Characteristics of unsatisfactory shoulder arthroplasties

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Failure of shoulder arthroplasty is often defined as a complication or the need for revision, but it may also be viewed as a result that does not meet the expectations of the patient. To enhance our understanding of failed shoulder arthroplasties, we identified the characteristics common to a series of 139 consecutive patients who came to our shoulder consultation service because of dissatisfaction with the result of their shoulder arthroplasty. Primary osteoarthritis (28%) and proximal humeral fractures (26%) were the most common indications for the initial arthroplasty. Seventy-three shoulders (fifty-two percent) had at least one surgery before arthroplasty was performed. Seventy-four percent of the shoulders were stiff, 35% were unstable, and in the total shoulders, 59% of the glenoids were loose. Components were substantially malpositioned in 23%. Forty-two percent of shoulders with a failed hemiarthroplasty had substantial glenoid erosion, and 43% of shoulders that had undergone a hemiarthroplasty for fracture had nonunion of the tuberosities. Patients demonstrated impaired shoulder function; on average, they could perform only 2 of 12 shoulder functions. The rate of revision underestimated the rate of failure, as 23% of arthroplasties did not undergo revision. The challenge of achieving patient satisfaction after arthroplasty may be greater than previously recognized. Many of these unsatisfactory shoulder arthroplasties did not meet the criteria for failure used in previously published series. These observations suggest that greater attention to achieving proper component position, postoperative motion, and in fracture cases, fixation of the tuberosities may lead to increased patient satisfaction after shoulder arthroplasty. (J Shoulder Elbow Surg 2002;11:431-41.)

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1058-2746/2002/$35.00 + 0 **32/1/125806**
doi:10.1067/mse.2002.125806

INTRODUCTION

Although prosthetic arthroplasty of the shoulder is far less common than that of the hip or knee,[31] it is the recommended treatment for many degenerative conditions of the glenohumeral joint as well as for certain proximal humeral fractures. The results of shoulder arthroplasties have been evaluated by means of clinical, functional, and radiographic criteria.[1,9,16,18,22,23,27] Successful results are reported in over 90% of shoulder arthroplasties.[1,2,9,24] The complication rate has been estimated at 15%.[10,18] In this regard, it is important to recognize that complications, such as intraoperative fracture or dislocation, do not necessarily lead to a bad clinical end result. Conversely, the absence of complications does not guarantee a good clinical result, as in the case of stiffness or unexplained pain.

Failure may also be defined as patient dissatisfaction with the result of the procedure, regardless of the severity of symptoms or physical findings.[7] In a long-term follow-up study of prosthetic shoulder arthroplasty in patients aged 50 years or younger, Sperling et al[27] found that one half of patients with a total shoulder arthroplasty and nearly one half of patients with a hemiarthroplasty graded their result as unsatisfactory or unsuccessful. Survivorship, as assessed by traditional criteria, was considerably higher. Similarly, Brenner et al[7] reported only 75% satisfaction after shoulder arthroplasty at 11 years.

In the present study, failure was defined as patient dissatisfaction with the results of a previous shoulder arthroplasty, which prompted a consultation with our shoulder service. Our hypotheses were that (1) many of these patients will not have had the type of complications traditionally defined in the literature, (2) the shoulder function of these patients will be poor, and (3) certain characteristics will be common to these cases of failure. Identifying these characteristics may provide insight for optimizing patient satisfaction after arthroplasty in the future.

Table I SST

Function	% Unable
Comfort at side	50
Sleep comfortably	82
Tuck in shirt (M)	78
Hand behind head (M)	81
Place coin on shelf (S, M)	73
Lift pint to shoulder level (S)	76
Lift gallon to head level (S)	92
Carry twenty pounds	66
Toss softball underhand	80
Throw softball overhand	94
Wash opposite shoulder (M)	91
Allow regular work	80

M, Questions relating to shoulder mobility; *S,* questions relating to shoulder strength.

MATERIALS AND METHODS

The study cohort included 139 consecutive patients who were seen by the senior author during a 5-year period from August 1994 through July 1999 with complaints related to a shoulder arthroplasty. Demographic and clinical factors were inventoried for all patients at initial presentation. All patients underwent a careful physical examination. Deficits in motion, strength, stability, and smoothness (eg, a complaint of crepitus, popping, snapping, grinding, or catching) were noted and recorded. A standard set of radiographs consisting of true anteroposterior and axillary views and a full-length anteroposterior radiograph of the humerus was available for evaluation in all patients. These were compared with previous radiographs, when available, and examined for evidence of glenoid or humeral component loosening, tuberosity nonunion, component malposition, dislocation or subluxation, obvious glenoid erosion or glenoid polyethylene wear, periprosthetic fracture, and the presence of heterotopic bone. For those 107 shoulders that underwent revision surgery, intraoperative findings were used to support or augment the findings identified on clinical and radiographic examination. These findings included glenoid or humeral component loosening, nonunion, rotator cuff tear, and component malposition.

Each patient characterized his or her shoulder function at initial presentation using a standardized inventory of 12 shoulder functions, the simple shoulder test (SST) (Table I).[3,15-18] Responses to 3 SST questions addressing strength and 4 questions addressing motion were tallied separately to provide self-assessment data on shoulder strength and mobility.

To complement this self-assessment of shoulder function, patients also completed the short form–36 (SF-36), a standardized general health status questionnaire.[12,13,19,29] The SF-36 data were stratified into 8 domains and then normalized with respect to age- and sex-matched control subjects.[26] The SST and SF-36 instruments complement one another; shoulder-specific instruments have been shown to reflect different dimensions of the patient's status than general health assessments.[12]

Analysis of data

The demographic and clinical factors associated with failed prosthetic hemiarthroplasty and total shoulder arthroplasty were determined. These factors included age, sex, number of previous surgeries, time since arthroplasty, number of comorbidities, and underlying diagnosis. Appropriate nonparametric statistical tests were used to determine the relationship of these factors to the SST data at the time of presentation to us, including Fisher exact, Mann-Whitney *U*, Spearman correlation, and Kruskal-Wallis tests. All statistical analyses were conducted at the $\alpha = .05$ level of significance with the use of StatView (Abacus Concepts, Inc, Berkeley, Calif), a commercially available statistical software package, running on a Macintosh personal computer (iMac-PC; Apple Corporation, Cupertino, Calif).

RESULTS

One hundred thirty-nine consecutive patients were evaluated with a total of 144 failed arthroplasties during the study interval. Neither relevant transcripts nor self-assessment data could be located for 3 patients (3 shoulders), so they were excluded from subsequent analyses. Of the remaining 136 patients (141 shoulders), 74 were men and 62 were women; the mean age was 62.3 years (range, 27.9-87.3 years) (Table II). One hundred ten patients were right-handed, 14 left-handed, and 5 ambidextrous; data on handedness were not available for the remaining 7 patients. The dominant extremity was involved in 61.5%. One hundred ten patients were noted to have at least 1 comorbidity (mean ± SD, 2.0 ± 1.8; range, 0-9).

Our analysis included 141 shoulders with failed arthroplasties. Sixty-four were hemiarthroplasties and 74 were total shoulder arthroplasties; the remaining 3 failures included 1 bipolar and 2 constrained implants. The indication for the initial arthroplasty (Figure 1) was primary osteoarthritis in 39 shoulders, cuff-tear arthropathy in 16, post-traumatic arthritis in 12, capsulorrhaphy arthropathy in 10, osteonecrosis in 8, rheumatoid arthritis in 6, and postseptic arthritis in 2. Thirty-seven implants (twenty-six percent) had been placed for the treatment of a proximal humeral fracture or its late sequelae such as malunion or nonunion, 30 of which were hemiarthroplasties. The initial diagnosis could not be ascertained for 8 shoulders. Sex and diagnosis were strongly associated ($P < .0001$): women accounted for 28 of 37 fractures and men for 29 of 39 cases of primary osteoarthritis, 8 of 10 cases of capsulorrhaphy arthropathy, and all 15 cases of post-traumatic arthritis.

A total of 137 procedures (range, 1-8) had been performed on 73 shoulders (52%) prior to the failed arthroplasty. Thirty shoulders had undergone at least one revision arthroplasty before presentation. In 26 cases the senior author had performed the previous arthroplasty; in the remaining cases it had been done

Table II Demographic data

	All shoulders*	Hemiarthroplasties	Total shoulder arthroplasties
No.	141	64	74
Men	78	21	54
Women	63	43	20
Age (SD) (y)	62.4 (13.8)	63.2 (14.4)	61.5 (13.5)
Comorbidities (SD)	2.0 (1.8)	2.2 (2.0)	1.9 (1.6)
Diagnosis			
Osteoarthritis	39	8	31
Osteonecrosis	8	4	4
Cuff-tear arthropathy	16	11	5
Capsulorrhaphy Arthropathy	10	2	8
Post-traumatic arthritis	12	5	7
Rheumatoid arthritis	6	2	4
Fracture	37	30	7
Septic arthritis	2	1	1
Previous surgeries (SD)†	1.0 (1.3)	0.9 (1.2)	1.1 (1.5)

*Including 1 bipolar prosthesis and 2 constrained prosthesis.
†Not including failed arthroplasty.

elsewhere. The date of the most recent arthroplasty could be determined with reasonable certainty for 123 of the 141 shoulders. The longevity of the arthroplasty before failure ranged from 28 days to 21.2 years (mean, 3.6 ± 4.2 years). Thirty-seven shoulders failed within 1 year after arthroplasty.

At initial evaluation, 116 shoulders (82%) were painful. However, all but 9 manifested at least 1 clinical finding other than pain; 5 of those 9 were hemiarthroplasties with radiographic evidence of glenoid erosion, and another one was a total shoulder with intraoperative evidence of glenoid polyethylene wear and delamination. Results of rotator cuff and deltoid isometric strength testing were not available for 21 of 141 shoulders, but evidence of substantial weakness (grade 4 or less) of either rotator cuff or deltoid was identified in 74 shoulders (52%). The finding of either a rotator cuff tear or tuberosity nonunion was highly correlated with weakness on strength testing ($P = .0008$).

We considered 13 different possible characteristics of failed arthroplasty (Table III, Figure 2). The average shoulder had 2.5 of these characteristics (range, 0-6). In 111 (79%) at least 2 characteristics of failure were identified (Figure 3).

One hundred four (seventy-four percent) of the shoulders were stiff and 49 (35%) were unstable by examination and radiographic assessment. Of 141 shoulders (23%), 33 had at least 1 substantially malpositioned component identified by radiography or surgery. Stiffness, instability, and malposition frequently coexisted (Figure 4); further analysis revealed that component malposition and shoulder instability were highly correlated ($P = .006$).

Of the 74 failed total shoulder arthroplasties, the glenoid components were loose in 44 (59%). Other characteristics identified in this group included stiffness in 51 (69%), instability in 26 (35%), component malposition in 21 (28%), glenoid polyethylene wear in 15 (20%), and rotator cuff tears in 13 (18%). Humeral loosening was noted in only 8 of the total shoulder arthroplasties (11%). Glenoid loosening, stiffness, and component malposition often coexisted (Figure 5). Of 74 failed total shoulder arthroplasties, 41 (55%) demonstrated at least 2 of these characteristics, and 8 failed total shoulder arthroplasties had all 3.

Of the 64 shoulders with a failed hemiarthroplasty, substantial glenoid erosion was identified in 27 (42%). As in the failed total shoulder arthroplasties, stiffness was the most common attribute of failed hemiarthroplasty, identified in 50 of 64 shoulders (78%). Tuberosity nonunion was identified in 13 of 30 hemiarthroplasties (43%) that had been implanted for a proximal humeral fracture. Other characteristics included instability in 23 (36%), rotator cuff tears in 16 (25%), humeral head malposition in 11 (17%), and humeral loosening in 7 (11%).

In addition to the objective findings, patients demonstrated substantial deficits in shoulder function and general health. Responses at initial presentation to the SST and SF-36 were available for 131 shoulders and 132 shoulders, respectively. On average, patients could perform only 2.5 of 12 shoulder functions on the SST (Figure 6). Eighty-two percent of patients reported they could not sleep comfortably, and 30 shoulders could not perform any of the functions (Table I, Figure 6). In addition, 57% of patients answered no to all 4 questions relating to shoulder

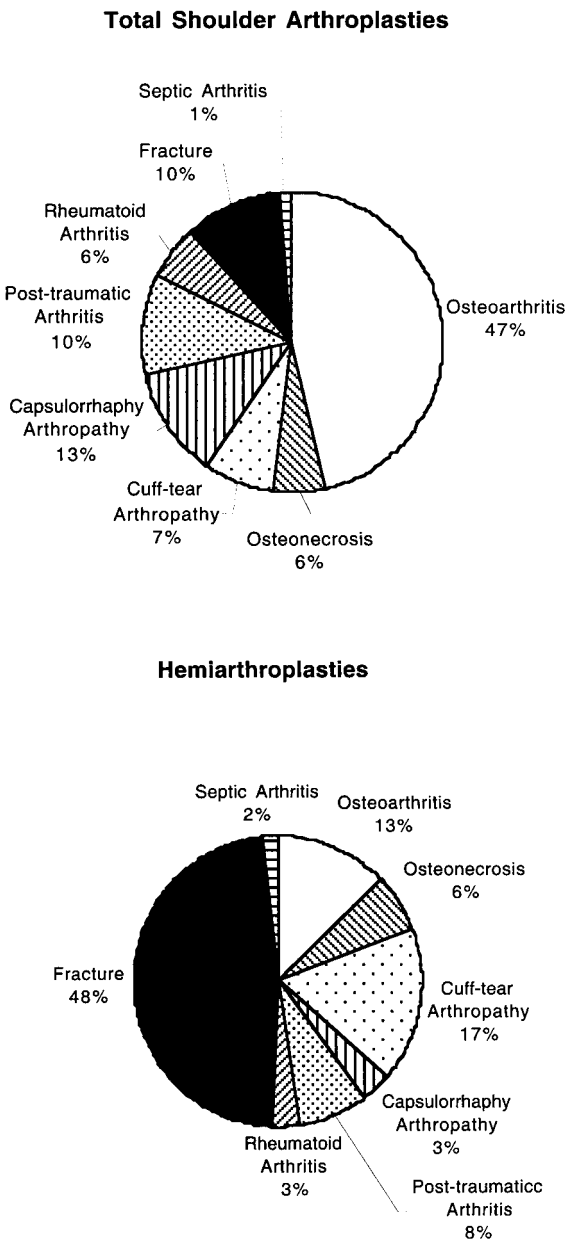

Figure 1 Number of total shoulder arthroplasties and hemiarthroplasties as a function of underlying diagnosis.

mobility, and 71% answered no to all 3 questions relating to strength.

Failure of the prosthetic shoulder arthroplasty also influenced the perception of general health. The scores for all 8 SF-36 domains were significantly lower than those of age- and sex-matched controls ($P < .0001$) (Figure 7). The normalized scores were lowest for the role of physical (23%) and pain (40%) domains and were highest for general health (87%) and mental health (86%). General health was influenced by the underlying diagnosis ($P < .05$) and was strongly correlated with the number of comorbidities ($P = .0002$).

Several clinical and demographic factors appeared to affect shoulder function at initial presentation (Table IV). Failed hemiarthroplasties had significantly worse function than failed total shoulder arthroplasties by SST: 1.7 functions compared with 3.2 ($P = .006$), even after excluding arthroplasties for fracture (1.9 functions compared with 3.3, $P < .05$). Shoulders that had undergone at least 1 surgery before arthroplasty had significantly worse function than those in which the unsatisfactory arthroplasty had been the index surgery ($P < .005$).

The underlying diagnosis significantly influenced shoulder function at presentation ($P = .007$). Function was lowest for patients with cuff-tear arthropathy (1/12 functions) and fracture (1.5/12 functions) and for the 2 patients with septic arthritis (0.5/12 functions). Shoulder function was also influenced by sex, as men performed significantly better on the SST than women (3.2 compared with 1.7, $P = .005$). When the data were stratified by underlying diagnosis, men performed better than women with an underlying diagnosis of osteoarthritis, osteonecrosis, capsulorrhaphy arthropathy, and fracture, but not cuff-tear arthropathy. Shoulder function was not influenced by patient age or number of comorbidities.

Of the 141 shoulders in this study, 107 (76%) subsequently underwent revision arthroplasty; revision surgery was being considered for 2 additional patients. Fifteen patients were treated with rehabilitation.

DISCUSSION

This study illustrates that (1) many failed arthroplasties are not associated with complications as they are usually defined in the literature, (2) the shoulders of patients dissatisfied with their arthroplasty have extremely poor function, and (3) most of the characteristics of failure are of the type that could be minimized by optimized surgical technique and perioperative management.

In an early report of the results of revision shoulder arthroplasty, Neer and Kirby[23] identified numerous causes of failure, which they grouped into preoperative, surgical, and postoperative considerations. Matsen et al[18] analyzed the results of 18 reports on total shoulder arthroplasty with a minimum 2-year follow-up. They observed a mean overall complication rate of 16% (range, 0%-62%). Furthermore, they identified the following factors, in order of decreasing frequency: component loosening, instability, rotator cuff tear, periprosthetic fracture, infection, implant failure including dissociation of a modular prosthesis, and deltoid dysfunction.[18,30] Cofield[10] also identified 8

Table III Distribution of characteristics of failure

Attribute of failure	All shoulders		Hemiarthroplasties		Total shoulder arthroplasties	
	n	%	n	%	n	%
Stiffness	104	74	50	78	51	69
Instability	49	35	23	36	26	35
Glenoid loosening	46	33	—	—	44	59
Component malposition	33	23	11	17	21	28
Rotator cuff tears	29	21	16	25	13	18
Glenoid erosion	27	19	27	42	—	—
Humeral loosening	17	12	7	11	8	11
Polyethylene wear	15	11	—	—	15	20
Nonunion	14	10	13	20	1	1
Nerve injury	6	4	6	9	0	0
Periprosthetic fracture	5	4	1	2	4	5
Infection/hematoma	5	4	1	2	4	5
Heterotopic bone	2	1	2	3	0	0

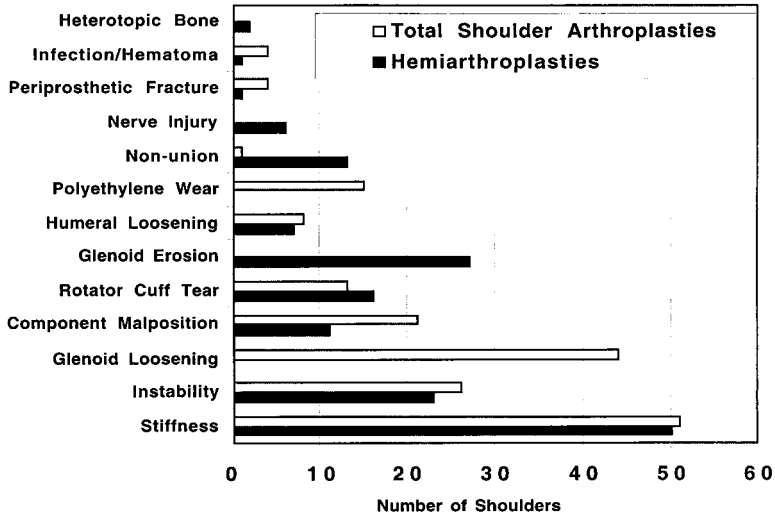

Figure 2 Distribution of characteristics of failure.

major complications after shoulder arthroplasty, in order of decreasing frequency: instability, rotator cuff tear, heterotopic ossification, glenoid component loosening, intraoperative fracture, nerve injury, infection, and humeral component loosening. On the basis of a review of 23 series comprising more than 1400 arthroplasties, he reported a 14% incidence of complications. This list of complications has been recently expanded to 23 different complications of total shoulder arthroplasty and 19 different complications of hemiarthroplasty.[11] Overall, the incidence of complications after total shoulder arthroplasty and hemiarthroplasty was 10.4% and 15.7%, respectively.[11]

Thirteen characteristics of failure were identified for the 141 arthroplasties in this study: stiffness, instability, rotator cuff tear, nonunion of the tuberosities or surgical neck, glenoid component loosening, glenoid erosion, glenoid polyethylene wear, component malposition, humeral component loosening, periprosthetic fracture, infection, nerve injury, and heterotopic bone (Table III). Deltoid dysfunction was also observed in several shoulders but was not analyzed separately. As in previous reports by Neer and Kirby[23], Wirth and Rockwood,[30,31] and Wirth et al.,[32] more than 1 attribute of failure was present in most cases. Some characteristics of failure were tightly coupled, such as component malposition and instability. Other characteristics were infrequently noted, such as periprosthetic fracture, infection, nerve injury, and heterotopic bone. Pain and weakness were 2 of the 3 most common clinical findings, but these were considered expressions of failure and not primary characteristics of failure.

The distribution of the characteristics of failure for

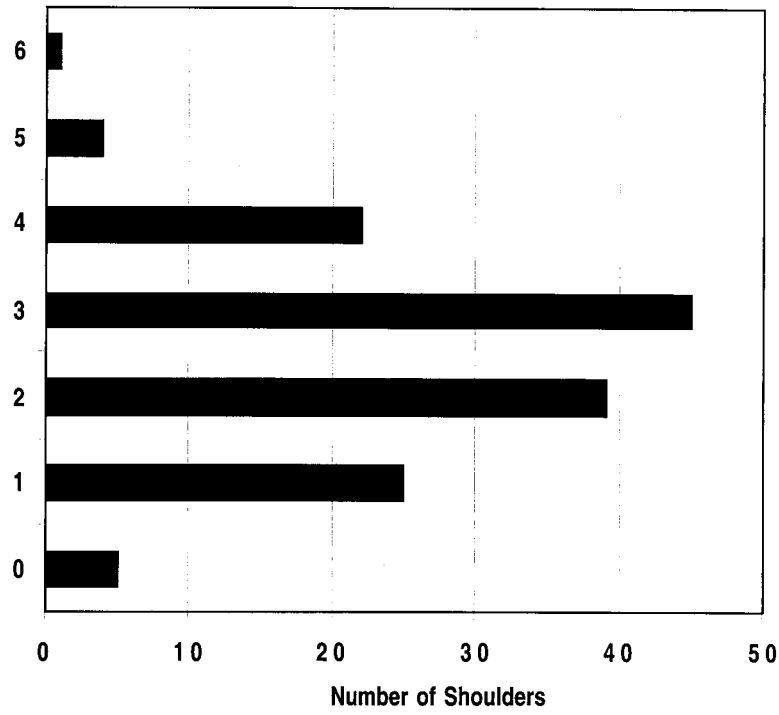

Figure 3 Number of characteristics of failure.

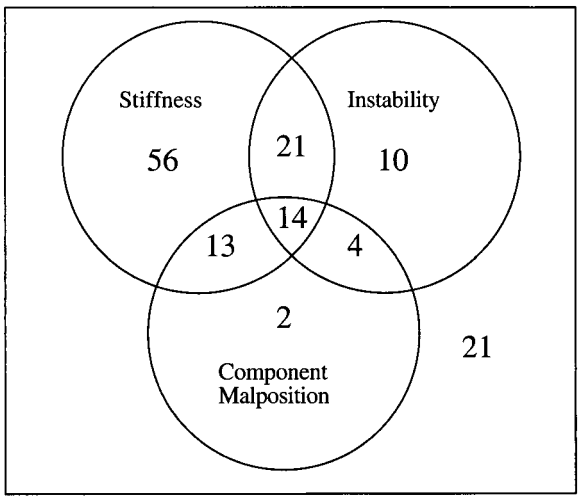

Figure 4 Coexistence of stiffness, instability, and component malposition among failed arthroplasties.

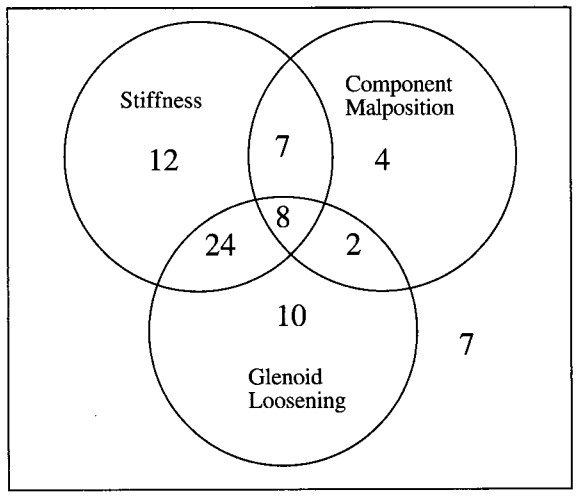

Figure 5 Coexistence of glenoid loosening, component malposition, and instability among failed total shoulder arthroplasties.

both total shoulder arthroplasty and hemiarthroplasty was compared with the distribution reported in other published series of at least 20 failed implants (Tables V and VI). Stiffness was the most common attribute of failure, contributing to nearly three fourths of the failures. Neer[22] described the most common causes of failure as "deltoid scars and detachment, tight subscapularis tendon with loss of external rotation. . .and an inadequate exercise program causing adhesions." Petersen and Hawkins[25] have also noted that stiffness is frequently associated with a failed shoulder arthroplasty. In a review by Cofield,[11] stiffness was one of the least common complications, accounting for only 1 of 123 complications after total shoulder arthroplasty and only 1 of 78 complications after hemiarthroplasty.

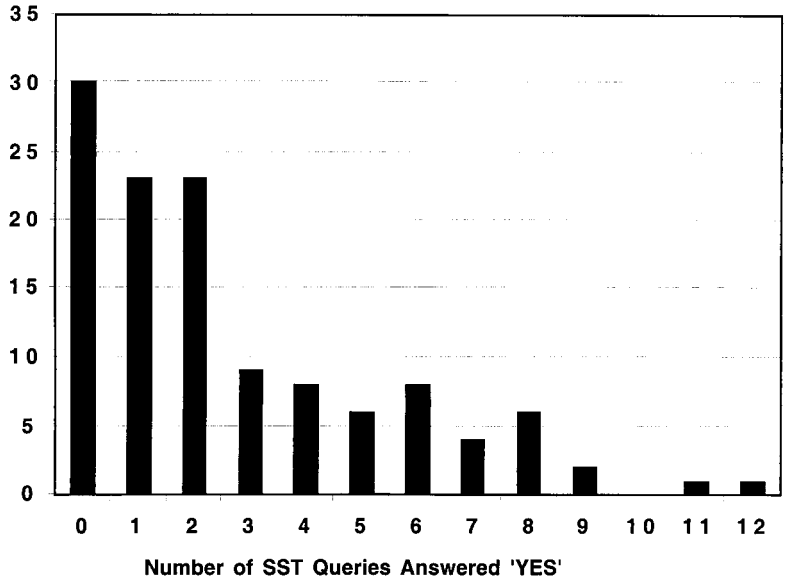

Figure 6 Distribution of responses to SST.

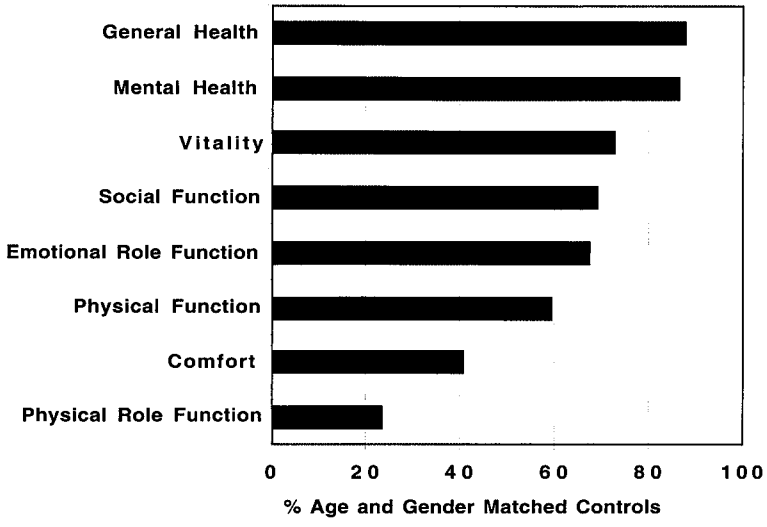

Figure 7 Influence of failed shoulder arthroplasty on general health status.

Other than stiffness, instability and rotator cuff tear were the most common characteristics of prosthetic shoulder arthroplasty failure in this study. However, the presentation of instability varied markedly, from the shoulder with chronic anterosuperior escape or fixed dislocation presenting as stiffness, to the subtle discomfort and dysfunction that result from imprecise soft-tissue balancing and component positioning. Instability after shoulder arthroplasty has been reported as having an incidence as high as 35%[18] and as comprising as much as 38% of all complications.[30,31] Barrett et al[2] reviewed 140 total shoulder arthroplasties retrospectively in patients with rheumatoid arthritis and found that of the 10 shoulders that developed complications, 2 resulted from fixed dislocation of the humeral component. Moeckel et al[20] reported on 10 of 236 total shoulder arthroplasties performed for various diagnoses that were complicated by instability. Anterior dislocation was often attributed to subscapularis failure, and posterior dislocation was attributed to excessive retroversion of the glenoid and/or humeral components. All underwent revision surgery within 1 year after arthroplasty. The authors concluded "that proper balancing of the soft tissues

Table IV Factors influencing total SST score

	Mean (SD)
All patients	2.5 (2.7)
Sex	
Men	3.2 (3.0)*
Women	1.7 (2.0)
Implant	
Hemiarthroplasties	1.7 (1.8)
Total shoulder arthroplasties	3.2 (3.1)†
Previous surgery	
No	3.1 (2.9)‡
Yes	1.8 (2.2)
Diagnosis§	
Osteoarthritis	3.7 (3.3)
Osteonecrosis	3.1 (2.9)
Cuff tear arthropathy	1.1 (1.4)
Capsulorrhaphy arthropathy	4.1 (3.2)
Post-traumatic arthritis	2.8 (2.7)
Rheumatoid arthritis	3.7 (3.3)
Fracture	1.4 (1.4)
Septic arthritis	0.5 (0.7)

*P = .005, compared with women.
†P = .006, compared with hemiarthroplasties.
‡P = .005, compared with no previous surgeries.
§Significant effect of diagnosis on total SST score (P = .007, Kruskal-Wallis test).

and positioning of the prosthetic components are essential to a successful arthroplasty."[20]

Among the failed hemiarthroplasties, the prevalence of glenoid erosion indicates that leaving the glenoid unaltered may not always provide a durable solution for the patient. Thus, concerns exist about the durability of prosthetic glenoid arthroplasty, as well as the longevity of the glenoid in hemiarthroplasty, exist. The predisposing factors for glenoid erosion after hemiarthroplasty need further study.

The incidence of rotator cuff tears after total shoulder arthroplasty is estimated to be 2%.[18] However, symptoms are usually minimal, reflecting the natural progression of cuff disease. Rotator cuff tears complicating hemiarthroplasty are even more difficult to evaluate, as many hemiarthroplasties are implanted in shoulders that are cuff-deficient or have sustained tuberosity fracture.

Among the failed total shoulder arthroplasties, glenoid component loosening was second only to stiffness among characteristics of failure and was identified in more than half of the shoulders. In some cases, glenoid component loosening was identified radiographically, but in the majority of cases, it was identified at the time of revision surgery. Matsen et al[18] concluded that loosening is the most common problem encountered with prosthetic shoulder arthroplasty. A review of the results of total shoulder arthroplasty from 5 centers known for their experience in shoulder arthroplasty revealed a 32% incidence of progressive glenoid loosening.[18]

Several recent follow-up studies have also demonstrated a disturbingly high incidence of glenoid component loosening. Sperling et al[27] identified radiolucent lines adjacent to 59% of glenoid components at patients' most recent follow-up. Torchia et al[28] analyzed 89 total shoulder arthroplasties at a mean follow-up of 12 years and found radiolucencies around 75 glenoid components (84%). Although the relationship between progressive radiolucent lines and symptomatic glenoid loosening remains unclear, they reported definite radiographic loosening around 39 glenoid components (44%), as well as a disconcertingly powerful association between glenoid component loosening and pain. In our study, pain was a ubiquitous feature of failure so that, with the numbers available, no meaningful association with component loosening could be established.

The prevalence of glenoid component failure in total shoulder arthroplasty, whether by loosening or by wear, points to the need for additional consideration of methods for increasing the reliability and durability of the glenoid aspect of shoulder arthroplasty. Limitations of space and volume within the joint, difficulties in glenoid exposure, the intolerance of components for rim loading, challenges of glenoid orientation, seating and fixation at the time of surgery, limited glenoid bone stock, material and structural challenges of glenoid component manufacture and sterilization, and the effect of the heat of curing bone cement on the glenoid bone all affect the surgeon's ability to achieve an ideal glenoid arthroplasty. In a sense, it is ironic that most of the work in improving shoulder arthroplasty has been directed at the humeral component while the majority of patients' problems concern the glenoid side of the equation.

Although stiffness was the most common attribute of failure, it was the second most common symptom, pain being more common. However, isolated pain, occurring in the absence of other symptoms or physical findings, was identified in only 9 shoulders, and unexplained pain accounted for only 3 of the 141 failures. These findings are comparable to those of Cofield[11]: 3 cases of unexplained pain among 123 complications after total shoulder arthroplasty and a single case of unexplained pain after hemiarthroplasty.

The clinical expression of failure was unrelated to patient age and number of comorbidities, but it was related to the number of previous surgeries. In a study by Neer and Kirby[23] of 40 failed arthroplasties undergoing revision, 14 (35%) had undergone 1 to 6 procedures prior to the failed arthroplasty. In our study, patients who had undergone 2 or more shoulder surgeries had lower SST scores than those whose failed arthroplasty had been their first shoulder surgery. Bigliani et al[5] have speculated that the outcome

Table V Comparison of publications regarding characteristics of failure (complications) among total shoulder arthroplasties

	Total shoulder arthroplasty			
	Neer[22]	**Cofield[11]**	**Cofield**	**This study**
No. of failures	22	—	—	74
Total No. of characteristics identified	22	152	123	187
Stiffness	—	—	1%	69%
Instability	—	54%	15%	35%
Glenoid loosening	9%*	13%	12%	59%
Component malposition	9%	—	6%	28%
Rotator cuff tear	14%	22%	19%	18%
Humeral loosening	—	6%	3%	11%
Polyethylene wear	—	—	—	20%
Nonunion	9%	1%	2%	1%
Nerve injury	—	7%	6%	0%
Periprosthetic fracture	9%	—	15%	5%
Infection/hematoma	9%	5%	6%	5%
Heterotopic ossification	—	—	1%	0%

*Excluding cases of glenoid component fracture (23%).[10]

Table VI Comparison of publications regarding characteristics of failure (complications) among hemiarthroplasties

	Hemiarthroplasty				
	Bonutti and Hawkins[6]	**Bigliani et al[4]***	**Muldoon and Cofield[21]***	**Cofield**	**This study**
No. of failures	12	29	—	—	64
Total No. of characteristics identified	—	61	49	78	157
Stiffness	—	—	—	1%	78%
Instability	38%	17%	24%	18%	36%
Component malposition	—	24%	6%	—	17%
Rotator cuff tear	46%	—	12%	12%	25%
Glenoid erosion	54%	—	18%	15%	42%
Humeral loosening	—	41%	6%	4%	11%
Nonunion	—	52%	8%	12%	20%
Nerve injury	—	31%	—	10%	9%
Periprosthetic fracture	—	—	6%	5%	2%
Infection/hematoma	—	14%	12%	9%	2%
Heterotopic ossification	—	—	—	1%	3%

*Hemiarthroplasty for fracture.[10]

of prosthetic shoulder arthroplasty is inversely related to the number of previous shoulder surgeries.

The clinical expression of failure appeared to relate to the underlying diagnosis. Patients with a failed arthroplasty for postseptic arthritis, cuff-tear arthropathy, or fracture had a lower score on the SST than other groups. Not surprisingly, the clinical expression of the failed hemiarthroplasties, most of which had been implanted for cuff-tear arthropathy or fracture, was significantly worse than that of the failed total shoulder arthroplasties. General health was influenced by the underlying diagnosis and was lowest among patients with rheumatoid arthritis, postseptic arthritis, and fracture. With the numbers available, the remaining 7 SF-36 domains were not significantly influenced by underlying diagnosis.

Arthroplasties performed for the treatment of acute or chronic proximal humeral fractures accounted for nearly half of the failed hemiarthroplasties in this study. Multiple characteristics of failure were often noted, such as stiffness, tuberosity nonunion, component malposition, and glenoid erosion. These findings echo the report of Bigliani et al,[4] in which multiple causes of failure could be identified in 68% of patients who had undergone hemiarthroplasty for a proximal humeral fracture. Specifically, tuberosity displacement or malunion and component malposition were the most common findings, occurring in 59% and 42% of shoulders, respectively.[4] Humeral loosening, instability, glenoid erosion, nerve injury, heterotopic bone, and sepsis were also noted. Muldoon and Cofield[21] reported 49 complications in 83 hemiarthroplasties for fractures; these were further stratified as follows: 13 complications in 28 hemiarthro-

plasties performed for acute fractures and 36 complications in 55 hemiarthroplasties performed for chronic fractures.

As shown in Tables V and VI, the distribution of the characteristics of failed shoulder arthroplasties differs from that reported by other authors. This may be attributed to differences in how complication and failure are defined or to differences in how characteristics such as loosening or stiffness are defined. In addition, some of the studies determine the distribution of characteristics of failure with respect to an overall population encompassing both failed and successful arthroplasties. In contrast, all patients in this study had a failed arthroplasty, and any patient dissatisfied with a previous shoulder arthroplasty was included, regardless of who had performed the surgery or when and where it had been performed.

This study differs from traditional follow-up studies of shoulder arthroplasty. It is recognized that most shoulder arthroplasties are performed by surgeons performing only 1 or 2 a year.[14] Arthroplasties performed by the occasional shoulder surgeon are unlikely to find their way into published follow-up studies. Because 115 of the 141 shoulders in this study had their original surgery performed outside major centers of shoulder surgery, it may be more representative of the general experience. A shortcoming of this study is that we do not know the total number of shoulder replacements performed by the surgeons whose cases are represented. Thus, the incidence of failure for these surgeons cannot be determined.

Patient dissatisfaction after prosthetic shoulder arthroplasty is nearly always coupled with severely limited shoulder function. This functional deficit appears to be most pronounced after hemiarthroplasty for fracture. Shoulder pain and stiffness are by far the most common presenting complaints of patients who are dissatisfied with the results of shoulder arthroplasty, but instability, rotator cuff tears, and glenoid erosions in shoulders with a hemiarthroplasty and glenoid polyethylene wear and loosening in the total shoulder arthroplasties are frequently encountered as well. Many of the unsatisfactory shoulder arthroplasties did not meet the criteria for failure traditionally used in published series. In this series the number of revisions was less than the number of failures.

The challenge of achieving patient satisfaction after arthroplasty may be even greater than previously recognized. The recognition that dissatisfaction may be related to technical and mechanical problems with the arthroplasty suggests that further attention needs to be directed at understanding the factors that contribute to a functionally excellent shoulder arthroplasty. When coupled with the limited improvement reported for revision arthroplasty,[8,18,22,23] our findings underscore the importance of achieving a successful primary arthroplasty. Optimizing component position, tuberosity fixation, glenoid resurfacing, and postoperative mobilization may lead to increased patient satisfaction after shoulder arthroplasty. Another potentially important source of dissatisfaction, not addressed in this study, is that the expectations of the patient and, perhaps those of the surgeon, may not always be realistic in view of the limitations of the procedure and the constraints imposed by the condition being treated.

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