesthesia
Jerry I. Huang, M.D.
Jason H. Ko, M.D.

Arthrex, Inc.

UW Hand Fellowship Education
Jerry I. Huang, M.D.

Ascension Orthopedics, Inc.

The Use of Vibration Anesthesia to Reduce Pain With Injections in the Hand: A Prospective Randomized Controlled Trial
Jerry I. Huang, M.D.

Baylor College of Medicine

Pathogenesis of Novel Forms of Osteogenesis Imperfecta
David R. Eyre, Ph.D.

Boston Medical Center

Intramedullary Nails versus Plate Fixation Re-Evaluation Study in Proximal Tibia Fractures a Multi-Center Randomized Trail Comparing Nails and Platel Fixation
Robert P. Dunbar, M.D.

DIApedia LLC

Advanced Military Footwear System with Composite Orthotic
Peter R. Cavanagh, Ph.D., D.Sc

Johns Hopkins University

The Major Extremity Trauma Research Consortium
Bruce J. Sangeorzan, M.D.

Omega Medical Grants Association

Omega Shoulder and Elbow Fellowship Program Grant
Winston J. Warme, M.D.

Omega Spine Fellowship
Carlo Bellabarba, M.D.

Omega Trauma Fellowship
David P. Barei, M.D.

Orthopaedic Research and Education Foundation

Clinical Efficacy and Cost Implications of Acute BMP-2
David P. Barei, M.D.

OREF Fellowship Grant in Shoulder and Elbow
Winston J. Warme, M.D.

OREF Residency Enhancement Grant AAOS
Douglas P. Hanel, M.D.

OREF Resident Journal Club Grant
Douglas P. Hanel, M.D.

OREF Spine Fellowship
Carlo Bellabarba, M.D.

OREF Trauma Fellowship Grant
David P. Barei, M.D.

The Lateral Tibial Plateau: Predicting and Preventing Failures in ACL reconstruction
Peter R. Cavanagh, Ph.D., D.Sc

Orthopaedic Trauma Association

Development of Fracture Specific MFA
Bradford M. Henley, M.D.

COTA Trauma Fellowship
David P. Barei, M.D.

Ostex International, Inc.

Molecular Markers of Connective Tissue Degradation
David R. Eyre, Ph.D.

Paradigm Spine LLC

A Multi-Center, Prospective, Randomized, Clinical Trial Comparing Stabilization with Coflex vs. Pedicle Screw Fixation and Fusion after Decompression for at Least Moderate Lumbar Spinal Stenosis
Jens R. Chapman, M.D.

Stryker

Stryker Educational Grant – USF F&A Course
Bruce J. Sangeorzan, M.D.

SYNTHES

Clinical Experience with Hindfoot Arthrodesis Nail for the Surgical Treatment of Ankle and Hindfoot Pathologies
Sigvard T. Hansen Jr., M.D.

PRODISC-C Versus Anterior Cervical Discectomy and Fusion (ACDF)
Jens R. Chapman, M.D.

Regulation of Bone Repair by Physiologic Loading
Steven D. Bain, Ph.D.
Ted S. Gross, Ph.D.

Spine End-Results Research Fund
Jens R. Chapman, M.D.

Synthes Grand Rounds
Richard J. Bransford, M.D.

Synthes Request for Grand Rounds Support
Douglas P. Hanel, M.D.

Research Grants

Synthes Request for Basic AO Course R2s
Douglas P. Hanel, M.D.

The Boeing Company

Randomized Clinical Trial of Open versus Endoscopic Carpal Tunnel Release and Hand Therapy Comparing Patient Satisfaction: Functional Outcome and Cost Effectiveness
Jerry I. Huang, M.D.

US Army Research Office

Digit Regeneration in Mammals
Christopher H. Allan, M.D.

UW Team-Advance on Single Nuclear Detection and Atomic-Scale Imaging
John A. Sidles, Ph.D.

UW Department of Bioengineering

Remote Monitoring of Knee Function after Total Joint Replacement (Coulter grant)
Peter R. Cavanagh, Ph.D., D.Sc
Paul A. Manner, M.D.

Department Publications 2011-2012

1. Aliprantis AO, Stolina M, Kostenuik PJ, Poliachik SL, Warner SE, Bain SD, et al. Transient muscle paralysis degrades bone via rapid osteoclastogenesis. FASEB journal : official publication of the Federation of American Societies for Experimental Biology. 2012 Mar;26(3):1110-8.

2. Amor IM, Rauch F, Gruenwald K, Weis M, Eyre DR, Roughley P, et al. Severe osteogenesis imperfecta caused by a small in-frame deletion in CRTAP. American journal of medical genetics Part A. 2011 Nov;155A(11):2865-70.

3. Apostle KL, Sangeorzan BJ. Anatomy of the varus foot and ankle. Foot and ankle clinics. 2012 Mar;17(1):1-11.

4. Ausk BJ, Huber P, Poliachik SL, Bain SD, Srinivasan S, Gross TS. Cortical bone resorption following muscle paralysis is spatially heterogeneous. Bone. 2012 Jan;50(1):14-22.

5. Baker GA, Cizik AM, Bransford RJ, Bellabarba C, Konodi MA, Chapman JR, et al. Risk factors for unintended durotomy during spine surgery: a multivariate analysis. The spine journal : official journal of the North American Spine Society. 2012 Feb;12(2):121-6.

6. Beingessner D, Moon E, Barei D, Morshed S. Biomechanical analysis of the less invasive stabilization system for mechanically unstable fractures of the distal femur: comparison of titanium versus stainless steel and bicortical versus unicortical fixation. The Journal of trauma. 2011 Sep;71(3):620-4.

7. Beingessner DM, Nork SE, Agel J, Viskontas D. A fragment-specific approach to Type IID Monteggia elbow fracture-dislocations. Journal of orthopaedic trauma. 2011 Jul;25(7):414-9.

8. Benirschke SK, Rush SM, Reddix RN, Jr., Zwipp H, Carpenter B, Schuberth JM. Locking plates. Foot & ankle specialist. 2012 Feb;5(1):54-9.

9. Bransford R, Chapman JR, Bellabarba C. Primary internal fixation of unilateral C1 lateral mass sagittal split fractures: a series of 3 cases. Journal of spinal disorders & techniques. 2011 May;24(3):157-63.

10. Bransford RJ, Freeborn MA, Russo AJ, Nguyen QT, Lee MJ, Chapman JR, et al. Accuracy and complications associated with posterior C1 screw fixation techniques: a radiographic and clinical assessment. The spine journal : official journal of the North American Spine Society. 2012 Mar;12(3):231-8.

11. Bransford RJ, Koller H, Caron T, Zenner J, Hitzl W, Tomasino A, et al. Cervical Spine Trauma in Diffuse Idiopathic Skeletal Hyperostosis (DISH) - Injury Characteristics and Outcome with Surgical Treatment. Spine. 2012 Apr 24.

12. Bransford RJ, Lee MJ, Reis A. Posterior fixation of the upper cervical spine: contemporary techniques. The Journal of the American Academy of Orthopaedic Surgeons. 2011 Feb;19(2):63-71.

13. Bransford RJ, Russo AJ, Freeborn M, Nguyen QT, Lee MJ, Chapman JR, et al. Posterior C2 instrumentation: accuracy and complications associated with four techniques. Spine. 2011 Jun 15;36(14):E936-43.

14. Butler-Wu SM, Burns EM, Pottinger PS, Magaret AS, Rakeman JL, Matsen FA, 3rd, et al. Optimization of periprosthetic culture for diagnosis of Propionibacterium acnes prosthetic joint infection. Journal of clinical microbiology. 2011 Jul;49(7):2490-5.

15. Butler-Wu SM, Sengupta DJ, Kittichotirat W, Matsen FA, 3rd, Bumgarner RE. Genome sequence of a novel species, Propionibacterium humerusii. Journal of bacteriology. 2011 Jul;193(14):3678.

16. Carter CW, Hoellwarth J, Weiss JM. Clinical outcomes as a function of meniscal stability in the discoid meniscus: a preliminary report. Journal of pediatric orthopedics. 2012 Jan-Feb;32(1):9-14.

17. Carter CW, Kocher MS. Meniscus repair in children. Clinics in sports medicine. 2012 Jan;31(1):135-54.

18. Carter CW, Micheli LJ. Training the child athlete for prevention, health promotion, and performance: how much is enough, how much is too much? Clinics in sports medicine. 2011 Oct;30(4):679-90.

19. Carter CW, Micheli LJ. Training the child athlete: physical fitness, health and injury. British journal of sports medicine. 2011 Sep;45(11):880-5.

20. Cavanagh PR, Bus SA. Off-loading the diabetic foot for ulcer prevention and healing. Plastic and reconstructive surgery. 2011 Jan;127 Suppl 1:248S-56S.

21. Chambers HG, Shea KG, Anderson AF, Brunelle TJ, Carey JL, Ganley TJ, et al. Diagnosis and treatment of osteochondritis dissecans. The Journal of the American Academy of Orthopaedic Surgeons. 2011 May;19(5):297-306.

22. Chapman JR, Norvell DC, Hermsmeyer JT, Bransford RJ, DeVine J, McGirt MJ, et al. Evaluating common outcomes for measuring treatment success for chronic low back pain. Spine. 2011 Oct 1;36(21 Suppl):S54-68.

23. Chou D, Samartzis D, Bellabarba C, Patel A, Luk KD, Kisser JM, et al. Degenerative magnetic resonance imaging changes in patients with chronic low back pain: a systematic review. Spine. 2011 Oct 1;36(21 Suppl):S43-53.

24. Christal AA, Taitsman LA, Dunbar RP, Jr., Krieg JC, Nork SE. Fluoroscopically guided hip capsulotomy: effective or not? A cadaveric study. Journal of orthopaedic trauma. 2011 Apr;25(4):214-7.

25. Cizik AM, Lee MJ, Martin BI, Bransford RJ, Bellabarba C, Chapman JR, et al. Using the spine surgical invasiveness index to identify risk of surgical site infection: a multivariate analysis. The Journal of bone and joint surgery American volume. 2012 Feb 15;94(4):335-42.

26. Dombroski D, Scolaro JA, Pulos N, Beingessner DM, Dunbar RP, Mehta S. Fibula Fracture Stabilization With a Guide Wire as Supplementary Fixation in Tibia Fractures. Am J Orthopedics. 2012;41(5):157-60.

27. Eary JF, Conrad EU. Imaging in sarcoma. Journal of nuclear medicine : official publication, Society of Nuclear Medicine. 2011 Dec;52(12):1903-13.

28. Eary JF, Link JM, Muzi M, Conrad EU, Mankoff DA, White JK, et al. Multiagent PET for risk characterization in sarcoma. Journal of nuclear medicine : official publication, Society of Nuclear Medicine. 2011 Apr;52(4):541-6.

29. Ehsan A, Hanel DP. Recurrent or Persistent Cubital Tunnel Syndrome. The Journal of hand surgery. 2012 Feb 1.

30. Eichinger JK, Beingessner D. Intraoperative fabrication of bone tamps for indirect reduction of depressed articular segments. Orthopedics. 2011 Dec;34(12):970-4.

31. Elgafy H, Bransford RJ, Chapman JR. Epidural hematoma associated with occult fracture in ankylosing spondylitis patient: a case report and review of the literature. Journal of spinal disorders & techniques. 2011 Oct;24(7):469-73.

32. Enning F, Murck H, Krieg JC, Vedder H. Hypericum perforatum differentially affects corticosteroid receptor-mRNA expression in human monocytic U-937 cells. Journal of psychiatric research. 2011 Sep;45(9):1170-7.

33. Esses SI, McGuire R, Jenkins J, Finkelstein J, Woodard E, Watters WC, 3rd, et al. The treatment of symptomatic osteoporotic spinal compression fractures. The Journal of the American Academy of Orthopaedic Surgeons. 2011 Mar;19(3):176-82.

34. Esses SI, McGuire R, Jenkins J, Finkelstein J, Woodard E, Watters WC, 3rd, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on: the treatment of osteoporotic spinal compression fractures. The Journal of bone and joint surgery American volume. 2011 Oct 19;93(20):1934-6.

35. Evans AR, Routt ML, Jr., Nork SE, Krieg JC. Oblique distraction external pelvic fixation. Journal of orthopaedic trauma. 2012 May;26(5):322-6.

36. Evans J, Beingessner DM, Agel J, Benirschke SK. Minifragment plate fixation of high-energy navicular body fractures. Foot & ankle international / American Orthopaedic Foot and Ankle Society [and] Swiss Foot and Ankle Society. 2011 May;32(5):S485-92.

37. Eyre DR, Weis M, Hudson DM, Wu JJ, Kim L. A novel 3-hydroxyproline (3Hyp)-rich motif marks the triple-helical C terminus of tendon type I collagen. The Journal of biological chemistry. 2011 Mar 11;286(10):7732-6.

38. Fassbind MJ, Rohr ES, Hu Y, Haynor DR, Siegler S, Sangeorzan BJ, et al. Evaluating foot kinematics using magnetic resonance imaging: from maximum plantar flexion, inversion, and internal rotation to maximum dorsiflexion, eversion, and external rotation. Journal of biomechanical engineering. 2011 Oct;133(10):104502.

39. Fehlings MG, Smith JS, Kopjar B, Arnold PM, Yoon ST, Vaccaro AR, et al. Perioperative and delayed complications associated with the surgical treatment of cervical spondylotic myelopathy based on 302 patients from the AOSpine North America Cervical Spondylotic Myelopathy Study. Journal of neurosurgery Spine. 2012 May;16(5):425-32.

40. Fernandes RJ, Farnand AW, Traeger GR, Weis MA, Eyre DR. A role for prolyl 3-hydroxylase 2 in post-translational modification of fibril-forming collagens. The Journal of biological chemistry. 2011 Sep 2;286(35):30662-9.

41. Friedrich JB, Katolik LI, Hanel DP. Reconstruction of soft-tissue injury associated with lower extremity fracture. The Journal of the American Academy of Orthopaedic Surgeons. 2011 Feb;19(2):81-90.

42. Gardner MJ, Routt ML, Jr. Transiliac-transsacral screws for posterior pelvic stabilization. Journal of orthopaedic trauma. 2011 Jun;25(6):378-84.

43. Gardner MJ, Silva MJ, Krieg JC. Biomechanical testing of fracture fixation constructs: variability, validity, and clinical applicability. The Journal of the American Academy of Orthopaedic Surgeons. 2012 Feb;20(2):86-93.

44. Ghatan A, Merritt A, Wahl CJ. Acute multiligament injured or dislocated knee: field assessment and management. Journal of Paramedic Practice. 2012;4(2):70-6.

45. Graves ML, Kosko J, Barei DP, Taitsman LA, Tarquinio TA, Russell GV, et al. Lateral ankle radiographs: do we really understand what we are seeing? Journal of orthopaedic trauma. 2011 Feb;25(2):106-9.

46. Graves ML, Routt ML, Jr. Iliosacral screw placement: are uniplanar changes realistic based on standard fluoroscopic imaging? The Journal of trauma. 2011 Jul;71(1):204-8; discussion 8.

47. Hacquebord JH, Leopold SS. In Brief: The Risser Classification: A Classic Tool for the Clinician Treating Adolescent Idiopathic Scoliosis. Clinical orthopaedics and related research. 2012 Apr 27.

48. Hanson AM, Gilkey KM, Perusek GP, Thorndike DA, Kutnick GA, Grodsinsky CM, et al. Miniaturized sensors to monitor simulated lunar locomotion. Aviation, space, and environmental medicine. 2011 Feb;82(2):128-32.

49. Helgeson MD, Lehman RA, Jr., Cooper P, Frisch M, Andersen RC, Bellabarba C. Retrospective review of lumbosacral dissociations in blast injuries. Spine. 2011 Apr 1;36(7):E469-75.

50. Hingorani P, Seidel K, Krailo M, Mascarenhas L, Meyers P, Marina N, et al. Body mass index (BMI) at diagnosis is associated with surgical wound complications in patients with localized osteosarcoma: a report from the Children's Oncology Group. Pediatric blood & cancer. 2011 Dec 1;57(6):939-42.

51. Howe CR, Agel J, Lee MJ, Bransford RJ, Wagner TA, Bellabarba C, et al. The morbidity and mortality of fusions from the thoracic spine to the pelvis in the adult population. Spine. 2011 Aug 1;36(17):1397-401.

52. Hu Y, Ledoux WR, Fassbind M, Rohr ES, Sangeorzan BJ, Haynor D. Multi-rigid image segmentation and registration for the analysis of joint motion from three-dimensional magnetic resonance imaging. Journal of biomechanical engineering. 2011 Oct;133(10):101005.

53. Huang JI, Hanel DP. Anatomy and Biomechanics of the Distal Radioulnar Joint. Hand Clinics. 2012 May 2012;28(2):157-63.

54. Huang JI, Paczas M, Hoyen HA, Vallier HA. Functional outcome after open reduction internal fixation of intra-articular fractures of the distal humerus in the elderly. Journal of orthopaedic trauma. 2011 May;25(5):259-65.

55. Hudson DM, Kim LS, Weis M, Cohn DH, Eyre DR. Peptidyl 3-hydroxyproline binding properties of type I collagen suggest a function in fibril supramolecular assembly. Biochemistry. 2012 Mar 27;51(12):2417-24.

56. Hudson DM, Weis M, Eyre DR. Insights on the evolution of prolyl 3-hydroxylation sites from comparative analysis of chicken and Xenopus fibrillar collagens. PloS one. 2011;6(5):e19336.

57. Iannuzzi NP, Leopold SS. In Brief: The Mason Classification of Radial Head Fractures. Clinical orthopaedics and related research. 2012 Mar 17.

58. Izquierdo R, Voloshin I, Edwards S, Freehill MQ, Stanwood W, Wiater JM, et al. American academy of orthopaedic surgeons clinical practice guideline on: the treatment of glenohumeral joint osteoarthritis. The Journal of bone and joint surgery American volume. 2011 Jan 19;93(2):203-5.

59. Jackson LT, Aubin PM, Cowley MS, Sangeorzan BJ, Ledoux WR. A robotic cadaveric flatfoot analysis of stance phase. Journal of biomechanical engineering. 2011 May;133(5):051005.

60. Kaplowitz P, Srinivasan S, He J, McCarter R, Hayeri MR, Sze R. Comparison of bone age readings by pediatric endocrinologists and pediatric radiologists using two bone age atlases. Pediatric radiology. 2011 Jun;41(6):690-3.

61. Kelikian A, Mosca V, Schoenhaus HD, Winson I, Weil L, Jr. When to operate on pediatric flatfoot. Foot & ankle specialist. 2011 Apr;4(2):112-9.

62. Kennedy SA, Allan CH. In brief: Mayfield et al. Classification: carpal dislocations and progressive perilunar instability. Clinical orthopaedics and related research. 2012 Apr;470(4):1243-5.

63. Kim EH, Linker DT, Coumar A, Dean LS, Matsen FA, Kim Y. Factors affecting acceptance of a Web-based self-referral system. IEEE transactions on information technology in biomedicine : a publication of the IEEE Engineering in Medicine and Biology Society. 2011 Mar;15(2):344-7.

64. King JC, Manner PA, Stamper DL, Schaad DC, Leopold SS. Is minimally invasive total knee arthroplasty associated with lower costs than traditional TKA? Clinical orthopaedics and related research. 2011 Jun;469(6):1716-20.

65. Kraus VB, Burnett B, Coindreau J, Cottrell S, Eyre D, Gendreau M, et al. Application of biomarkers in the development of drugs intended for the treatment of osteoarthritis. Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society. 2011 May;19(5):515-42.

66. Krieg JC. Locked plating of distal femur fractures leads to inconsistent and asymmetric callus formation. Journal of orthopaedic trauma. 2011 Feb;25(2):e21; author reply e-2.

67. Lamblin CJ, Wahl CJ. Treatment of an articular lesion of the lateral tibial plateau utilizing a tibial "drawer-exposure" osteotomy and osteochondral allograft transplant: a case report. The Journal of bone and joint surgery American volume. 2011 Jun 15;93(12):e66(1-6).

68. Lee MJ, Hacquebord J, Varshney A, Cizik AM, Bransford RJ, Bellabarba C, et al. Risk factors for medical complication after lumbar spine surgery: a multivariate analysis of 767 patients. Spine. 2011 Oct 1;36(21):1801-6.

69. Lee MJ, Konodi MA, Cizik AM, Bransford RJ, Bellabarba C, Chapman JR. Risk factors for medical complication after spine surgery: a multivariate analysis of 1,591 patients. The spine journal : official journal of the North American Spine Society. 2012 Mar;12(3):197-206.

70. Lehman RA, Jr., Paik H, Eckel TT, Helgeson MD, Cooper PB, Bellabarba C. Low lumbar burst fractures: a unique fracture mechanism sustained in our current overseas conflicts. The spine journal : official journal of the North American Spine Society. 2011 Oct 7.

71. Leopold S. "Active" is less active than we think...and "active" is harder on total hip replacements than we believe. The Journal of bone and joint surgery American volume. 2011;93(18):1.

72. Leopold S. " On the evidence": welcome to hip surgery highlights. The Journal of bone and joint surgery American volume. 2011;93(15):1.

73. Leopold S. Numbers for breakfast: summary of hip arthroplasty outcomes from the national joint registry for England and wales 8th annual report (2011). The Journal of bone and joint surgery American volume. 2011;93(21):1.

74. Leopold S. Spinal rhBMP and Orthopaedic Integrity. The Journal of bone and joint surgery American volume. 2011;93(17):1.

75. Leopold SR, Sawyer SA, Whittam TS, Tarr PI. Obscured phylogeny and possible recombinational dormancy in Escherichia coli. BMC evolutionary biology. 2011;11:183.

76. Leopold SS. Challenging the assumptions about chemical thromboprophylaxis in knee replacement: commentary on an article by Alma B. Pedersen, MD, PhD, et al.: "Venous thromboembolism in patients having knee replacement and receiving thromboprophylaxis: a danish population-based follow-up study". The Journal of bone and joint surgery American volume. 2011 Jul 20;93(14):e81.

77. Leopold SS. Who is interested in our conflicts? J Bone Joint Surg Am. 2011;93(1-4).

78. Leopold SS. Association or causation? A common misunderstanding in clinical research. J Bone Joint Surg Am. 2012 May 2;94(9):1-3.

79. Leopold SS. Words and Images (Editorial). J Bone Joint Surg Am. 2012;94(1-3).

80. Leopold SS. AAOS or ACCP? Still No Answers on Thromboprophylaxis. J Bone Joint Surg Am. 2012;94(1-3).

81. Lewis R, Ravindran S, Wirthlin L, Traeger G, Fernandes RJ, McAlinden A. Disruption of the developmentally-regulated Col2a1 pre-mRNA alternative splicing switch in a transgenic knock-in mouse model. Matrix biology : journal of the International Society for Matrix Biology. 2012 Apr;31(3):214-26.

82. Li L, Weinreb V, Francklyn C, Carter CW, Jr. Histidyl-tRNA synthetase urzymes: Class I and II aminoacyl tRNA synthetase urzymes have comparable catalytic activities for cognate amino acid activation. The Journal of biological chemistry. 2011 Mar 25;286(12):10387-95.

83. Lichtman DM, Bindra RR, Boyer MI, Putnam MD, Ring D, Slutsky DJ, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on: the treatment of distal radius fractures. The Journal of bone and joint surgery American volume. 2011 Apr 20;93(8):775-8.

84. Lindsey JD, Krieg JC. Femoral malrotation following intramedullary nail fixation. The Journal of the American Academy of Orthopaedic Surgeons. 2011 Jan;19(1):17-26.

85. Loraas EK, Schmale GA. Endoscopically aided physeal bar takedown and guided growth for the treatment of angular limb deformity. Journal of pediatric orthopaedics Part B. 2011 Apr 27.

86. Malone KJ, Martineau PA, Hanel DP. Ulnar collateral ligament reconstruction in posttraumatic elbow release. Orthopedics. 2012;35(2):e202-7.

87. Manner P. Good start on using biochemical markers to compare surgical trauma in total hip replacement approaches: commentary on an article by Patrick F. Bergin, MD, et al.: "Comparison of minimally invasive direct anterior versus posterior total hip arthroplasty based on inflammation and muscle damage markers". The Journal of bone and joint surgery American volume. 2011 Aug 3;93(15):e89.

88. Manner P. Minimally invasive hip surgery. Orthopedics. 2012 Feb 1;35(2):123-4.

89. Martinez-Glez V, Valencia M, Caparros-Martin JA, Aglan M, Temtamy S, Tenorio J, et al. Identification of a mutation causing deficient BMP1/mTLD proteolytic activity in autosomal recessive osteogenesis imperfecta. Human mutation. 2012 Feb;33(2):343-50.

90. Matsen FA, 3rd. Commentary on Codman's 1911 article on rotator cuff repairs. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]. 2011 Apr;20(3):350-1.

91. Mehta S, Gardner MJ, Barei DP, Benirschke SK, Nork SE. Reduction strategies through the anterolateral exposure for fixation of type B and C pilon fractures. Journal of orthopaedic trauma. 2011 Feb;25(2):116-22.

92. Mercer D, Saltzman MD, Neradilek MB, Gilmer BB, Warme WJ, Matsen FA, 3rd. A reproducible and practical method for documenting the position of the humeral head center relative to the scapula on standardized plain radiographs. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]. 2011 Apr;20(3):363-71.

93. Mercer DM, Gilmer BB, Saltzman MD, Bertelsen A, Warme WJ, Matsen FA, 3rd. A quantitative method for determining medial migration of the humeral head after shoulder arthroplasty: preliminary results in assessing glenoid wear at a minimum of two years after hemiarthroplasty with concentric glenoid reaming. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]. 2011 Mar;20(2):301-7.

94. Merrit AL, Wahl CJ. Rationale and Treatment of Multiple-Ligament Injured Knees: The Seattle Perspective. Operative Techniques in Sports Medicine. 2011;19(1):51-72.

95. Merritt AL, Huang JI. Hand injuries in rock climbing. The Journal of hand surgery. 2011 Nov;36(11):1859-61.

96. Merritt AL, Wahl C. Initial assessment of the acute and chronic multiple-ligament injured (dislocated) knee. Sports medicine and arthroscopy review. 2011 Jun;19(2):93-103.

97. Miller AN, Barei DP, Iaquinto JM, Ledoux WR, Beingessner DM. Iatrogenic Syndesmosis Malreduction Via Clamp and Screw Placement. Journal of orthopaedic trauma. 2012 Apr 28.

98. Miller AN, Routt ML, Jr. Variations in sacral morphology and implications for iliosacral screw fixation. The Journal of the American Academy of Orthopaedic Surgeons. 2012 Jan;20(1):8-16.

99. Moustafa A, Sugiyama T, Prasad J, Zaman G, Gross TS, Lanyon LE, et al. Mechanical loading-related changes in osteocyte sclerostin expression in mice are more closely associated with the subsequent osteogenic response than the peak strains engendered. Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. 2012 Apr;23(4):1225-34.

100. Nicandri GT, Slaney SL, Neradilek MB, Larson RV, Green JR, Wahl CJ. Can magnetic resonance imaging predict posterior drawer laxity at the time of surgery in patients with knee dislocation or multiple-ligament knee injury? The American journal of sports medicine. 2011 May;39(5):1053-8.

101. Nuzzo MS, Posner M, Warme WJ, Medina F, Wicker R, Owens BD. Compression force and pullout strength comparison of bioabsorbable implants for osteochondral lesion fixation. American journal of orthopedics. 2011 Apr;40(4):E61-3.

102. O'Kane JW, Levy MR, Pietila KE, Caine DJ, Schiff MA. Survey of injuries in Seattle area levels 4 to 10 female club gymnasts. Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine. 2011 Nov;21(6):486-92.

103. O'Sullivan F, Wolsztynski E, O'Sullivan J, Richards T, Conrad EU, Eary JF. A statistical modeling approach to the analysis of spatial patterns of FDG-PET uptake in human sarcoma. IEEE transactions on medical imaging. 2011 Dec;30(12):2059-71.

104. Olson S, Clinton JM, Working Z, Lynch JR, Warme WJ, Womack W, et al. Thermal effects of glenoid reaming during shoulder arthroplasty in vivo. The Journal of bone and joint surgery American volume. 2011 Jan 5;93(1):11-9.

105. Papadonikolakis A, McKenna M, Warme W, Martin BI, Matsen FA, 3rd. Published evidence relevant to the diagnosis of impingement syndrome of the shoulder. The Journal of bone and joint surgery American volume. 2011 Oct 5;93(19):1827-32.

106. Papadonikolakis A, McKenna M, Warme WJ, Matsen FA. Intramedullary fibular and impaction allografting in revision total elbow arthroplasty with endosteal deficiency. Techniques in hand & upper extremity surgery. 2012 Mar;16(1):5-11.

107. Pollack SM, Li Y, Blaisdell MJ, Farrar EA, Chou J, Hoch BL, et al. NYESO-1/LAGE-1s and PRAME are targets for antigen specific T cells in chondrosarcoma following treatment with 5-Aza-2-deoxycitabine. PloS one. 2012;7(2):e32165.

108. Pyott SM, Schwarze U, Christiansen HE, Pepin MG, Leistritz DF, Dineen R, et al. Mutations in PPIB (cyclophilin B) delay type I procollagen chain association and result in perinatal lethal to moderate osteogenesis imperfecta phenotypes. Human molecular genetics. 2011 Apr 15;20(8):1595-609.

109. Rains DD, Rooke GA, Wahl CJ. Pathomechanisms and complications related to patient positioning and anesthesia during shoulder arthroscopy. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2011 Apr;27(4):532-41.

110. Reichel LM, Wiater BP, Friedrich J, Hanel DP. Arthrodesis of the elbow. Hand clinics. 2011 May;27(2):179-86, vi.

111. Reinhold M, Bellabarba C, Bransford R, Chapman J, Krengel W, Lee M, et al. Radiographic analysis of type II odontoid fractures in a geriatric patient population: description and pathomechanism of the "Geier"-deformity. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. 2011 Nov;20(11):1928-39.

112. Richard MJ, Katolik LI, Hanel DP, Wartinbee DA, Ruch DS. Distraction plating for the treatment of highly comminuted distal radius fractures in elderly patients. The Journal of hand surgery. 2012 May;37(5):948-56.

113. Richardson ML, Wahl CJ. Detached femoral bone plug following anterior cruciate ligament repair. Radiology Case Reports. 2011;6(4).

114. Riddle RC, Leslie JM, Gross TS, Clemens TL. Hypoxia-inducible factor-1alpha protein negatively regulates load-induced bone formation. The Journal of biological chemistry. 2011 Dec 30;286(52):44449-56.

115. Saltzman MD, Chamberlain AM, Mercer DM, Warme WJ, Bertelsen AL, Matsen FA, 3rd. Shoulder hemiarthroplasty with concentric glenoid reaming in patients 55 years old or less. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]. 2011 Jun;20(4):609-15.

116. Sanders JO, Jevsevar DS, Goldberg MJ, Weber KL. Quality guidelines need evidence, not opinion: commentary on an article by Robert A. Pedowitz, MD, PhD, et al.: "American Academy of Orthopaedic Surgeons Clinical Practice Guideline on optimizing the management of rotator cuff problems". The Journal of bone and joint surgery American volume. 2012 Jan 18;94(2):e14.

117. Scharschmidt TJ, Lindsey JD, Becker PS, Conrad EU. Multiple myeloma: diagnosis and orthopaedic implications. The Journal of the American Academy of Orthopaedic Surgeons. 2011 Jul;19(7):410-9.

118. Segal AD, Shofer J, Hahn ME, Orendurff MS, Ledoux WR, Sangeorzan BJ. Functional limitations associated with end-stage ankle arthritis. The Journal of bone and joint surgery American volume. 2012 May 2;94(9):777-83.

119. Shank CF, Wiater BP, Pace JL, Jinguji TM, Schmale GA, Bittner RC, et al. The lateral capitellohumeral angle in normal children: mean, variation, and reliability in comparison to Baumann's angle. Journal of pediatric orthopedics. 2011 Apr-May;31(3):266-71.

120. Srinivasan S, Gross TS, Bain SD. Bone mechanotransduction may require augmentation in order to strengthen the senescent skeleton. Ageing research reviews. 2012 Jan 5.

121. Standaert CJ, Friedly J, Erwin MW, Lee MJ, Rechtine G, Henrikson NB, et al. Comparative effectiveness of exercise, acupuncture, and spinal manipulation for low back pain. Spine. 2011 Oct 1;36(21 Suppl):S120-30.

122. Streubel PN, Glasgow D, Wong A, Barei DP, Ricci WM, Gardner MJ. Sagittal plane deformity in bicondylar tibial plateau fractures. Journal of orthopaedic trauma. 2011 Sep;25(9):560-5.

123. Tadepalli SC, Erdemir A, Cavanagh PR. Comparison of hexahedral and tetrahedral elements in finite element analysis of the foot and footwear. Journal of biomechanics. 2011 Aug 11;44(12):2337-43.

124. Teitz CC. Shadowing physicians. JAMA : the journal of the American Medical Association. 2011 Jun 15;305(23):2414; author reply 5-6.

125. Valli M, Barnes A, Gallanti A, Cabral W, Viglio S, Weis M, et al. Deficiency of CRTAP in non-lethal recessive osteogenesis imperfecta reduces collagen deposition into matrix. Clinical genetics. 2011 Sep 28.

126. Vilela MD, Bransford RJ, Bellabarba C, Ellenbogen RG. Horizontal C-1 fractures in association with unstable distraction injuries of the craniocervical junction. Journal of neurosurgery Spine. 2011 Aug;15(2):182-6.

127. Vining NC, Done S, Glass IA, Parnell SE, Sternen DL, Leppig KA, et al. EXT2-positive multiple hereditary osteochondromas with some features suggestive of metachondromatosis. Skeletal radiology. 2012 May;41(5):607-10.

128. Wahl CJ, Westermann RW, Blaisdell GY, Cizik AM. An association of lateral knee sagittal anatomic factors with non-contact ACL injury: sex or geometry? The Journal of bone and joint surgery American volume. 2012 Feb 1;94(3):217-26.

129. Wang VM, Bell RM, Thakore R, Eyre DR, Galante JO, Li J, et al. Murine tendon function is adversely affected by aggrecan accumulation due to the knockout of ADAMTS5. Journal of orthopaedic research : official publication of the Orthopaedic Research Society. 2012 Apr;30(4):620-6.

130. White KK. Orthopaedic aspects of mucopolysaccharidoses. Rheumatology. 2011 Dec;50 Suppl 5:v26-33.

131. White KK, Karol LA, White DR, Hale S. Musculoskeletal manifestations of Sanfilippo Syndrome (mucopolysaccharidosis type III). Journal of pediatric orthopedics. 2011 Jul-Aug;31(5):594-8.

132. White KK, Song KM, Frost N, Daines BK. VEPTR growing rods for early-onset neuromuscular scoliosis: feasible and effective. Clinical orthopaedics and related research. 2011 May;469(5):1335-41.

133. Wiater BP, Neradilek MB, Polissar NL, Matsen FA, 3rd. Risk factors for chondrolysis of the glenohumeral joint: a study of three hundred and seventy-five shoulder arthroscopic procedures in the practice of an individual community surgeon. The Journal of bone and joint surgery American volume. 2011 Apr 6;93(7):615-25.

134. Wilcox JJ, Snow BJ, Aoki SK, Hung M, Burks RT. Does Landmark Selection Affect the Reliability of Tibial Tubercle-Trochlear Groove Measurements Using MRI? Clinical orthopaedics and related research. 2012 Feb 9.

135. Wolf CF, Gu NY, Doctor JN, Manner PA, Leopold SS. Comparison of one and two-stage revision of total hip arthroplasty complicated by infection: a Markov expected-utility decision analysis. The Journal of bone and joint surgery American volume. 2011 Apr 6;93(7):631-9.

136. Zhang Y, Paul EM, Sathyendra V, Davison A, Sharkey N, Bronson S, et al. Enhanced osteoclastic resorption and responsiveness to mechanical load in gap junction deficient bone. PloS one. 2011;6(8):e23516.

137. Zhu Y, Wu JJ, Weis MA, Mirza SK, Eyre DR. Type IX collagen neo-deposition in degenerative discs of surgical patients whether genotyped plus or minus for COL9 risk alleles. Spine. 2011 Nov 15;36(24):2031-8.

Residency

Residents Daniel Holtzman, Laura Stoll, Andrew Ghatan, and Timothy Alton.

Resident Dr. Kenneth Gundle practicing in the ISIS cadaver training lab.

A dinner to celebrate the upcoming graduation of our year 5 residents.

Dr. Routt demonstrating advanced pelvic fixation techniques in the ISIS lab.

Spinal navigation lab led by Dr. Wally Krengel.

Frances Huisman, Amanda Schwanz, and Angela Weiss.

Why Orthopaedic In Training Examination Scores Matter

Douglas P. Hanel, M.D.

The second Saturday of November is set-aside for the Orthopaedic In Training Examination (OITE), an examination that is completed by Orthopaedic Residents across North America and 17 international programs. This 256 question examination reflects a resident's basic knowledge of musculoskeletal disease and injury, the foundation of their chosen profession. The spirit of the examination is to provide feedback for each resident and to serve as a personal report card for the progress they are making compared to their peers nationally. The majority of the knowledge required to answer these questions comes from hours of self-directed studies. This information isn't learned on rounds or in the operating room and reflects a resident's ability to learn outside of a formal mentor/teacher/pupil setting. Most importantly, the annual OITE is a reflection of a resident's ability to become a life long learner, an adults who will continue to advance their knowledge beyond the formal training of their residency.

Our program does not teach for or to the OITE but it does emphasize how the examination reflects the culture of continuing self disciplined education. Doing well on this examination is an expectation, and as such residents are not rewarded for doing well, nor are they punished for doing poorly. They are all made aware of the following practical trend. The overall performance of a UW resident's OITE scores predicts the performance of that resident on the basic knowledge portion (Part 1) of the examination required to become a member of the American Board of Orthopaedic Surgery (ABOS). Between 1990 and 2011, 118 residents completed Orthopedic Residency training at the University of Washington; all but six passed Part 1 on their first attempt. Reviewing the OITE performance of those residents who failed, we find two critical trends; five of the six scored lower then the 35 Percentile on the OITE in their last year of training and all showed a trajectory for failure based on consecutively declining scores from one years score to the next. Of the 112 residents who passed on the first attempt the great majority scored consistently higher then the 50th percentile,

Douglas P. Hanel, M.D.

In an effort to reflect our commitment to resident teaching and resident learning we have now instituted training programs for those individuals who fall into either of the above two "critical" trends, building a study program with individual counseling and defined study methods that will carry a trainees education beyond the years of residency. Whether these efforts translate into sustained behavior in the years that follow residency is unanswerable. However in the short run, the results are reflected in OITE scores and passing rates on Part 1 of the ABOS board examinations.

Since taking this active approach to the role of life long learning, we find that our residents have done well as a program with an overall score of 78, 98 and 90 percentile for the last three years. It is our hopes that our goal of never having another resident fail their boards will be reflected by these trends.

Understanding Admission to the University of Washington School of Medicine

Carol C. Teitz, M.D.

Interest in how undergraduate and graduate schools select incoming students has increased across the nation. The medical school application process is one of the most competitive of any profession. Given the very strong interest and competition for medical school positions nationally, many applicants are elated when they are accepted at the medical school of their choice and disappointed when they are not. The University of Washington School of Medicine (UW SOM) works hard to make its admissions process fair, transparent, contemporary, and highly relevant to the Northwest region. In this article, we provide basic information about the process and outcomes for our medical school.

The Admissions Process

The UW SOM typically receives almost 5,000 applications for 220 positions in each class. A maximum of 80 positions are reserved for students from Wyoming, Alaska, Montana, and Idaho. Ten positions are reserved for the combined MD/PhD program which receives 250-300 applications annually.

The Admissions Committee consists of University of Washington faculty members from throughout the WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) region as well as medical students and a few community members. The 178 members of the Admissions Committee are responsible for interviewing applicants. The Executive Committee, a subset of the Admissions Committee, has 23 members, all of whom hold faculty appointments. Executive Committee members are responsible for screening applications, interviewing applicants, and voting on whether to accept or reject applicants. Executive committee members have typically served on the Admissions Committee for at least three years before being appointed to the Executive Committee where they may serve two three-year terms. Two to three members of the Executive Committee screen each application. Applicants who are "screened in" (two positive "screens") are interviewed sometime between October and March by a panel of three Admissions Committee members. The interview is a practical way to assess the applicant's communication skills, motivation for a career in medicine, knowledge of the field of medicine and healthcare issues, and problem-solving skills. Two of the three interviewers consider the applicant solely on the basis of his/her performance during the interview. An Executive Committee member is the third interviewer in each interview panel and is the only one of the three panelists with access to the applicant's grades and MCAT scores.

Each Executive Committee member presents the applicants he or she has interviewed to the rest of the Executive Committee for consideration, discussion, and decision. This presentation includes information from both the written application and the interview. Executive Committee members have access to each applicant's entire application, including the interview results submitted independently by each interviewer and the summary report from the interview panel. Applicants are accepted on a rolling basis between the end of October and mid-March.

The Results

Applicants

The number of medical school applicants has increased nationally over the last five years from 37,372 in 2005-2006 to 42,741 in 2010-2011. In 2011 44 percent of applicants were accepted to enter medical school. In 2010-2011, 784 Washington residents applied to medical schools across the United States, including 714 who applied to the UW. 121 matriculated at the UW and an additional 198 matriculated at another medical school.[1] The percentage of applicants from the state of Washington who matriculated at any medical school was forty one percent, not quite up to the proportion of applicants accepted nationally.

Positions Available

Washington and the Pacific Northwest have fewer seats for students who want to go to medical school than other states with similar population numbers. Other than the University of Oregon, the University of Washington is the only allopathic medical school in the Pacific Northwest and has a longstanding contract with Wyoming, Alaska, Montana and Idaho, to educate set numbers of residents of those states. In Washington, there are typically five to six applicants for each available medical school seat.

Our relatively limited number of medical school seats and the national recognition for the quality of our medical school make the admissions process to UW SOM highly competitive. For the 18th consecutive year, a US News and World Report survey ranked the UW School of Medicine No. 1 in the country for primary-care training, and for the 20th year, the School was ranked No. 1 in both family medicine and rural medicine training. The School was ranked No. 2 in research funding from the National Institutes of Health (among all medical schools) and No. 1 among public medical schools. Among the 123 medical schools in the rankings, the UW School of Medicine was one of only three schools in the top 10 for both primary care and research. In addition our medical students benefit greatly from our affiliation with the WWAMI states not only because of the diverse backgrounds of the students, but also because of the unusually wide range of available training sites. Our students have clinical training opportunities at over 200 sites in all types of medical practices ranging from single-physician rural practices to tertiary-care hospitals. In between are community health centers, Indian health service clinics, and international health clinics, both in the U.S. and abroad, as well as private practices caring for both insured and uninsured patients. Experiences are available in urban and rural, primary care and specialty care, clinical and research environments.

Interviews and Acceptance Rates

Over the last five years, the UW School of Medicine Admissions Committee has interviewed up to 850 applicants each year. Applicants from our partner states may interview in their home states and are considered in comparison to their peers from the same state. Washington applicants may interview in Seattle or Spokane and are compared to other applicants from throughout Washington. In a five–year analysis that compared the acceptance rates of UW SOM of applicants from Eastern Washington with those from Western Washington, the acceptance rates were not significantly different (19.96 and 19.16 percent, respectively.) The acceptance rate for the WWAMI states, combined, averages 19 percent. Applicants from within the WWAMI region who were not accepted on their first application and choose to reapply are typically accepted at a rate of 20 percent. Although the UW School of Medicine receives approximately 3,600 applications from outside the WWAMI region each year, relatively few of these applicants are interviewed, and their acceptance rate is typically 0.3 percent.

The Characteristics of Our Students

The UW SOM admits the best and the brightest students who have characteristics that patients want in their physicians such as problem-solving ability and communication skills.[2] Our holistic decision-making process considers motivation for and understanding of a medical career, record of service, broad interests and life experiences, and other characteristics in addition to academic ability demonstrated through grades and MCAT scores. Our mean MCAT score and GPA are at the national average.

Given the commitment of time and money necessary to become a practicing physician, medical schools across the country look for demonstrable understanding of the day-to-day rewards and difficulties in the life of a physician. This is most often gleaned from the observation of doctors as they care for patients. Even pre-medical students who grew up in a family in which one or both parents are physicians benefit from observing the patient-physician interaction. In a series of recent analyses at the UW SOM, the acceptance rate for offspring of physicians was identical to the rate for applicants whose parents were not physicians. Moreover, the representation of physicians' offspring in the accepted applicants mirrors their representation in the applicant pool.

We do not consider age as a factor in our decisions, but rather what insights the applicants have gained from the totality of their life experiences. Over the last five years, the age of students beginning medical school at the University of Washington has typically ranged from 19 to 46 with a mean age of 25. The mean age nationally has been 23.6 for the last three years. Broad life experience can enhance a physician's cultural competence, empathy, and ability to handle stress.

The mission of the UW School of Medicine is to improve the health and well being of the public. In pursuit of this goal, the UW SOM is committed to excellence in biomedical education, research, and health care. The people of the state and region are served best when graduates of the UW SOM choose a variety of careers that will meet the healthcare needs of our region, recognizing the importance of primary care, clinical specialties, and leadership in the biomedical sciences and academic medicine. An applicant does not have to be interested in a primary care career to be admitted to the UW School of Medicine although we have a special focus on primary care. Students interested in any specialty receive the best training for their future careers.

In summary, the large pool of highly qualified applicants to the University of Washington School of Medicine places the school in an enviable and difficult position. The School can fill its seats with bright, talented, compassionate people who will make great physicians. Unfortunately, in the process, some applicants will be disappointed when they are not accepted. The Admissions Office has worked hard to make the admissions process transparent and fair, and to put all applicants on an even playing field with regard to our expectations for applicants. The Admissions Office holds town hall meetings each spring and provides detailed information on its website. For more information please see uwmedicine.washington.edu/Education/MD-Program/Admissions/Pages/default.aspx and especially uwmedicine.washington.edu/Education/MD-Program/Admissions/Applicants/Pages/AdvicefromAdmissionsDean.aspx. There are additional sites on the website for applicants and their families, as well as for physicians who are interested in helping future applicants. In addition, the Notable Features section summarizes distinguishing characteristics of the UW MD program (uwmedicine.washington.edu/Education/MD-Program/Admissions/Pages/Notable-Features-UWSOM.aspx). Comments and suggestions are welcome and can be directed to Carol C. Teitz, M.D., Associate Dean for Admissions via teitz@uw.edu.

References

1. https://www.aamc.org/data/facts/applicantmatriculant/

2. Martin, Christopher, Perspective: To What End Communication? Developing a Conceptual Framework for Communication in Medical Education. Academic Medicine: December 2011 - Volume 86 - Issue 12 - pp 1566-1570

An earlier version of this article was previously published in the WSMA report, September, 2011.

Orthopaedic Alumni Update

Lyle Sorensen, M.D.

Jeremiah Clinton, Jon Braman, and Eric Klineberg

It has been a wonderful year and "Life Is Good". Our generous Alumni continue to fund the best Ortho program in the country. One of the best things that we can do for our patients is to promote the education and welfare of those young surgeons that follow us into practice.

Many of our Alumni contribute to our Resident Discretionary Fund annually. We sent out a request last year for those that had not 'repaid' or rather 're-contributed' what they had received while in residency and had a good response. We hope that as the Alumni group grows, so do the contributions. Sometimes it is hard to remember what a person has contributed to during the year. We have the Residents write a note to Alumni annually and include a biocard for personal contact at our "Noteathon". This has generally been successful, but still we didn't make our budget last year, and withdrew savings to cover our "investment in our Residents".

We fund books and journals (software), R3 and R5 review courses, Resident Research Days, and the Clawson and Rogge Libraries. We are also grateful to the Washington State Orthopaedic Association (WSOA) for support of the Chief Resident Banquet and the now, combined UW Alumni / WSOA Reception at our Annual Academy Meeting. We think there is a natural alliance between our UW Ortho

Frederick Matsen, Aaron Chamberlain, Craig Arntz, William Barrett, Brett Wiater and Christopher Howe

Jesse Jupiter and Adam Bakker

William Barrett, Stuart Weinstein, and Pierce Scranton

Residency and our State Association and it has been a very successful bond indeed.

We had a great time at the Academy Reception in San Francisco this year with Alumni and the WSOA members. I would encourage any of you to attend our reception in Chicago next year. What a good time to catch up on old friendships, trade stories, and meet people that you always meant to talk to.

I think it is more important than ever in our changing health care environment to stay connected. We really have a unique perspective on what is best for individuals with musculoskeletal injuries and disease, not to forget congenital and genetic problems as well. There are more nonphysicians, committees, and "stakeholders" that want to decide what should happen with patients in terms of care than ever before. We are a group with a unique perspective and should acknowledge that and make our expertise be felt as advocates for our patients.

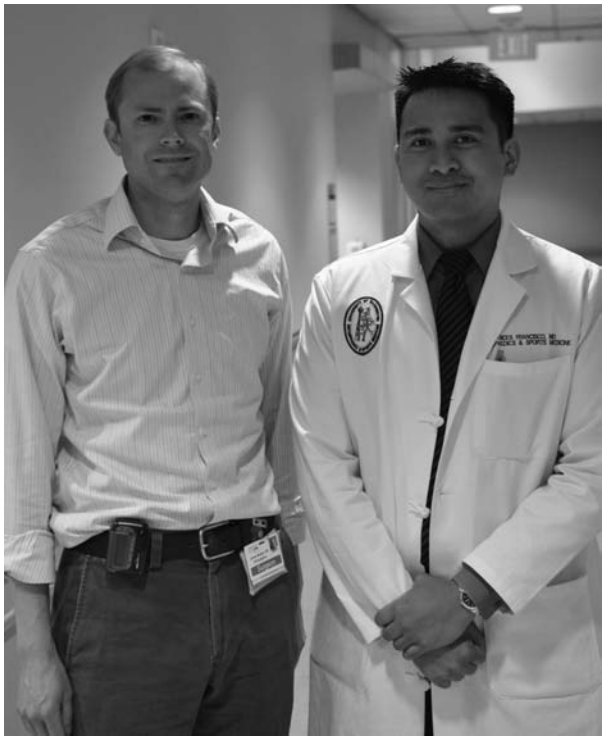
It was great having Dr. Stuart Weinstein as the LeCocq Lecturer this year. There were more people at the LeCocq Dinner than I have seen in years. He is a great man and I sense the desire for people in the community to reconnect. Surgeons came from all over the state.

Dr. Jesse Jupiter from Harvard Medical School was an impressive adjudicator and lecturer at Resident Research Days this year. Our UW Resident Research projects are very impressive with many pertinent and thought provoking findings. I hope we as an Alumni organization will continue to support such a great program and a noble cause like this. I am very proud to be a part of our Alumni group and help in any way I can. I am sure you feel the same way.

Lyle Sorensen, M.D.

Fellowships

Our 2011-2012 Hand Fellows Jason Ko, Andrew Watt, Lucie Krenek, Stephen Kennedy, and Assistant Professor and Hand Surgeon Jerry Huang.



James Meeker and Ramces Francisco, our two Foot and Ankle ACEs.

Musculoskeletal Oncology ACE Antoinette Lindberg and Fellowship Director Ernest Conrad.

Our Shoulder and Elbow Team: Fellowship Director Winston Warme, Physician Assistant Alex Bertelsen, Shoulder and Elbow ACEs Bradley Carofino and Matthew Jenkins, Physical Therapist Sarah Jackins, and Professor Frederick Matsen.

Our Trauma ACEs: Jonathan Eastman, Thomas Large, Reza Firoozabadi, Jason Schneidkraut, and Mark Adams.

UW Spine Serve Members: Ali Ravanpay, James Mok, Ted Wagner, Dena Pruitt, Spine ACE Amit Patel, Michael Lee, Richard Bransford, Dan Riew, Spine ACE Sree Harsha Malempati, Noojan Kazemi, and Jens Chapman.

Alumni

1952
Park W. Gloyd, M.D. ★

1954
Trygve Forland, M.D. ★

1955
Robert W. Florence, M.D.

1956
J. Michael Egglin, M.D. ★
John E. Goeckler, M.D.
Robert L. Romano, M.D. ★

1957
John H. Aberle, M.D. ★★
John R. Beebe, M.D.

1958
Harry H. Kretzler, Jr., M.D. ★
James R. Friend, M.D. ★
Kenneth L. Martin, M.D. ★
Samuel L. Clifford, M.D.

1959
James W. Tupper, M.D.

1960
Irving Tobin, M.D. ★
William V. Smith, M.D. ★

1961
Robert C. Colburn, M.D. ★

1962
Arthur Ratcliffe, M.D.
Marr P. Mullen, M.D. ★★★★

1963
Alfred I. Blue, M.D.
Robert A. Kraft, M.D.

1964
David E. Karges, M.D. ★★★★★
Harold J. Forney, M.D. ★★
Theodore K. Greenlee II, M.D. ★★★★★★
Thomas E. Soderberg, M.D.

1966
F. Richard Convery, M.D. ★
Joseph S. Mezistrano, M.D. ★
William A. Reilly, Jr., M.D.

1967
Ivar W. Birkeland, M.D. ★★
J. Conrad Clifford, M.D. ★
Robert F. Smith, M.D. ★★★★★

1968
Lynn T. Staheli, M.D. ★
Stewart M. Scham, M.D. ★★
William T. Thieme, M.D. ★★

1969
Edward E. Almquist, M.D. ★★★
Edward L. Lester, M.D. ★
Hugh E. Toomey, M.D. ★★★
Sigvard T. Hansen, Jr., M.D. ★★★★★★

1970
John C. Brown, M.D. ★★
John M. Coletti, Jr., M.D. ★
Malcolm B. Madenwald, M.D. ★★
Michael T. Phillips, M.D. ★
Robert D Schrock, Jr., M.D.

1971
Bruce E. Bradley, Jr., M.D. ★
Franklin G. Alvine, M.D. ★★★★★
Jerome H. Zechmann, M.D.
Louis A. Roser, M.D. ★
Nils Fauchald, Jr., M.D.

1972
David J. LaGasse, M.D. ★
David R. Nank, M.D. ★★
Donald D. Hubbard, M.D. ★
John A. Neufeld, M.D. ★★
Thomas L. Gritzka, M.D. ★

1973
Frederick J. Davis, M.D. ★
Larry D. Hull, M.D. ★
Robert P. Watkins, Jr., M.D. ★
Theodore A. Wagner, M.D. ★★★★★

1974
Richard A. Dimond, M.D. ★★
Ronald B.H. Sandler, M.D. ★★★★
Samuel R. Baker, M.D. ★★★★
Robert A. Winquist, M.D. ★★★★★★★

1975
Donald L. Plowman, M.D. ★★★★
Frederick A. Matsen III, M.D. ★★★★★★★
Gunter Knittel, M.D.
Larry R. Pedegana, M.D. ★★
Thomas M. Green, M.D. ★★★★★★
William M. Backlund, M.D., P.S. ★

1976
Douglas K. Kehl, M.D.
Douglas T. Davidson III, M.D. ★
John F. Burns, M.D. ★
Peter Melcher, M.D.
Richard A. Zorn, M.D. ★

1977
Carl A. Andrews, M.D. ★
Geoffrey W. Sheridan, M.D. ★★★
Larry D. Iversen, M.D. ★
Mark C. Olson, M.D. ★★
Steven T. Bramwell, M.D.

1978
Arnold G. Peterson, M.D. ★★★★
Gary J. Clancey, M.D. ★★★★★
John W. Brantigan, M.D.
Richard S. Westbrook, M.D. ★★
Robert J. Strukel, M.D.
William Oppenheim, M.D. ★★

1979
Allan W. Bach, M.D. ★★★★★
Gregory M. Engel, M.D. ★★
Jonathan L. Knight, M.D. ★★
Richard L. Semon, M.D. ★★★★

1980
Carol C. Teitz, M.D. ★★★★
Douglas G. Norquist, M.D. ★
John M. Hendrickson, M.D. ★★★
Michael A. Sousa, M.D. ★★★★★
Stuart R. Hutchinson, M.D. ★

1981
Dennis J. Kvidera, M.D. ★
John M. Clark, Jr., M.D., Ph.D. ★★★
Martin S. Tullus, M.D. ★★★★★★
Robert G. Veith, M.D. ★★★★★★★

1982
John L. Thayer, M.D. ★★
Richard M. Kirby, M.D. ★★★★★★★
Steven S. Ratcliffe, M.D. ★★★★
William D. Burman, M.D.

1983
Elizabeth Anne Ouellette, M.D. ★★
Edward L. Farrar III, M.D. ★★★★★
Henry K. Yee, M.D. ★
Joseph D. Zuckerman, M.D. ★★★★★
Keith A. Mayo, M.D. ★★★★★
Robert M. Berry, M.D. ★★★

1984
Jeffrey C. Parker, M.D. ★
Jeffrey W. Akeson, M.D. ★★★★
Kevin P. Schoenfelder, M.D. ★
Marc F. Swiontkowski, M.D. ★★★★★★★
Thomas J. Fischer, M.D. ★★★★★

1985
Daniel L. Flugstad, M.D. ★★★★★
Jeffrey N. Hansen, M.D. ★★★
Paul J. Abbott, M.D. ★★★★
Richard J. Barry, M.D. ★★
William P. Barrett, M.D. ★★★★★

1986
Carleton A. Keck, Jr., M.D. ★★★
Gary Bergman, M.D. ★★★★★★
Lawrence E. Holland, M.D. ★★
Michael E. Morris, M.D. ★★★★

1987
Craig T. Arntz, M.D. ★★★
Herbert R. Clark, M.D. ★★
Michael K. Gannon, M.D. ★
Steven L. Reed, M.D. ★

1988
Jonathan L. Franklin, M.D. ★★★★★
Michael A. Thorpe, M.D. ★★★★★★
Richard V. Williamson, M.D. ★

1989
James P. Crutcher, M.D. ★★★★★
Lawrence V. Page, D.O. ★★★
Martin G. Mankey, M.D. ★★★★★
Nancy J. Ensley, M.D.
Steve C. Thomas, M.D. ★★★★

1990
David M. Kieras, M.D. ★
J. Roberto R. Carreon, M.D.
Jay A. Winzenried, M.D. ★★★
Ken Fujii, M.D. ★
Walter F. Krengel III, M.D. ★★★★

1991
David H. Bishop, M.D. ★★
Kit M. Song, M.D.
Mark Remington, M.D. ★★★★
Mark E. Murphy, M.D., Ph.D. ★★
Tim P. Lovell, M.D. ★★

1992
Curt Rodin, M.D.
Don Striplin, M.D. ★★
Eli Powell, M.D. ★
Jeff Stickney, M.D. ★★
John D. West, M.D. ★★
Michael Sailer, M.D. ★★★★

1993
J. Eric Vanderhooft, M.D. ★★★★★
Lyle S. Sorensen, M.D. ★★★★★★★
Philip J. Kregor, M.D. ★★
Susan R. Cero, M.D. ★★★★★★

1994
Brodie Wood, M.D. ★★★★★★★
Eric Bowton, M.D. ★★
Jim Vahey, M.D. ★
Sohail K. Mirza, M.D. ★
William Obremskey, M.D. ★★★★

1995
Ron Kristensen, M.D. ★★
Scott Hormel, M.D. ★★★
Timothy Beals, M.D. ★★
Todd Clarke, M.D. ★★★★
William J. Mills III, M.D. ★★★

1996
David Deneka, M.D. ★★
Peter Mitchell, M.D. ★★★
Peter T. Simonian, M.D. ★★★★
Vernon Cooley, M.D. ★★
William Wagner, M.D. ★★★★

1997
Daniel Stechschulte, Jr., M.D. ★★★★★★★
David Levinsohn, M.D. ★★
L. Anthony Agtarap, M.D. ★
Mohammad Diab, M.D.
Randall W. Viola, M.D.

1998
Colin Poole, M.D. ★
David Belfie, M.D. ★
Don Ericksen, M.D. ★★★★★
Jay Crary, M.D. ★★★★★
Oriente DiTano, M.D. ★

1999
Craig Boatright, M.D.
Jeffrey Garr, M.D. ★
John Michelotti, M.D. ★★
Julie A. Switzer, M.D. ★
Thomas D. Chi, M.D. ★

2000
Brett Quigley, M.D. ★
Cara Beth Lee, M.D. ★
Daniel Jones, M.D. ★
Joel Hoekema, M.D. ★★
Patrick McNair, M.D.

2001
Eric Novack, M.D.
Frederick Huang, M.D. ★★★★
Matthew Camuso, M.D.
Michael Metcalf, M.D. ★★★★★
Richard Bransford, M.D. ★

2002
Timothy DuMontier, M.D.
Scott Hacker, M.D. ★
Timothy Rapp, M.D. ★
William Sims, M.D. ★
Carla Smith, M.D. ★★

2003
Ben DuBois, M.D. ★
Andy Howlett, M.D. ★
Guy Schmidt, M.D. ★★
Brian Shafer, M.D. ★
Emma Woodhouse, M.D. ★

2004
Jon Braman, M.D. ★
Alexis Falicov, M.D. ★
Mike McAdam, M.D. ★
Jason Thompson, M.D. ★
Thea Khan-Farooqi, M.D.

2005
Tony Buoncristiani, M.D. ★
Waqqar Khan-Farooqi, M.D.
Wren McCallister, M.D.
Tim O'Mara, M.D. ★
David Stevens, M.D. ★

2006
Heidi Shors, M.D. ★
Stacey Donion, M.D.
Eric Klineberg, M.D. ★
Bill Montgomery, M.D. ★
Mel Wahl, M.D. ★
Burt Yaszay, M.D. ★

2007
Jamie Antoine, M.D. ★
Jeremiah Clinton, M.D. ★
Mary Cunningham, M.D. ★
Evan Ellis, M.D. ★
Joseph Lynch, M.D. ★
Allison MacLennan, M.D. ★

2008
Drew Fehsenfeld, M.D. ★
Mark Freeborn, M.D. ★
Christopher Howe, M.D. ★
John Howlett, M.D. ★
Michael Lee, M.D. ★
Gregg Nicandri, M.D. ★

2009
Rajshri Maheshwari Bolson, M.D. ★
Jason King, M.D. ★
Soren Olson, M.D. ★
Karen Perser, M.D. ★
Scott Ruhlman, M.D. ★
Addison Stone, M.D. ★
Jason Wilcox, M.D. ★

2010
Sean Amann, M.D. ★
Jeremy Bauer, M.D. ★
Aric Christal, M.D. ★
Wendy Emerson, M.D. ★
Mike Hwang, M.D. ★
Lee Pace, M.D. ★
Chris Wolf, M.D. ★
Vinko Zlomislic, M.D. ★

2011
Aaron Chamberlain, M.D. ★
Brian Daines, M.D. ★
Cory Lamblin, M.D. ★
Edward Moon, M.D. ★
Derek Rains, M.D. ★
Peter Scheffel, M.D. ★
Christian Sybrowsky, M.D. ★
Brett Wiater, M.D. ★

2012
Benjamin Amis, M.D.
Adam Bakker, M.D.
Greg Blaisdell, M.D.
Josh Lindsey, M.D.
Grant Lohse, M.D.
Matthew Lyons, M.D.
Andrew Merritt, M.D.
Nels Sampatacos, M.D.

STARS INDICATE TOTAL DONATIONS IN SUPPORT OF THE RESIDENCY

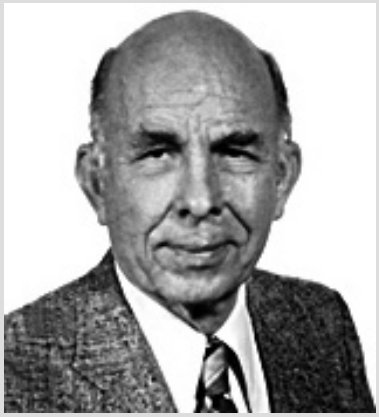
★★★★★★★ = $20,000 and above
★★★★★★ = $15,000 - $19,999
★★★★★ = $10,000 - $14,999
★★★★ = $7,500 - $9,999
★★★ = $5,000 - $7,499
★★ = $2,500 - $4,999
★ = $1 - $2,499

Passages

Albert Basil Harris, M.D.
January 19, 1929 - May 6, 2012

'Basil', as he preferred to be called by his friends, attended the Medical College of Alabama and completed his Neurosurgical Residency at Barnes Hospital in St. Louis followed by military service as Captain in the US Army from 1955-1957. After initially joining the faculty at Washington University in St. Louis, Dr. Harris switched to the University of Washington in 1967 where he practiced until his retirement in 2001. Dr. Harris also held numerous political offices in the most prestigious regional and national professional societies. For our UW Spine Service he was a valued partner as Joint Professor in Orthopaedics. He advanced the field of spine surgery with many research endeavors. His original description of transpedicular approaches for thoracic discectomies is particularly memorable as it changed surgical practice and saved patients the risks of the usual standard of care conducted through painful thoracotomies. He also developed power drill technologies, which have become the standard inventory for spine surgery. Most importantly Basil was a patient teacher to all of us, a wise partner in all matters of patient care and a faithful friend. He will be missed - the memories of his teachings will live on. (www.legacy.com/obituaries/seattletimes/obituary.aspx?n=albert-basil-harris&pid=157561002&fhid=11419).

Jens R. Chapman, M.D.



John E. Stewart, M.D.
December 9, 1912 - April 17, 2012

John Stewart was born and raised in the Alaska territory and attended UW for premed school. He attended the Harvard School of Medicine and stayed on for residency training at Harvard as well. During WWII he served in the US Navy in the Pacific and earned the Legion of Merit for his acts of heroism on the beaches on Tarawa. Upon his return to Seattle he became one of the founding members of Orthopaedic Physician Associates and specialized in spine surgery. He crossed paths with Dr. Sigvard T. Hansen when Ted served under him during a medical school clerkship in 1960. Dr. Stewart became a regular fixture at the weekly Harborview fracture conference from 1973 onwards and was – like so many – initially concerned but later supportive of the aggressive new 'Seattle way' of treating fractures. After serving as Chief of Staff at Swedish Medical Center from 1976-1978 Dr. Stewart retired from regular clinical practice, but continued on as a volunteer surgeon in Tanzania and Malawi and began attending Harborview Trauma clinics on a regular basis. He did so until 1999, when progressive hearing loss made patient interactions impossible. Drs. Routt and Hansen remember him as a very generous and dedicated gentleman and as professional as any colleague could ever hope to be. We thank Dr. Stewart for over 22 years of volunteering in our Trauma clinics and teaching hundreds of students, residents and fellows – as well as faculty - along the way.

Sigvard T. Hansen, Jr., M.D. and Milton L. Routt, Jr., M.D.

Left to right: Jim Tupper, Ted Wagner, John Loeser and Marr Mullen.

James W. Tupper, M.D.
April 27, 1928 - December 27, 2011

James Warren Tupper was born in Montana and attended UW for undergraduate training and the University of Pennsylvania for Medical School. He was a graduate of the UW Orthopaedics Residency program in 1959. It was during a rotation at Children's Hospital that Dr. Jim Tupper was designated to become a pediatric spine surgeon by Dr. Ernest Burgess. He received his spine training in Texas by Dr. Paul Harrington together with Dr. Marr Mullen and subsequently became one of the early spine surgeons in Seattle and in fact was one of the founding members of the Scoliosis Research Society. Such can the power of enlightened predeterminism be - an entire career pathway chosen by a senior colleague. His main practice locations were at Swedish and Seattle Children's Hospital, where his later association with Drs. Ted Wagner, Ed Laurnen and Donald Gunn provided the foundations for Seattle being recognized as one of the leading spine centers in the country. Dr. Tupper was devoted to his family, outdoor activities and woodworking. He was noted for his craftsmanship well after his retirement from spine surgery. He passed away from complications of aortic valve surgery. Throughout his life Dr. Tupper remained very proud of the UW and his medical peers.

Theodore A. Wagner, M.D.

Endowments

We express our appreciation to all who have contributed to the endowments of the Department of Orthopaedics and Sports Medicine. This assistance makes possible special research activities, educational programs, and other projects that we could not offer without this extra support from our alumni, faculty, and friends in the community. In this day and age of funding cutbacks and decreased returns on investment an endowment in the University of Washington continues to provide above market returns and is a crucial way to support advancement of musculoskeletal medicine. If you have any questions, please contact our Chairman, Jens Chapman (jenschap@uw.edu), or our Director, Ken Karbowski (kkarb@uw.edu). Thank You!

HansJörg Wyss Endowed Chair - Jens R. Chapman, M.D.

Ernest M. Burgess Endowed Chair for Orthopaedics Investigation - David R. Eyre, Ph.D.

Sigvard T. Hansen Jr. Endowed Chair in Orthopaedic Traumatology - Ted S. Gross, Ph.D.

Jerome H. Debs II Endowed Chair in Orthopaedic Traumatology - Stephen K. Benirschke, M.D.

Bob and Sally Behnke Endowed Chair for the Health of the Student Athlete - John W. O'Kane, M.D.

Endowed Chair for Women's Sports Medicine and Lifetime Fitness - Peter R. Cavanagh, Ph.D.

Surgical Dynamics Endowed Chair for Spine Research

Douglas T. Harryman II/DePuy Endowed Chair for Shoulder Research - Frederick A. Matsen III, M.D.

Synthes Spinal Surgery Outcomes Research Endowed Fund

Fracture Fixation Biology Endowed Professorship

Ostex Bone and Joint Research Endowment

Orthopaedic Traumatology Endowed Lectureship

John F. LeCocq Lectureship in Orthopaedic Surgery

Don and Carol James Research Fund in Sports Medicine and Fitness

Victor H. Frankel Endowed Award

Esther Whiting Award

Edwin L. Laurnen, M.D. Award

Spine Research Endowment

James G. Garrick Endowed Lectureship in Sports Medicine

Allan Treuer - Ted Wagner, M.D. Endowed Chair in Regenerative Spine Surgery

Richard and Betsy Kirby Orthopaedic Resident Endowed Fund

Huang-Biu Orthopaedic Resident Endowed Support Fund

Orthopaedic Resident Endowed Support Fund

Josh and Max Myers Endowed Orthopaedic Fellowship Fund

Sarcoma Oncology Endowed Fund

Clawson Family Orthopaedic Library Endowed Fund


HUSKY STADIUM