

QUALITY-OF-LIFE OUTCOME FOLLOWING HEMIARTHROPLASTY OR TOTAL SHOULDER ARTHROPLASTY IN PATIENTS WITH OSTEOARTHRITIS

A PROSPECTIVE, RANDOMIZED TRIAL

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Background: Both total shoulder arthroplasty and hemiarthroplasty have been used commonly to treat severe osteoarthritis of the shoulder; however, their effect on disease-specific quality-of-life outcome is unknown. The purpose of this study was to compare the quality-of-life outcome following hemiarthroplasty with that following total shoulder arthroplasty in patients with osteoarthritis of the shoulder.

Methods: Forty-two patients with a diagnosis of osteoarthritis of the shoulder were randomized to receive a hemiarthroplasty or a total shoulder arthroplasty. One patient died, and all others were evaluated preoperatively and at six weeks and three, six, twelve, eighteen, and twenty-four months postoperatively with use of a standardized format including a disease-specific quality-of-life measurement tool (Western Ontario Osteoarthritis of the Shoulder [WOOS] index), general shoulder rating scales (University of California at Los Angeles [UCLA] shoulder scale, Constant score, and American Shoulder and Elbow Surgeons [ASES] evaluation form), general pain scales (McGill pain score and visual analogue scale), and a global health measure (Short Form-36 [SF-36]). When a patient required revision of a hemiarthroplasty to a total shoulder arthroplasty, the last score before he or she “crossed over” was used for the analysis.

Results: Significant improvements in disease-specific quality of life were seen two years after both the total shoulder arthroplasties and the hemiarthroplasties. There were no significant differences in quality of life (WOOS score) between the group treated with total shoulder arthroplasty and that treated with hemiarthroplasty (90.6 ± 13.2 and 81.5 ± 24.1 points, respectively; $p = 0.18$). The other outcome measures demonstrated similar findings. Two patients in the hemiarthroplasty group crossed over to the other group by undergoing a revision to a total shoulder arthroplasty because of glenoid arthrosis.

Conclusions: Both total shoulder arthroplasty and hemiarthroplasty improve disease-specific and general quality-of-life measurements. With the small number of patients in our study, we found no significant differences in these measurements between the two treatment groups.

Level of Evidence: Therapeutic Level I. See Instructions to Authors for a complete description of levels of evidence.

Although not as prevalent as osteoarthritis of the hip or knee, osteoarthritis of the shoulder has been demonstrated, in cadaver and radiographic studies, to affect up to 32.8% of patients over the age of sixty years (ten [20%

of fifty¹, thirty-four [28.6%] of 119², and twenty-three [33%] of seventy³). While only a subset of patients is symptomatic, many have pain, crepitus, loss of motion, and loss of function^{4,6}. There is a wide range of treatment modalities for osteoarthritis of the shoulder (e.g., analgesics, nonsteroidal anti-inflammatory drugs, physiotherapy, arthroscopic débridement, arthrodesis, etc.), but arthroplasty remains the standard treatment for advanced osteoarthritis^{5,6}.



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It has been estimated that more than 10,000 shoulder arthroplasties are performed annually in the United States. This figure represents an exponential increase during the past forty years⁷. Total shoulder arthroplasty has been shown to be as cost-effective as total hip or knee arthroplasty for improving quality of life, as assessed by determining quality-of-life-adjusted years^{8,9}.

Recent reviews have focused on what is arguably the most contentious and yet fundamental issue in shoulder arthroplasty: whether total shoulder arthroplasty or hemiarthroplasty is preferable for the treatment of osteoarthritis of the shoulder¹⁰⁻¹³. This controversy exists for several reasons. First, both total shoulder arthroplasty and hemiarthroplasty may achieve good short-term and mid-term results¹⁴⁻²⁸. Second, while total shoulder arthroplasty may provide slightly superior and more reproducible pain relief, this must be balanced against the technical difficulties of inserting a glenoid prosthesis and the long-term durability of glenoid prostheses in terms of loosening and wear²⁹⁻³⁷. Alternatively, despite good early and mid-term results with hemiarthroplasty, glenoid arthrosis and the need for revision to total shoulder arthroplasty have been demonstrated after longer-term follow-up^{38,39}. Finally, both procedures are associated with a relatively high rate of complications^{7,38-42}.

Recently, several studies have compared the results of hemiarthroplasty with those of total shoulder arthroplasty for the treatment of osteoarthritis of the shoulder^{29,31-34,36,43}. While hemiarthroplasty and total shoulder arthroplasty were evaluated in a comparative or randomized fashion in each of these studies, we are not aware of any assessments of the patient's perspective of his or her quality of life, an important determinant of the success of treatment⁴⁴.

The purpose of the current study was to compare the effectiveness of hemiarthroplasty with that of total shoulder arthroplasty for the treatment of osteoarthritis of the shoulder. Our primary outcome measure was disease-specific quality of life as measured with the Western Ontario Osteoarthritis of the Shoulder (WOOS) index, which has been determined to be valid, reliable, and highly responsive in this patient population⁴⁵.

Materials and Methods

Study Design

We performed a prospective, randomized, double-blind clinical trial at a single university center with three orthopaedic surgeons. Each patient was randomly assigned to be treated with either a total shoulder arthroplasty or a hemiarthroplasty. Both the patient and an independent evaluator remained blinded to the group assignment for the duration of the study.

Consent

The study protocol was reviewed and approved by the institutional research ethics review board. All patients provided written informed consent.

Justification of Sample Size

The sample size was estimated with use of an equation appropriate for comparing two independent group means⁴⁶ (see

Appendix) and was based on a two-sided alpha level of 0.05 having 80% power to detect a 30% change in the McGill pain score. The McGill pain score, a validated pain-rating scale, was used to estimate sample size because, when this study was initiated, the WOOS index, although available for use, had not been fully validated. It was validated and published in 2001⁴⁵ (see Appendix).

Patient Population

The patients included in the study had a diagnosis of primary osteoarthritis of the shoulder, had a failure of a minimum of six months of nonoperative treatment (including analgesics, anti-inflammatory medication, and physiotherapy), and wished to have surgical intervention. Primary osteoarthritis of the shoulder was defined as shoulder pain; no history of major trauma, infection, osteonecrosis, cuff tear arthropathy, chronic dislocation, or a secondary cause of osteoarthritis; and radiographic evidence of joint space narrowing, osteophyte formation, and/or subchondral sclerosis.

Exclusion criteria included a condition other than shoulder osteoarthritis that would substantially contribute to shoulder dysfunction (e.g., cervical spine disease), a rotator cuff tear (>1 cm), inflammatory arthritis, post-capsulorrhaphy osteoarthritis, a major medical illness that would substantially influence quality of life (e.g., unstable angina), an active infection, substantial muscle paralysis, and a lack of fitness for surgery or an unwillingness to be followed for two years. All patients underwent a standardized preoperative assessment by a physician and a research assistant. Preoperative radiographs (anterior and posterior glenohumeral joint, transscapular lateral, and axillary views) and a computed tomography scan of the affected shoulder were made prior to the surgery.

Randomization

Patients were stratified according to surgeon. Randomization was performed intraoperatively. After it was confirmed that the patient had primary osteoarthritis as well as good-quality glenoid bone stock that was adequate for the performance of either a hemiarthroplasty or a total shoulder arthroplasty, a sealed envelope containing the randomly assigned treatment-group allocation was opened by the circulating nurse.

Surgical Intervention

A Neer Series-II modular total shoulder prosthesis or hemiarthroplasty (3M Modular Shoulder System; 3M Canada, London, Ontario, Canada) was implanted in all patients. Radiographic templating was performed preoperatively for all patients to estimate the size of the prosthesis, but the final implant was determined intraoperatively with the use of trial implants. Preoperative prophylactic antibiotics were given to all patients, and all procedures were performed with the patient under general anesthesia. A deltopectoral approach was used to expose the glenohumeral joint, and the integrity of the rotator cuff, as assessed by direct visualization and palpation, was documented. The subscapularis was completely released to achieve maximum external rotation of the shoulder. The re-

lease was achieved through resection of the anterior and inferior aspects of the capsule and release of the coracohumeral ligaments so that excursion of the subscapularis tendon was limited only by the muscle tension.

The humerus was prepared, according to the manufacturer's instructions, with progressive intramedullary reaming. The humeral osteotomy was performed with the use of an intramedullary guide at approximately 30° of retroversion. The proximal part of the humerus was broached and reamed, and the humeral prosthesis was sized appropriately.

In each patient, the glenoid was exposed and the severity of glenoid arthritis was documented. The version of the glenoid and the amount of posterior erosion were confirmed intraoperatively and were compared with their appearance on preoperative radiographs and computed tomography scans. No attempt was made to alter the glenoid anatomy in the patients being treated with a hemiarthroplasty. If a glenoid prosthesis was to be implanted, the glenoid was formally exposed. We did not exclude any patient because of glenoid morphology or posterior glenoid erosion, and eccentric glenoids were included in both groups.

For the total shoulder arthroplasty, eccentric reaming was performed as necessary to allow the implantation of the glenoid component in the center of the glenoid, parallel to the neck and in the appropriate version. A slot was made in the glenoid to accommodate the glenoid component and to allow for cement interlock. Next, the glenoid was irrigated and was dried with thrombin-soaked gauze (Thrombostat [100 units/mL]; Pfizer, Arnprior, Ontario, Canada), and the component was cemented into place with thumb pressurization.

The size of the humeral head was chosen to adequately cover the humeral osteotomy site and to restore the height of the humeral head, soft-tissue tension, and approximately 50% translation anteriorly and posteriorly. The humeral component was press-fit when possible. When adequate press-fit fixation could not be obtained, the humeral component was

cemented with use of vacuum cement mixing, a distal cement restrictor, retrograde filling of the shaft, and cement pressurization. The subscapularis was closed with number-2 Ethibond suture (Ethicon, Somerville, New Jersey) to allow a minimum of 30° of external rotation. Patients with <30° of external rotation had the subscapularis transferred medially to the osteotomized humeral neck.

Postoperative Care

A sling was applied with the arm at the side. Active-assisted range-of-motion exercises were begun on the first postoperative day in the hospital, with emphasis on forward elevation and external rotation. External rotation was limited according to the intraoperative assessment of the tension of the subscapularis repair and was usually 30°. An active range of motion was allowed at four weeks postoperatively, and strengthening exercises were begun at eight weeks postoperatively. The patient's return to normal activities progressed as tolerated over three to six months.

Outcomes

A research assistant who was blinded to the treatment group performed a standardized assessment of all patients preoperatively; at six weeks postoperatively; and at three, six, twelve, eighteen, and twenty-four months postoperatively. At each evaluation, the patients completed a disease-specific quality-of-life instrument (Western Ontario Osteoarthritis of the Shoulder [WOOS] index)⁴⁵, general shoulder assessment instruments (University of California at Los Angeles [UCLA] shoulder scale¹⁴, Constant score⁴⁷, and American Shoulder and Elbow Surgeons [ASES] evaluation form⁴⁸), general pain scales (McGill pain score and visual analogue scale)⁴⁹, and a global health measure (Short Form-36 [SF-36])⁵⁰. The range of motion was extracted from the range-of-motion domain of the Constant shoulder scale.

The primary outcome measure was the WOOS (see Ap-

TABLE I Preoperative Age, Gender, and Scores on the Questionnaires

	Hemiarthroplasty*	Total Shoulder Arthroplasty*	P Value
Age (yr)	70.3 ± 7.3	70.4 ± 9.0	0.89
Male:female (no.)	8:13	10:10	0.60
Score (points)			
McGill pain questionnaire	16.0 ± 10.6	12.5 ± 9.4	0.71
McGill pain visual analogue scale	65.2 ± 24.3	65.0 ± 20.9	0.85
Short Form-36 (SF-36) mental component scale	55.5 ± 11.8	51.4 ± 14.7	0.42
Short Form-36 (SF-36) physical component scale	29.5 ± 7.6	31.3 ± 8.4	0.45
Range of motion	13.7 ± 7.2	13.4 ± 9.5	0.97
American Shoulder and Elbow Surgeons (ASES) evaluation form	31.1 ± 16.6	30.7 ± 19.5	0.98
Constant score	30.7 ± 14.2	28.7 ± 16.4	0.77
University of California at Los Angeles (UCLA) shoulder rating scale	12.6 ± 3.5	13.2 ± 3.9	0.60
Western Ontario Osteoarthritis of the Shoulder (WOOS) index	33.5 ± 19.7	31.4 ± 17.7	0.95

*The values (except for gender) are given as the mean and one standard deviation.

TABLE II WOOS Scores Before and Two Years After Shoulder Arthroplasty in Entire Series

	Preop.*	Postop.*	P Value
Total quality of life	32.4 ± 18.4	87.2 ± 18.3	<10 ⁻¹⁴
Domain			
Physical symptoms	34.3 ± 20.5	80.5 ± 25.0	<10 ⁻¹⁴
Sports/recreation/work	27.0 ± 23.9	86.0 ± 19.8	<10 ⁻¹¹
Lifestyle	25.4 ± 20/7	91.9 ± 14.4	<10 ⁻¹³
Emotions	44.5 ± 29.1	85.9 ± 18.8	<10 ⁻¹⁶

*The values are given, in points, as the mean and one standard deviation.

pendix), which is a patient-generated, self-evaluated, disease-specific tool for measurement of the quality-of-life of patients with osteoarthritis of the shoulder. The WOOS has proven to be valid, reliable, and highly responsive in that patient population⁴⁵. Each question is answered on a visual analogue scale, and the possible scores range from 0 to 1900. For simplicity of presentation, the raw scores from each domain and the total WOOS score can be converted to a percentage of a normal score, out of 100. A score of 0 therefore signifies that the patient had an extreme decrease in the shoulder-related quality of life, whereas a score of 100 signifies that the patient had no decrease in the shoulder-related quality of life.

Data Analysis

Paired two-tailed t tests were used to compare differences between preoperative and two-year postoperative scores for both groups. Unpaired two-tailed t tests were used to assess differences between groups, and analysis of covariance was used as well with adjustment for the baseline value of the outcome measure. Three analyses were conducted on the two-year postoperative data. The first was an intention-to-treat analysis in which all patients, regardless of further treatment (i.e., crossover), remained in their original group. The second analysis was an efficacy analysis in which the subjects who eventually crossed over into the other group were dropped from the analysis. The third was a conservative efficacy analysis in which the patient's last score before he or she crossed over to the other treatment group was identified and carried forward through the remaining evaluations. A p value of <0.05 was considered significant.

Results

Demographic Data

Forty-two patients were enrolled in the study. One patient died from a thromboembolism two days postoperatively and was excluded from the analysis of the data. Data were therefore collected on forty-one patients; twenty-one in the hemiarthroplasty group and twenty in the total shoulder arthroplasty group.

Subjects

Baseline variables are summarized in Table I. There were no significant differences between the groups in terms of age, gender, or preoperative range of motion or functional status.

Intraoperative Findings

All patients had osteoarthritis of the glenohumeral joint that was confirmed intraoperatively. No patient was excluded because of an inability to insert a glenoid component. One patient in the hemiarthroplasty group had a full-thickness 1-cm tear of the supraspinatus tendon, which was repaired. The rotator cuffs of the remaining patients were intact. The humeral stem was press-fit in thirty patients (fourteen in the hemiarthroplasty group and sixteen in the total shoulder arthroplasty group) and cemented in eleven (seven in the hemiarthroplasty group and four in the total shoulder arthroplasty group). The mean operative time (and standard deviation) was 118.4 ± 38.6 minutes for the hemiarthroplasty group and 157.3 ± 33.0 minutes for the total shoulder arthroplasty group (p < 0.002).

TABLE III Two-Year WOOS Scores Following Hemiarthroplasty and Total Shoulder Arthroplasty

	Hemiarthroplasty*	Total Shoulder Arthroplasty*	P Value
Total quality of life	81.5 ± 24.1	90.6 ± 13.2	0.18
Domain			
Physical symptoms	82.7 ± 23.5	91.9 ± 12.8	0.17
Sports/recreation/work	75.2 ± 28.9	86.1 ± 20.8	0.21
Lifestyle	82.5 ± 25.4	89.7 ± 13.8	0.31
Emotions	87.1 ± 23.7	97.0 ± 4.6	0.11

*The values are given, in points, as the mean and one standard deviation.

TABLE IV Secondary Outcome Scores Before and Two Years After Shoulder Arthroplasty in Entire Series

Evaluation Tool	Preop.*	Postop.*	P Value
McGill pain questionnaire	11.2 ± 10.01	1.8 ± 4.2	<10 ⁸
McGill pain visual analogue scale	49.2 ± 22.6	10.1 ± 20.6	<10 ⁻¹³
Short Form-36 (SF-36) mental component scale	52.1 ± 13.2	57.9 ± 10.0	0.28
Short Form-36 (SF-36) physical component scale	30.3 ± 7.9	42.5 ± 12.0	<10 ⁻⁷
Range of motion	10.3 ± 8.3	28.0 ± 8.8	<10 ⁻⁸
American Shoulder and Elbow Surgeons (ASES) evaluation form	23.4 ± 18.0	87.0 ± 20.1	<10 ⁻¹⁷
Constant score	22.7 ± 15.3	68.9 ± 18.4	<10 ⁻¹⁷
University of California at Los Angeles (UCLA) shoulder rating scale	9.6 ± 3.7	25.4 ± 4.4	<10 ⁻¹⁵

*The values are given, in points, as the mean and one standard deviation.

Outcomes

Two patients from the hemiarthroplasty group crossed over to the total shoulder arthroplasty group; one did so at twelve months and the other, at eighteen months postoperatively.

All results were obtained at the two-year follow-up evaluation.

The results presented in this paper were derived from the conservative efficacy analysis, in which the patient's last score before he or she crossed over was identified and carried forward through the remaining evaluations. The overall results of the intention-to-treat and efficacy analyses were not significantly different from those of the conservative efficacy analysis (see Appendix).

Disease-Specific Quality of Life

At the two-year follow-up evaluation, both groups demonstrated significant improvement in the disease-specific quality of life ($p = 0.000$) as measured by all four domains of the WOOS (Table II). However, with the numbers available for the study, there was no significant difference between the hemiarthroplasty and total shoulder arthroplasty groups in terms of the overall WOOS score ($p = 0.18$) or the scores for any of the domains of the WOOS (Table III).

Secondary Outcomes

Similar to the WOOS, the UCLA shoulder rating scale, ASES shoulder evaluation form, and Constant score showed significant improvements in global shoulder function following both types of shoulder arthroplasty (Table IV). Again, with the numbers available, there were no significant differences between the two treatment groups (Table V). The McGill pain scale, the McGill visual analogue scales (for specific domains), the physical component of the SF-36, and the range of motion demonstrated similar trends in improvement (Tables IV and V). There was, however, no significant difference between the preoperative and postoperative scores for the mental component of the SF-36.

Complications

Intraoperative Complications

Two patients in the hemiarthroplasty group had an intraoperative fracture, which involved the greater tuberosity in one patient and the humeral shaft in another. The fractured greater tuberosity was secured back to the shaft with number-5 Mersilene tape, and the patient recovered excellent external rotation strength. The humeral shaft fracture was treated with a long-stem prosthesis, bone graft from the humeral

TABLE V Two-Year Secondary Outcome Scores Following Hemiarthroplasty and Total Shoulder Arthroplasty

Evaluation Tool	Hemiarthroplasty*	Total Shoulder Arthroplasty*	P Value
McGill pain questionnaire	2.7 ± 6.8	0.9 ± 1.4	0.27
McGill pain visual analogue scale	13.9 ± 27.4	6.1 ± 13.5	0.28
Short Form-36 (SF-36) mental component scale	57.4 ± 10.9	58.4 ± 9.1	0.78
Short Form-36 (SF-36) physical component scale	42.9 ± 10.9	42.1 ± 13.2	0.84
Range of motion	26.8 ± 9.3	29.2 ± 8.3	0.40
American Shoulder and Elbow Surgeons (ASES) evaluation form	83.1 ± 25.6	91.1 ± 14.3	0.25
Constant score	67.1 ± 19.6	70.8 ± 17.2	0.55
University of California at Los Angeles (UCLA) shoulder rating scale	24.2 ± 5.0	26.7 ± 3.8	0.10

*The values are given, in points, as the mean and one standard deviation.

head, and cerclage wiring. The fracture healed uneventfully.

One patient in the total shoulder arthroplasty group had a nondisplaced fracture of the greater tuberosity, for which the treatment was similar to that for the fracture described above. The patient recovered strength without incident. A second patient in that group had a fracture of the anterior-inferior corner of the glenoid during reaming. This fracture was secured with a 3.0-mm cannulated AO screw, and bone graft from the humeral head was applied. It healed without complication.

Late Complications

Evidence of superior migration of the humeral component with rotator cuff deficiency developed in three patients in the hemiarthroplasty group. Two patients were doing well and continued to demonstrate improvements in quality of life. However, one patient had increasing pain and decreased motion and strength. Despite the disability, the patient did not wish to have more surgery.

An infection developed in one patient two weeks after a total shoulder arthroplasty. The patient was treated with two operative débridements and intravenous antibiotics for six weeks, and the infection resolved. In another patient, antero-superior instability of the prosthesis developed six months after the total shoulder arthroplasty. Although passive motion was excellent, the patient had poor active forward elevation and external rotation. Ultrasonography demonstrated massive tears of the supraspinatus and subscapularis tendons, for which the patient declined further treatment.

Analysis of Failures

Four hemiarthroplasties were considered to be failures. One patient, who is described above, had superior humeral head migration and decreased motion. Two years following the surgery, the patient demonstrated only a shoulder shrug of 30° of active forward elevation. This patient's quality of life was not substantially improved postoperatively. Progressive glenoid arthrosis developed in three other patients. They had pain that was severe enough to require a revision to a total shoulder arthroplasty, which was performed in two of them and was being considered by the third. One of the revisions was performed nineteen months after the hemiarthroplasty, and the patient had a decrease in the pain and improvements in motion and the quality of life at twelve months following this revision. The second patient had the revision surgery at approximately sixteen months after the hemiarthroplasty. This patient initially had decreased pain and an improvement in the quality of life, but the pain had increased and the quality of life had decreased by two years following the revision.

Discussion

While it was not surprising that our study confirmed that many patients with osteoarthritis of the shoulder have pain, loss of motion, and loss of function^{4,6}, it also demonstrated that osteoarthritis of the shoulder leads to more global dysfunction. Substantial impairments were noted in all four domains of the WOOS—i.e., physical symptoms, sports/recre-

ation/work, lifestyle, and emotions. Thus, shoulder osteoarthritis may substantially affect all aspects of health⁵¹, and these impairments are quantifiable⁴⁵. Importantly, these results suggest that the validity of previous assessments in which such evaluations were not performed may be limited, and they support the continued use of comprehensive disease-specific quality-of-life measurement tools in the evaluation of orthopaedic disorders⁴⁵.

Both total shoulder arthroplasty and hemiarthroplasty significantly decreased shoulder pain and improved function and quality of life. However, we found no significant difference between hemiarthroplasty and total shoulder arthroplasty with regard to any of the outcomes evaluated at two years, although there was a trend for superior results in the total shoulder arthroplasty group.

Our study differs from previous studies^{29,31,34-36,43} in several important ways. Our purpose was to measure disease-specific quality of life as it pertains to patients with osteoarthritis of the shoulder. In many of the previous studies, physician-generated questionnaires were utilized as the primary outcome measures; therefore, the items in the measurement tools are those that physicians deem to be important and not necessarily those that are important to patients. Our study was also prospective, randomized, and double-blinded (patient and evaluator), thus decreasing the bias in both the clinical assessments and the patient self-evaluations.

Whenever a study demonstrates an insignificant difference, it is important to establish the power of the investigation in order to determine if the final conclusion is valid (i.e., that there is truly no significant difference between treatment groups)⁴⁶. Our preliminary sample-size estimates were based on a group of ten patients who were assessed with the McGill pain score, a validated outcome measure, following shoulder arthroplasty. However, our post-investigation sample-size estimates, based on the same 30% difference in the McGill pain score with $\alpha = 0.05$ and $\beta = 0.20$, suggest that a sample size of 855 hemiarthroplasties and 382 total shoulder arthroplasties would be necessary to determine this difference. (It is necessary for the numbers in the two groups to be unequal because the variances of the groups are unequal; i.e., hemiarthroplasties have a larger variance than total shoulder arthroplasties.) Obviously, these numbers are much different from our pre-investigation estimates, and they were due to the wide variance in the McGill pain scores. However, the use of a highly responsive outcome measurement tool such as the WOOS index can decrease this number. For example, when the WOOS outcome data were used, the power of the study was 0.29. Although this power to detect a 30% difference in the WOOS scores is low (ideally, the power of a clinical trial should be ≥ 0.80), only eighty-six hemiarthroplasties and forty-seven total shoulder arthroplasties were expected to be needed.


A recent meta-analysis⁵² of randomized clinical trials comparing total shoulder arthroplasty with hemiarthroplasty confirmed the trends demonstrated in the current study. After two years of follow-up of 117 patients (fifty-three treated with hemiarthroplasty and sixty-four treated with total should-

der arthroplasty), the mean UCLA score following total shoulder arthroplasty (26.5 ± 4.1 points) was found to be superior to that following hemiarthroplasty (22.4 ± 5.9 points; $p < 0.0001$). In addition, the outcomes in the domains of pain and function were superior after the total shoulder arthroplasties.

Three hemiarthroplasties were considered to be failures secondary to the development of glenoid arthrosis, and two were eventually converted to a total shoulder arthroplasty. Despite these two cross-overs, there was no significant difference between the results of the intention-to-treat analysis and those of the efficacy analysis. This is because one of these patients had substantial improvement in the WOOS score (13.4 points before the revision and 67.3 points after it), whereas the other patient had a less successful revision (a WOOS score of 59.5 points before the revision and 52.4 points after it). Mixed results following revision total shoulder arthroplasty in patients with glenoid arthrosis were previously reported by Sperling and Cofield³⁸.

In conclusion, patients with osteoarthritis of the shoulder demonstrated significant impairment in the quality of life preoperatively. Total shoulder arthroplasty and hemiarthroplasty resulted in significant improvement in the quality of life in all domains of health. Although there was a trend toward superior outcomes following total shoulder arthroplasty, there was no significant difference between the two groups within the limits of the study. Longer-term follow-up is necessary to continue to evaluate disease-specific quality of life following these procedures.

Appendix

 The details of the sample-size calculation, the WOOS shoulder index, and the intention-to-treat analysis and the efficacy analysis are available with the electronic versions

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