Characterizing the Functional Improvement After Total Shoulder Arthroplasty for Osteoarthritis

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CHARACTERIZING THE FUNCTIONAL IMPROVEMENT AFTER TOTAL SHOULDER ARTHROPLASTY FOR OSTEOARTHRITIS

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Background: Both shoulder surgeons and patients who are considering total shoulder arthroplasty are interested in the anticipated improvement in shoulder comfort and function after the procedure. The purpose of the present study was to characterize shoulder-specific functional gains in relation to preoperative shoulder function and to present this information in a way that can be easily communicated to patients who are considering this surgery.

Methods: We analyzed the preoperative and follow-up shoulder function in patients managed with total shoulder arthroplasty for the treatment of primary glenohumeral osteoarthritis. Functional self-assessments were available for 102 (80%) of 128 shoulders after thirty to sixty months of follow-up. Outcome was assessed with respect to the change in the number of shoulder functions that were performable, the change in shoulder function as a percentage of the preoperative functional deficit, and the change in the ability to perform specific shoulder functions.

Results: The average number of shoulder functions that were performable improved from four of twelve preoperatively to nine of twelve postoperatively ($p < 0.01$). Function improved in ninety-six shoulders (94%). The number of functions that were performable at the time of follow-up was positively associated with preoperative shoulder function ($p < 0.05$): the better the preoperative function, the better the follow-up function. The improvement in function was greatest for shoulders with less preoperative function ($p < 0.01$). On the average, patients regained approximately two-thirds of the functions that had been absent preoperatively. Significant improvement was noted in eleven of the twelve shoulder functions that were examined ($p < 0.01$). The chance of regaining a function that had been absent before surgery was 73%, whereas the chance of losing a function that had been present before surgery was 6%. Older men tended to have greater functional improvement than younger men.

Conclusion: Total shoulder arthroplasty for the treatment of primary glenohumeral osteoarthritis significantly improves shoulder function. Postoperative function is related to preoperative function. The improvement that was observed in this clinical series can be conveyed to patients most simply by stating that, after surgery, shoulders typically regained approximately two-thirds of the functions that had been absent preoperatively.

In spite of the numerous reports concerning the outcomes of shoulder arthroplasty[1-13], shoulder surgeons lack an effective way of communicating the likely result of surgery to prospective patients. Scores or improvements on various scales carry little meaning for patients. Our goal was to document the outcomes of total shoulder arthroplasty in terms of specific functional improvements that might be more easily understandable to patients considering this procedure.

Materials and Methods

Between January 1, 1993, and December 31, 1997, one surgeon (F.A.M. III) performed 128 consecutive total shoulder arthroplasties for the treatment of primary glenohumeral osteoarthritis in 114 patients. Fourteen patients (12%) had a bilateral procedure. There are three possible approaches for the evaluation of patients who are managed with a bilateral shoulder procedure: (1) to select one shoulder at random, (2) to average the results for the two shoulders, and (3) to include the results for both shoulders. We selected the latter approach so that we could include every shoulder in the study. Eighty-seven patients were men, and twenty-seven were women. Patients evaluated their shoulder function before surgery and at six-month intervals after surgery with use of the Simple Shoulder Test, a standardized questionnaire with items re-

TABLE I Age and Functional Characteristics of the Shoulders According to the Gender of the Patients*

	Male (N = 82)	Female (N = 20)
Age *(yr)*		
20-29	1	–
30-39	–	–
40-49	10	–
50-59	26	5
60-69	42	30
70-79	20	50
80-89	2	15
Number of shoulder functions performable before surgery		
0-3	37	65
4-7	50	30
8-12	13	5

*The values are expressed as percentages.

lated to twelve shoulder functions. This twelve-item functional inventory has been demonstrated to have discriminant construct validity, to be reproducible, and to be responsive to changes in shoulder function resulting from therapeutic interventions[5,6,9,12-19]. We selected this method of functional assessment because it is the simplest instrument that has been validated for the shoulder. Longer assessment tools take additional time for completion and analysis and, as such, they are less practical for use in the context of a busy office practice. Furthermore, the "yes" or "no" format of this questionnaire, while a simplification, also makes it easier to communicate the results to patients.

Since the functional questionnaire has two specific questions regarding shoulder comfort, we did not perform an additional assessment of shoulder pain before and after surgery. We also did not ask questions regarding satisfaction, which tends to reflect the patient's impression of the process of care rather than its effect on shoulder function. Finally, we did not ask questions regarding the patient's impression of the relief of symptoms since that would require the patient to remember the condition of the shoulder three to five years previously.

Because this functional assessment tool previously has been demonstrated to be reproducible when the patient's condition is not changing[14], we did not include multiple preoperative assessments. Shoulders were classified into three groups on the basis of their preoperative ability to perform the twelve functions. Preoperatively, forty-three of the 102 shoulders that were ultimately included in the study could perform zero to three functions, forty-seven could perform four to seven functions, and twelve shoulders could perform eight to ten functions. No shoulder could perform more than ten functions before surgery.

All of the procedures were performed by the same surgeon, and a consistent protocol was used before, during, and after surgery. At the time of surgery, emphasis was placed on normalizing the normal position and orientation of the articular surfaces, on ensuring sufficient soft-tissue laxity, on secure fixation, and on robust subscapularis reattachment. A consistent prosthesis (Global; DePuy, Warsaw, Indiana) with a tapered humeral body was press-fit into the canal with use of humeral head autograft to ensure fit and fill. A pegged glenoid component was secured to the glenoid with minimal pressurized cement that was injected into the fixation holes after they were dried with a carbon dioxide spray. Continuous passive motion was begun immediately after surgery and was continued for the forty-eight to seventy-two-hour period of hospitalization. Patients conducted their own rehabilitation programs after receiving instruction from the surgeon and the therapist.

We chose to analyze only the 102 shoulders (80%) for which thirty to sixty-month follow-up data were available. Eighty-two of these shoulders were in men, and twenty were in women. If data from multiple follow-up intervals in this time-frame were available for an individual shoulder, the results were averaged. The rationale for averaging the data was that we wanted to have the best possible representation of the patient's self-assessed functional status within the selected follow-up interval without biasing the choice toward the first or last assessment within the interval. Several outcome variables were analyzed: (1) the number of functions

TABLE II Age and Gender-Adjusted Outcomes of Total Shoulder Arthroplasty in Relation to Preoperative Shoulder Function

Outcome	0-3 Functions Performable Before Surgery* (N = 43)	4-7 Functions Performable Before Surgery* (N = 47)	8-10 Functions Performable Before Surgery* (N = 12)	P Value†
Number of functions performable after surgery	8.5 (7.7-9.4)	9.7 (8.9-10.5)	10.7 (9.0-12.3)	<0.05
Change in number of functions performable	6.7 (5.8-7.5)	4.6 (3.7-5.4)	1.9 (0.3-3.6)	<0.01
Improvement *(% of preoperative functional deficit)*	67.7 (55.2-80.2)	65.3 (53.5-77.1)	59.0 (35.4-82.6)	NS

*The values are expressed as the average, with the 95% confidence interval in parentheses. †NS = not significant.

TABLE IV Thirty to Sixty-Month Outcomes for Male Patients According to Age and Preoperative Shoulder Function*

Outcome	0-3 Functions Performable Before Surgery	4-6 Functions Performable Before Surgery	8-12 Functions Performable Before Surgery
Number of functions performable after surgery			
50-59 years old	8.7 (0.5)	9.7 (0.5)	10.5 (0.8)
60-69 years old	9.2 (0.5)	10.3 (0.4)	11.0 (0.8)
70-79 years old	9.8 (0.6)	10.9 (0.6)	11.6 (0.9)
Change in number of functions performable			
50-59 years old	6.5 (0.5)	4.5 (0.5)	1.7 (0.9)
60-69 years old	7.2 (0.5)	5.0 (0.4)	2.2 (0.9)
70-79 years old	7.7 (0.6)	5.5 (0.6)	2.7 (0.9)
Improvement *(% of preoperative functional deficit)*			
50-59 years old	69 (8)	65 (7)	56 (12)
60-69 years old	77 (7)	73 (6)	64 (12)
70-79 years old	85 (9)	81 (8)	72 (13)

*The values are given as the average, with the standard error in parentheses.

preoperative shoulder function.

Overall, the number of functions that were performable improved significantly, from an average (and standard error) of 4.2 ± 2.6 preoperatively to 9.3 ± 3.1 postoperatively ($p < 0.01$). The total number of shoulder functions that were performable improved in ninety-six shoulders (94%).

Table II indicates that, after adjustment for age and gender, the function at the time of follow-up was greater for shoulders with better preoperative function ($p < 0.05$), the improvement in the number of functions was greater for shoulders with worse preoperative function ($p < 0.01$), and the percentage of lost function regained was not significantly related to the preoperative shoulder function. Six shoulders (6%) had a decrease in the number of functions that were performable: four shoulders lost the ability to perform one function, one lost the ability to perform two functions, and one lost the ability to perform six functions. One of the four shoulders that lost the ability to perform one function was in a patient who had been diagnosed with Parkinson disease during the follow-up period.

Table III shows the percentage of shoulders that regained each of the twelve shoulder functions if it had been absent preoperatively. Significant improvement was noted for eleven of the twelve functions ($p < 0.01$); the likelihood of regaining each of these lost functions was >50%. Of the 797 functions that had been absent in the 102 shoulders before surgery, 582 were regained; thus, the overall likelihood of regaining a lost function was 73%. Table III also shows the percentage of shoulders that lost each of the twelve functions if it had been present preoperatively. For example, all of the thirty-one shoulders that had been uncomfortable with the arm at the side before surgery were comfortable with the arm at the side after surgery. However, four (6%) of the seventy-one shoulders that had been comfortable with the arm at the side before surgery were uncomfortable with the arm at the side after surgery. Of the 427 functions that had been present in the 102 shoulders before surgery, twenty-six were lost after surgery; thus, the likelihood of losing a function that had been present before surgery was 6%.

Table IV shows the regression-predicted outcomes for the shoulders of male patients according to age and preoperative shoulder function. Postoperative function, the change in the number of functions that were performable, and the percentage of lost function that was regained were greater for older patients than for younger ones.

Discussion

When considering a shoulder arthroplasty for the treatment of osteoarthritis, patients often ask questions such as (1) "How much better will my shoulder be?", (2) "In what ways will my shoulder be improved?", and (3) "What are the chances that my shoulder will lose the function it currently has?" The results of the present study suggest the following answers: (1) "In our experience, patients similar to you have regained approximately two-thirds of the shoulder functions that were absent before surgery," (2) "In our experience, patients similar to you have usually regained the ability to rest comfortably with their arm at their side, to sleep comfortably, to tuck in their shirt, to put their hand behind their head, to lift various weights in front of them, to carry weight at their sides, to wash the opposite shoulder, to throw, and to do their usual work. The chance of regaining one of the specified lost functions is about 70%," and (3) "It is possible that a shoulder like yours may lose the ability to perform some of the functions that were possible before surgery. The chance of losing one of the specified functions that was present before surgery is about 6%."

We also noted that the shoulders of older male patients improved more than those of younger male patients. This re-

sult is consistent with the findings reported by Sperling et al., who noted that patients who were younger than fifty years old had less satisfactory results than did older individuals[10].

The application of our data has several important limitations. Our data were derived from only one practice and, as such, may not be generalizable to all practices. Even in this series, thirty to sixty-month follow-up data were available for only 80% of the shoulders, raising the possibility that the results for the twenty-six shoulders that were excluded may have been different from those for the 102 shoulders that were included. When a patient had a bilateral shoulder arthroplasty, both shoulders were included, as the present study was designed around the preoperative and postoperative status of each shoulder rather than around patients. The twelve functions that were assessed in this study do not represent the full spectrum of shoulder function. Factors extrinsic to the shoulder may have affected the patients' self-assessment of their shoulder function. None of these limitations, however, diminish the value of this attempt to present information in a way that allows patients to incorporate it into their decision-making regarding the treatment of osteoarthritis.

Many previous studies have documented functional improvement following shoulder arthroplasty[1,2,5,7,8,10-13]. The emphasis of the present study was to relate shoulder function after surgery to that before surgery and to present this information in a way that can be easily communicated to patients who are considering this surgery.

In this study, total shoulder arthroplasty for the treatment of primary glenohumeral osteoarthritis substantially improved the patients' self-assessments of shoulder function. Postoperative function was better in patients who had had a higher level of preoperative function, the improvement in function was greater in patients who had had a lower level of preoperative function, and older men had greater functional improvement than did younger men. Shoulders achieved approximately two-thirds of the maximal possible improvement, regardless of preoperative level of function. There was a small but definite risk of loss of one of the specified functions that had been present preoperatively. The presentation of these data to patients considering shoulder arthroplasty for the treatment of glenohumeral osteoarthritis should be straightforward, and the information should be easily understood. ■

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