PRE-OPERATIVE AND INTRA-OPERATIVE FACTORS RELATED TO SHOULDER ARTHROPLASTY OUTCOMES

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ABSTRACT

The purpose of this study was to analyze pre-operative and intra-operative factors that affect the outcome of shoulder arthroplasty. We undertook a retrospective review of all shoulder arthroplasties performed at our institution between 1986 and 2003. Patients were contacted and outcomes were assessed using the Simple Shoulder Test and the Western Ontario Osteoarthritis of the Shoulder Index questionnaires. One hundred six patients (126 shoulders) participated in the study. The average length of follow-up was 6 years 9 months (range 2 to 20 years). Revision arthroplasty surgery and female gender were associated with worse outcomes. Age, the number of medical comorbidities, obesity, pre-operative range of motion, prior non-arthroplasty surgery, smoking, and alcohol abuse did not correlate with outcome. Patients who had shoulder arthroplasty for osteoarthritis had better outcome scores than those with rheumatoid arthritis. For intra-operative variables, significantly worse outcomes were found both with the use of hemiarthroplasty and in patients with a rotator cuff tear identified at the time of surgery. These findings may help to optimize patient and surgery selection in shoulder arthroplasty and assist in preoperative patient counseling.

INTRODUCTION

The outcome of shoulder arthroplasty can be affected by several factors. These include patient related variables, such as the underlying etiology for glenohumeral degeneration, comorbid conditions and demographics, as well as intra-operative findings. Pre-operatively, the diagnoses most frequently encountered in advanced glenohumeral degeration include osteoarthritis (OA), rheumatoid arthritis (RA), severe proximal humerus fractures, post-traumatic degenerative arthritis, avascular necrosis and cuff-tear arthropathy. For the diagnosis of OA, multiple studies have shown that arthroplasty reliably improves pain and ROM.[2,6,17] Likewise, several studies have demonstrated that RA patients benefit from shoulder arthroplasty.[8,13,14,29] There is less information on the impact of demographics and comorbid conditions.[11]

Intra-operative findings and decisions may impact patient outcomes in shoulder arthroplasty as well, including the presence of a rotator cuff tear and whether a HA or TSA is performed. Multiple studies have suggested that a rotator cuff tear is associated with worse outcomes by both subjective and objective scores,[3,7,10,11] although other studies have not validated this finding in OA[5,12] or RA.[8] Controversy still exists regarding the superiority of TSA versus HA for the treatment of glenohumeral arthrosis from OA and RA.

Although prior studies have examined the effect of some preoperative and intra-operative factors,[4,5,7,11,12] none has simultaneously examined the effect of multiple pre-operative and intra-operative variables on outcomes in shoulder arthroplasty patients. The goal of the present study was to validate previous findings of preoperative and intraoperative factors that have been shown to affect outcome as well as attempt to delineate other characteristics of patients whose outcomes are better (or worse) after shoulder arthroplasty in a group of patients with varying etiologies of shoulder degeneration.

MATERIALS AND METHODS

Institutional Review Board Approval was obtained for the study. We searched hospital records between 1986 and 2003 for current procedural terminology (CPT) codes involving shoulder arthroplasty (23470 and 23472). A chart review was performed and underlying diagnosis, patient demographics, length of follow up, medical comorbidities, pre-operative range of motion, and prior ipsilateral shoulder surgery were recorded. Significant medical comorbidities were recorded as present or absent in a binary fashion and then summed. The impact of the total number of comorbidities on outcome was

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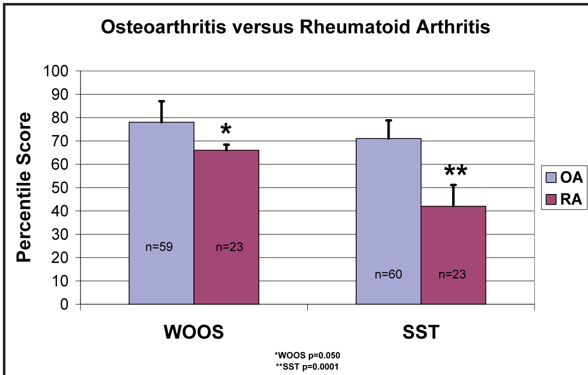

Figure 1. Osteoarthritis patients has significantly higher WOOS and SST scores compared to patients with Rheumatoid arthritis.

analyzed. The following comorbidities were recorded: chronic obstructive pulmonary disease, hypertension, heart disease (CAD, arrythmia, congestive heart failure), diabetes mellitus, tobacco abuse, alcohol abuse, Axis I psychiatric disease, and other rheumatologic disease. Patient weight, as measured by body mass index, was assessed as well, and patients were divided into normal weight (BMI less than 25), overweight (BMI greater than or equal to 25), and obese (BMI greater than or equal to 30) based on standard BMI cutoffs. For each case a chart review of the operative report was done to identify those patients who had a rotator cuff tear identified at the time of surgery. When no specific mention was made of a cuff tear the patient was recorded in the database as having an intact rotator cuff. The use of a TSA or HA was also documented.

Questionnaires and informed consent documents were sent by mail to each patient. Patients who had had bilateral shoulder arthroplasties returned separate outcomes measures for each shoulder. Each patient received and returned two outcomes questionnaires, the Simple Shoulder Test (SST) and the Western Ontario Osteoarthritis of the Shoulder Questionnaire (WOOS).[15,16]

The Simple Shoulder Test consists of 12 simple ‘yes’ or ‘no’ questions and is easy to administer and understand. It has been tested in populations of patients with multiple shoulder pathologies, including OA, RA, avascular necrosis, and rotator cuff tears.[15] It has been shown to be able to distinguish between normal shoulders and those with the previously listed conditions. In the present study SST scores were expressed as a percent of tasks that the patient could complete. A score of 50 meant that the patient could complete half of the tasks, while a score of 100 meant that the patient could complete all of the tasks with that shoulder. The WOOS is a validated questionnaire designed specifically for use in patients with OA.[16] It has been correlated with multiple other measures of shoulder function. The WOOS was chosen for these reasons and because the plurality of patients studied had OA as their primary diagnosis. As for the SST, the WOOS score has been expressed as a percent of a total best score (i.e., 100 is best possible score, 0 is lowest score possible).

Data was analyzed using the SAS statistical analysis package (v. 9.0 Cary, NC). For comparisons between two groups, we used t-test for univariate variables and Pearson’s correlation for continuous variables. T-tests were used for the analysis of revision surgery, patient sex, and individual comorbidities. T-tests were also used for paired comparison of variables after ANOVA analysis. Pearson’s correlation was used for analysis of SST and WOOS scores and patient age, length of follow-up, and range of motion. We used ANOVA for data where multiple comparisons were made, including underlying diagnosis, comorbidities, and BMI.

RESULTS

We identified 169 patients who had undergone either a HA or TSA during the study period who were still living. Six patients were mentally or physically unable to participate, leaving 163 patients. We were unable to contact 21 patients after a thorough search using hospital records and internet search databases. This left a total of 142 patients. Of those we were able to locate and contact, 106 participated in the study. Of the 106 participants, 20 had bilateral shoulder arthroplasty, for a total of 126 shoulders.

There were 43 men and 63 women. Average time to follow-up was 6.8 years (range 2-20 years).

Pre-operative Factors

The underlying diagnoses were as follows: 61 patients had primary OA, 23 had RA, 9 had acute fractures, 10 had revision of a failed HA to a TSA, 8 had cuff tear arthropathy, 5 had post-traumatic OA, 4 had osteonecrosis, 5 had revision of a prosthesis for other reasons, and one had a recurrent giant cell tumor. Outcomes were compared for patients with a diagnosis of primary OA (n=60) to patients with RA (n=23). Both WOOS and SST scores were significantly better for patients with primary OA (WOOS 78 versus 66, $p=0.05$; SST 70 versus 42, $p<0.0001$) (Figure 1). Multivariate regression of outcomes based on underlying diagnosis revealed OA patients had the best outcomes overall.

The effect of patient demographics on outcome was examined. The 54 shoulders in male patients had better outcomes than the 72 shoulders in females (WOOS 68 versus 53, $p=0.0065$, SST 75 versus 52, $p=0.0001$) (Figure 2). Neither age nor length of follow-up correlated with outcome ($p>0.05$, WOOS and SST).

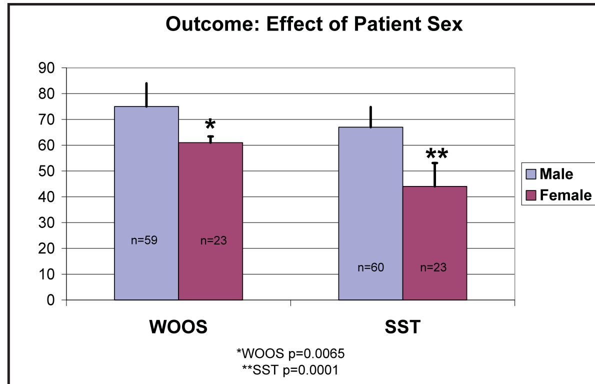

Figure 2. Males had statistically significant higher WOOS and SST scores compared with females.

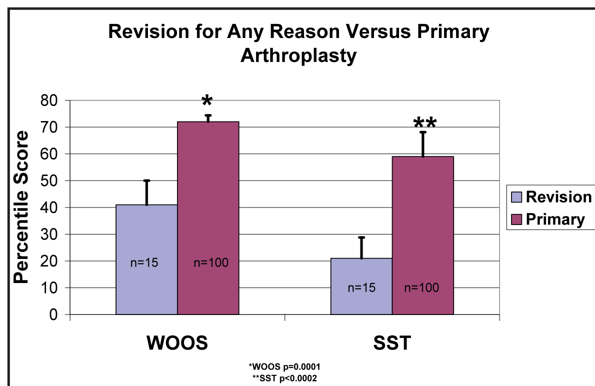

Figure 3. Primary arthroplasty patients had higher WOOS and SST scores compared to revision cases.

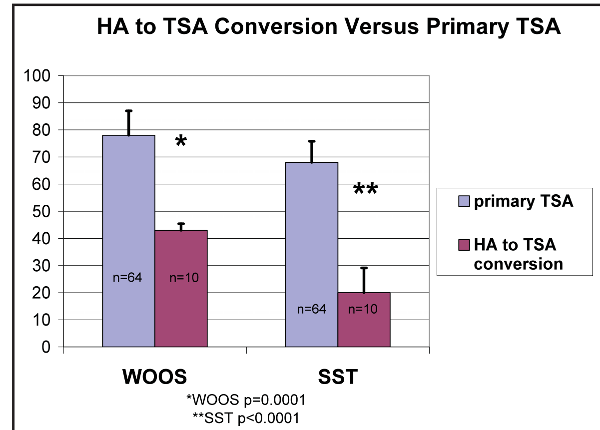

Figure 4. Patients who underwent conversion of hemiarthroplasty to total shoulder arthroplasty had worse average WOOS and SST scores compared to patients undergoing total shoulder arthroplasty as their primary procedure.

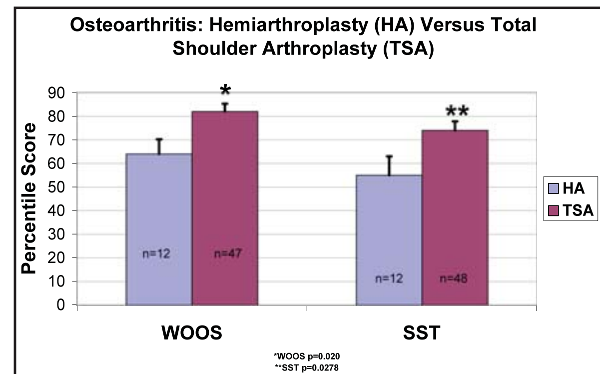

Figure 5. In patients with OA, total shoulder replacement resulted in better outcomes than hemiarthroplasty.

The total number of comorbidities ranged from 0 to 6. There was no correlation between the number of co-morbidities and outcome (p=0.63 for WOOS and p=0.77 for SST). There was no correlation between BMI and outcome (p=0.61 for WOOS and p=0.50 SST). No range of motion variable correlated with outcome (p>0.05 for all measures of ROM, WOOS and SST).

Revision surgery for any reason was analyzed as a pre-operative risk factor. Ten revisions were for glenoid arthrosis after HA and five were for other reasons. When these 15 revisions were compared with primary arthroplasty, revisions were found to do significantly worse on both the WOOS and SST (Figure 3). The mean WOOS score for revisions was 44.2 versus 70.1 for primary arthroplasty (p<0.001). Revision shoulders scored only 28 on the SST and primary arthroplasty patients 56 (p<0.001).

We compared the ten shoulders which had revisions of HA to TSA to the 64 patients who had primary TSA. These “conversion” patients had worse outcomes (Figure 4). The average WOOS score for revision HA to TSA was 43 and for primary TSA it was 78 (p=0.0001). On the SST, HA revisions scored 20 while primary TSA scored 68 (p<0.0001).

Only 8 patients in our study group had a documented *previous* rotator cuff tear (RTC) repair. There was no significant difference in outcome by either WOOS or SST between this small group of patients with a prior RTC repair and those without (p=0.58 for WOOS, p=0.58 for SST, student’s t-test). Twenty patients had had a prior non-arthroplasty surgery on the shoulder (including prior RTC repair). Compared with the remaining shoulders, these patients tended to do worse, but this was not statistically significant (WOOS [p=0.052] SST [p=0.13]).

Intra-operative Factors

Of those patients with primary OA forty-seven had TSA and twelve had HA. The TSA shoulders had better outcomes than the HA shoulders on both the WOOS (64.1 versus 81.5, p=0.050) and SST (42 versus 71, p=0.028) (Figure 5). In the 23 patients with an underly-

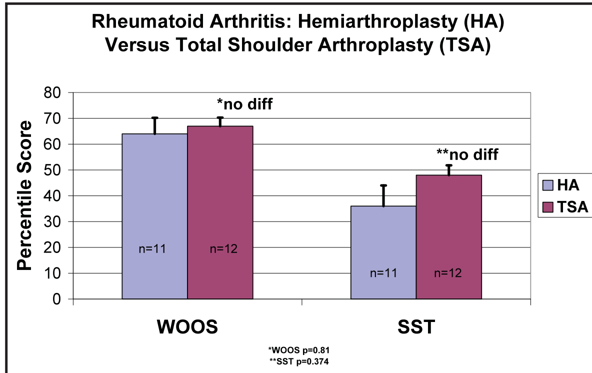

Figure 6. In patients with RA, there was no significant difference between outcomes from total shoulder replacement and hemiarthroplasty.

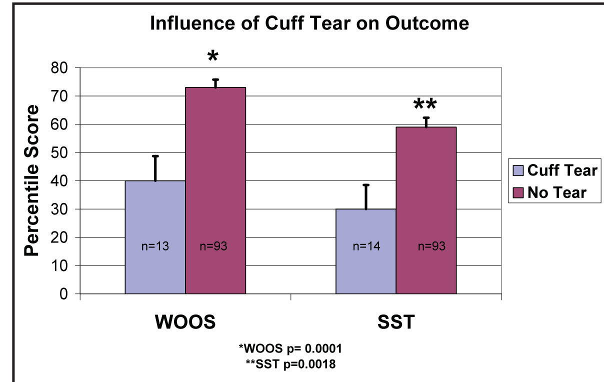

Figure 7. Patient with rotator cuff tears diagnosed at the time of surgery had worse outcomes than those without rotator cuff tears.

ing diagnosis of RA there were 12 who underwent TSA and 11 that underwent HA. There were no detectable differences between TSA and HA (p=0.81 and 0.37 for WOOS and SST, respectively) (Figure 6).

Excluding cuff tear arthropathy patients, there were 14 patients with a cuff tear and 93 where the operative note indicated the cuff was intact or no mention was made of a rotator cuff tear. The cuff tear was repaired at the surgeon's discretion. The mean WOOS score of patients with cuff tear was 40.5 versus a score of 72.8 with an intact cuff ($p<0.0001$). The SST score was 30 for those with a cuff tear and 59 for those with an intact cuff ($p<0.001$) (Figure 7).

DISCUSSION

Shoulder arthroplasty is a well-established procedure which is used for pain relief and functional improvement in multiple pathological conditions ranging from osteoarthritis to trauma. As with all surgical interventions there is variability in the subjective success and outcome of the operation. This variability is potentially reflective of variability in the pre-operative factors present in each case. Previous literature has defined some pre-operative factors predictive of outcome, including glenoid erosion, fatty degeneration of the rotator cuff, gender, and humeral head subluxation.[5,7,11,12] The present study was designed to identify other pre-operative and intra-operative factors that could be associated with outcome after shoulder arthroplasty. In our study, statistically significant worse outcome scores were found for female patients, patients with rheumatoid arthritis, and patients who were undergoing revision arthroplasty on the operative shoulder. For intra-operative variables, significantly worse outcomes were found both with the use of hemiarthroplasty and in patients with a rotator cuff tear identified at the time of surgery.

We were unable to show a significant correlation with several other demographic pre-operative factors, comorbid conditions, and preoperative clinical status measures. These included weight, number of comorbidities, smoking status, EtOH abuse, and pre-operative range of motion. The lack of correlation is in contrast to the findings of some other studies. Matsen et al reported that higher pre-operative measures of physical function, social function, and shoulder function were predictive of improved outcomes after shoulder arthroplasty.[18] Similarly, a study of arthroplasty for fracture showed a correlation between age, EtOH use, tobacco use and outcome.[23] Rozencwaig et al. found that an increased number of comorbidities correlated with poorer outcomes from total shoulder arthroplasty.[24] Our inability to identify similar correlations in our study may be due to a lack of power. Matsen et al. did find, consistent with our study, that male gender predicted improved outcomes,[18] whereas Hettrich et al. found that gender did not significantly affect outcome from hemiarthroplasty.[11]

Regarding the effect of preoperative diagnosis on outcome, our finding that RA patients had worse outcomes than OA patients is consistent with other reports. Kelly et al reported worse outcomes in their RA group undergoing total shoulder replacement, mostly related to poor elevation, compared to outcomes in their OA patients.[13] In their report on 71 hemiarthroplasties, Hettrich et al. found that patients with RA had significantly less functional improvement than those with primary degenerative joint disease.[11] We did not have preoperative functional values for comparison, but did find that postoperative WOOS and SST scores were significantly lower for RA patients than for OA patients, consistent with the studies by Kelly and Hettrich.[11,13] It should be noted, however, that in the current study and other studies on shoulder arthroplasty in RA patients,

although functional improvement is modest, the majority of patients do receive significant pain relief.

Revision surgery was also found in this study to be a significant preoperative predictor of outcome in shoulder arthroplasty patients. We found that patients undergoing revision shoulder arthroplasty had significantly poorer outcomes compared to patients undergoing primary arthroplasty procedures. Our finding is consistent with other authors, including Hettrich et al, who reported that shoulders that had not had previous surgery had greater functional improvement after hemiarthroplasty than did those that had previous surgery.[11] Bosch et al. had the same result in their analysis of primary and secondary hemiarthroplasty after fracture.[1] In addition, we looked specifically at the subgroup of revision patients who had conversion of a HA to a TSA. We found that the conversion group had statistically worse outcomes than primary TSA. This finding is useful in considering HA as a primary procedure. Many surgeons continue to recommend HA as primary treatment for OA and RA, accepting a known risk of glenoid wear. It is believed that these patients could then be converted to a total shoulder by glenoid resurfacing. Results from the present study suggest that secondary TSA to treat arthrosis from glenoid wear in hemiarthroplasty patient is inferior to a primary TSA. Sperling et al similarly reported a high incidence of unsatisfactory results in this group of patients, with 7 of 18 patients with conversion from HA to TSA found to have limited range of motion or need for a subsequent operation.[27] These findings may influence a surgeon to consider TSA as the primary procedure rather than a hemiarthroplasty in certain patients.

The relative merits of HA versus TSA for primary glenohumeral OA are debated. Some studies have shown a trend toward TSA performing better than HA at intermediate follow-up,[6,9,17,22] while at least one study did not show a difference.[21] Two randomized controlled trials showed a trend toward superiority of TSA to HA for OA, but the studies included a small number of patients.[9,17] A meta-analysis of published and unpublished randomized controlled trials showed better outcomes after TSA at minimum 2-year follow-up.[2] Our results agree with that meta-analysis, showing better outcomes for patients treated with TSA than HA in for glenohumeral OA and intact rotator cuffs. However, the modest outcome advantage of TSA as well as the risk of glenoid arthrosis from HA need to be balanced against the risk of glenoid loosening and failure in TSA at longer follow-up. Currently it is not definitely known what the best treatment is. Other patient factors should be considered, including pre-operative glenoid wear, shoulder subluxation, and activity level when making a decision about HA versus TSA.

In patients with RA, both HA and TSA have been demonstrated to improve pain and function.[8,13,14,19,25,26,28,29] No significant difference has yet been demonstrated following HA or TSA in this group of patients.[29] Consistent with that, we found no significant difference between HA and TSA in RA patients.

Multiple studies have suggested that shoulder arthroplasty in patients with a rotator cuff tear is associated with worse outcomes than in patients with intact cuffs by various measures,[3,9,10,11] although other studies have not validated this finding in OA[5,12] and RA.[8] Edwards et al. could not demonstrate a difference in Constant scores in a large cohort of shoulder arthroplasty patient with a rotator cuff tear at the time of surgery versus those who had intact rotator cuffs; the same study actually showed a superior outcome in regards to pain relief for those patients with a full-thickness tear.[5] Another recent study of 128 shoulders showed no effect of repaired rotator cuff tears on final outcome.[12] A recent study by Hettrich et al. reviewed seventy-one shoulders undergoing HA for multiple diagnoses and concluded that the presence of a rotator cuff tear predicted worse outcomes.[11] The present study also found that the presence of a rotator cuff tear at the time of shoulder arthroplasty predicted worse outcomes in a large group of combined TSA and HA patients. Regression analysis showed that among factors including OA versus RA, TSA versus HA, male versus female, and presence of a cuff tear, only a cuff tear independently correlated with outcome. The other variables affected outcome only insofar as they were related to cuff tear.

Our study is limited inherently due to its retrospective nature. In addition our results reflect subjective outcomes using validated quality of life measures focused on the shoulder. We did not collect physical examination or radiological follow up of these patients which would have provided additional important information relevant to their outcomes. We also did not have preoperative functional measures on this cohort as some of these patients are nearly 20 years from surgery and questionnaires were not standard at that time at our institution.

In summary, our study reflects the outcomes of 106 shoulder arthroplasty patients with varying preoperative factors. Female gender, revision arthroplasty, and a non-osteoarthritis diagnosis were correlated with lower outcome scores. Hemiarthroplasty and the presence of a rotator cuff tear at the time of surgery also correlated with lower outcome scores. This information can be very valuable in counseling patients who are candidates for shoulder arthroplasty and can aid in surgeons' decision making.

REFERENCES

1. **Bosch U, Skutek M, Fremerey RW, Tscherne H.** Outcome after primary and secondary hemiarthroplasty in elderly patients with fractures of the proximal humerus. *J Should Elb Surg.* 1998;7:479-484.
2. **Bryant D, Litchfield R, Sandow M, Gartsman GM, Guyatt G, Kirkley A.** A comparison of pain, strength, range of motion, and functional outcomes after hemiarthroplasty and total shoulder arthroplasty in patients with osteoarthritis of the shoulder. *J Bone Joint Surg Am*. 2005;87:1947-1955.
3. **Cofield RH.** Total shoulder arthroplasty with the Neer prosthesis. *J Bone Joint Surg Am*. 1984;66:899-906.
4. **Demirhan M, Kilicoglu O, Altinel L, Eralp L, Akalin Y.** Prognostic factors in prosthetic replacement for acute proximal humerus fractures. *J Orth Trauma*. 2003;17:181-189.
5. **Edwards TB, Boulahia A, Kempf JF, Boileua P, Nemoz C, Walch G.** The influence of rotator cuff disease on the results of shoulder arthroplasty for primary osteoarthritis. *J Bone Joint Surg Am*. 2002;84:2240-2248.
6. **Edwards TB, Kadakia NR, Boulahia A, Kempf JF, Boileau P, Nemoz C, Walch G.** A comparison of hemiarthroplasty and total shoulder arthroplasty in the treatment of primary glenohumeral osteoarthritis: Results of a multicenter study. *J Should Elb Surg*. 2003;12:207-213.
7. **Figgie HE, Inglis AE, Goldberg VM, Ranawat CS, Figgie MP, Wile JM.** An analysis of factors affecting the long-term results of shoulder arthroplasty for inflammatory arthritis. *J Arthroplasty*. 1988;2:123-130.
8. **Friedman RJ, Thornhill TS, Thomas WH, Sledge CB.** Non-constrained total shoulder replacement in patients who have rheumatoid arthritis and class-IV function. *J Bone Joint Surg Am*. 1989;71:494-498.
9. **Gartsman GM, Roddey TS, Hammerman SM.** Shoulder replacement with or without resurfacing of the glenoid in patients who have osteoarthritis. *J Bone Joint Surg Am*. 2000;82:26-33.
10. **Hawkins RJ, Bell RH, Jallay B.** Total shoulder arthroplasty. *Clin Orthop Relar Res*. 1989;242:188-194.
11. **Hettrich CM, Weldon E, Boorman RS, Parsons M, Matsen FA.** Preoperative factors associated with improvements in shoulder function after humeral hemiarthroplasty. *J Bone Joint Surg Am*. 2004; 7:1446-1451.
12. **Iannotti JP, Norris TR.** Influence of preoperative factors on outcome of shoulder arthroplasty for glenohumeral osteoarthritis. *J Bone Joint Surg Am*. 2003;85:251-258.
13. **Kelly IG, Foster IS, Fisher WD.** Neer total shoulder replacement in rheumatoid arthritis. *J Bone Joint Surg Br*. 1987;69:723-726.
14. **Koorevaar RC, Merkies NDF, de Waalk Malefijt MC, Teeuwen M, van den Hoogen FHJ.** Shoulder hemiarthroplasty in rheumatoid arthritis. *Acta Orth Scand*. 1997;68:243-245.
15. **Lippitt SB, Harryman DT, Matsen FA.** A practical tool for evaluating shoulder function: The Simple Shoulder Test. In Matsen FA, Fu FH, Hawkins RJ eds. *The shoulder: A balance of mobility and stability.* Rosemont, IL: American Academy of Orthopadic Surgeons, 1992: 501-518.
16. **Lo IK, Griffin S, Kirkley A.** The development of a disease-specific quality of life measurement tool for osteoarthritis of the shoulder: the Western Ontario Osteoarthritis of the Shoulder (WOOS) index. *Osteoarthritis and Cartilage*. 2001;9:771-778.
17. **Lo IK, Litchfield RB, Griffin S, Faber K, Patterson SD, Kirkley A.** Quality-of-life outcome following hemiarthroplasty or total shoulder arthroplasty in patients with osteoarthritis. *J Bone Joint Surg Am*. 2005;87:2178-2185.
18. **Matsen FA, Antoniou J, Rozencwaig R, Campbell B, Smith KL.** Correlates with comfort and function after total shoulder arthroplasty for degenerative joint disease. *J Should Elb Surg*. 2000;9:465-469.
19. **McCoy SR, Warren RF, Bade III HA, Ranawat CS, Inglis AE.** Total shoulder arthroplasty in rheumatoid arthritis. *J Arthroplasty.* 1989; 4:105-113.
20. **Neer CS.** Replacement arthroplasty for glenohumeral osteoarthritis. *J Bone Joint Surg Am*. 1974;56:1-13.
21. **Norris TR, Iannotti JP.** Functional outcome after shoulder arthroplasty for primary osteoarthritis. *J Should Elb Surg.* 2002;11:130-135.
22. **Orfaly RM, Rockwood CA, Esenyl CZ, Wirth MA.** A prospective functional outcome study of shoulder arthroplasty for osteoarthritis with an intact rotator cuff. *J Should Elb Surg*. 2003;12:214-221.
23. **Robinson CM, Page RS, Hill RMF, Sanders DL, Court-Brown CM, Wakefield AE.** Primary hemiarthroplasty for treatment of proximal humeral fractures. *J Bone Joint Surg Am*. 2003;85:1215-1223.
24. **Rozencwaig R, van Noort A, Moskal MJ, Smith KL, Sidles JA, Matsen FA III.** The correlation of comorbidity with function of the shoulder and health status of patients who have glenohumeral degenerative joint disease. *J Bone Joint Surg Am*. 1998;80(8):1146-53.
25. **Sneppen O, Fruensgaard S, Johannsen HV, Olsen BS, Sojbjerg JO, Andersen NH.** Total shoulder replacement in rheumatoid arthritis: proximal migration and loosening. *J Should Elb Surg.* 1996;5:47-52.

26. **Sojbjerg JO, Frich LH, Johannsen HV, Sneppen O.** Late results of total shoulder arthroplasty in patients with rheumatoid arthritis. *Clin Orthop Relat Res*. 1999;366:39-45.
27. **Sperling JW, Cofield RH.** Revision total shoulder arthroplasty for the treatment of glenoid arthrosis. *J Bone Joint Surg Am*. 1998;80:860-867.
28. **Stewart MPM, Kelly IG.** Total shoulder replacement in rheumatoid disease:7 to 13 year follow-up of 37 joints. *J Bone Joint Surg Br*. 1997;79:68-72.
29. **Trail IA, Nuttall D.** The results of shoulder arthroplasty in patients with rheumatoid arthritis. *J Bone Joint Surg Br*. 2002;84:221-1125.
30. **Woodruff MJ, Cohen AP, Bradley JG.** Arthroplasty of the shoulder in rheumatoid arthritis with rotator cuff dysfunction. *International Orthopedics*. 2003;27:7-10.