Does more “normal” shoulder motion after arthroplasty improve patient satisfaction?: Correlation of range of motion, patient-reported function, and patient satisfaction following shoulder arthroplasty.

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Dedication

To my incredible parents. Mom and Dad, thank you so much for encouraging and supporting me through a major change of direction in life and the transition to pursuing my true calling. I could not have done this without you. I could not have done anything without you.

To my fantastic husband. Caleb, I love you more than you will ever know. Thank you for always being there for me and for knowing exactly what I need (usually, a laugh). You seem to have always known I would eventually pursue medicine and have never allowed me to second-guess myself. You are my rock.

To my amazing daughter. You are the light of my life, and I cannot wait to see who you become in yours.

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Abstract

Objective and Hypothesis

The goals of this study are to address the following questions regarding shoulder arthroplasty (TSA): (a) Does restoring range of motion (ROM) lead to increased patient satisfaction? (b) How is ability to carry out activities of daily living (ADLs) influenced by ROM? (c) How does ADL performance correlate with patient satisfaction? We hypothesize that more "normal" ROM following TSA leads to increased patient satisfaction and better performance of ADLs.

Methods

Patients who underwent TSA, reverse TSA, hemiarthroplasty, or humeral head resurfacing were prospectively enrolled in a shoulder arthroplasty registry. 155 patients who had preoperative and 6-month postoperative data for ROM, patient satisfaction, and performance of ADLs were included in the study.

Results

Of these 155 shoulders, the response rate for patient satisfaction was only 82 (52.9%), with 96.8% reporting they were "satisfied or "very satisfied". Postoperative ROM was associated with patient satisfaction for forward flexion, adduction, and external rotation. This association demonstrated a "dose-response" relationship, as higher percentage of normal ROM correlated with higher satisfaction. Mean ADL scores were higher for patients who achieved normal ROM in each plane of motion. The greatest improvement in mean ADL score occurred when a patient achieved normal ROM for at least 3 of 5 measurements. There was also a significant association between improved ADL and higher patient satisfaction.

Significance

Glenohumeral arthrosis causes considerable morbidity, and rates of shoulder arthroplasty are increasing. As the predominant goals of TSA are pain relief and restoration of ROM, it is important to assess postoperative patient satisfaction. While most historic studies have

focused on measures of implant performance, interest is increasing in patient-centered outcomes. Both objective and subjective outcomes should be included in future large multicenter registries. Data collected from these registries has the potential to substantially improve success rates and longevity of shoulder arthroplasty.

Table of Contents

List of Figures and Tables

Introduction

Total shoulder arthroplasty

The total shoulder arthroplasty (TSA) is a commonly performed procedure for the treatment of severe glenohumeral osteoarthropathy. The true prevalence of shoulder arthrosis is impossible to obtain, as unlike the knee and hip, many patients are asymptomatic and arthrosis is an incidental finding in the assessment of shoulder soft tissue pathology. Also, unlike the other major joints of the human body, shoulder arthroses are more commonly attributable to coexisting abnormalities of the supportive soft tissue structures surrounding the joint, as opposed to osteoarticular destruction[1]. For this reason, the clinical course of shoulder arthrosis, and therefore specific treatment, is dependent upon the underlying etiology.

Shoulder arthroplasty may be the oldest large joint replacement in the human body, with the first documented case dating back to 1893, when Jules Emile Péan inserted a platinum cylinder with a rubber head in a 37-year-old patient suffering from tuberculosis of the shoulder (Figure 1); the prosthesis was removed two years later due to infection[2,3,4]. In the 1950s, Neer modernized the procedure and utilized it in the treatment of proximal humeral fractures[3,5,6]. Despite great advances in surgical technique and technology in the subsequent decades, including increased use of the hemiarthroplasty (replacement of the humeral head only, leaving the glenoid surface intact), outcomes following TSA in the rotator cuff-deficient shoulder were inconsistent and unpredictable at best[7,8]. While hemiarthroplasty was found to provide pain relief in glenohumeral arthropathy, Neer noted varying results in strength and function in those patients with concomitant irreparable rotator cuff tears[9,10]. Throughout the 1970s, Neer and many other surgeons explored the use of constrained prostheses for these patients[11,10]; unlike the unconstrained design of the traditional anatomic TSA prosthesis, the constrained type included a component physically connecting the humeral and glenoid components, eliminating the need to rely on musculotendinous structures to stabilize the joint.

Figure 1. First artificial shoulder joint. Illustration by Péan of his first artificial joint made of hardened rubber and platinum used in 1893[2].

Complication rates remained high, however: Cofield & Stauffer reported loosening of the prosthesis in 9%, fracture in 18%, and pain in 27% at 18 to 39 months postoperatively[12,10].

Because of the small and almost flat morphology of the glenoid, the rotator cuff is required to compress the humeral head against the glenoid, providing a fulcrum which allows the deltoid to elevate the arm. Without these encircling muscles, the humeral head is displaced toward the acromion, which often leads to painful erosions[13,7,14] (Figure 2). In rotator cuff-deficient patients, TSA has been associated with a high failure rate due to a "rocking horse" phenomenon[15]. In 1987, Grammont proposed a new type of shoulder replacement prosthesis: the reverse arthroplasty. While the conventional TSA procedure combines a large prosthetic humeral head with a concave and shallow glenoid component, Grammont's prosthesis reversed this arrangement, placing the shallow concavity on the humeral head and a large hemispheric head as the glenoid prosthesis (Figure 3). Grammont based this design on four key principles: intrinsic prosthetic stability, concavity of the supporting part and convexity of the weight-bearing part (glenoid), placing the glenosphere center at or within the glenoid neck, and a medialized and distalized center of rotation[17]. While this design corrected the issue of glenoid component loosening in cuff-deficient TSA patients, it has been noted to cause scapular neck impingement leading to inferior scapular notching (erosion of the bony glenoid). It is, however, unknown whether this phenomenon has clinical significance[18]. The reverse total shoulder arthroplasty procedure was approved by the United States Food and Drug Administration in November 2003.

The incidence of both TSA (including both the traditional anatomic procedure and the newer reverse variant) and hemiarthroplasty (replacement of a broken or diseased humeral head) in the United States increased between 1993 and 2008 (Figure 4). More than two thirds of these are performed annually on patients over the age of 65, a fact which predicts a further increase in TSA procedures when considering our aging population. Starting in 2003, there has been a relative increase in TSA over hemiarthroplasty procedures, which is likely related to the

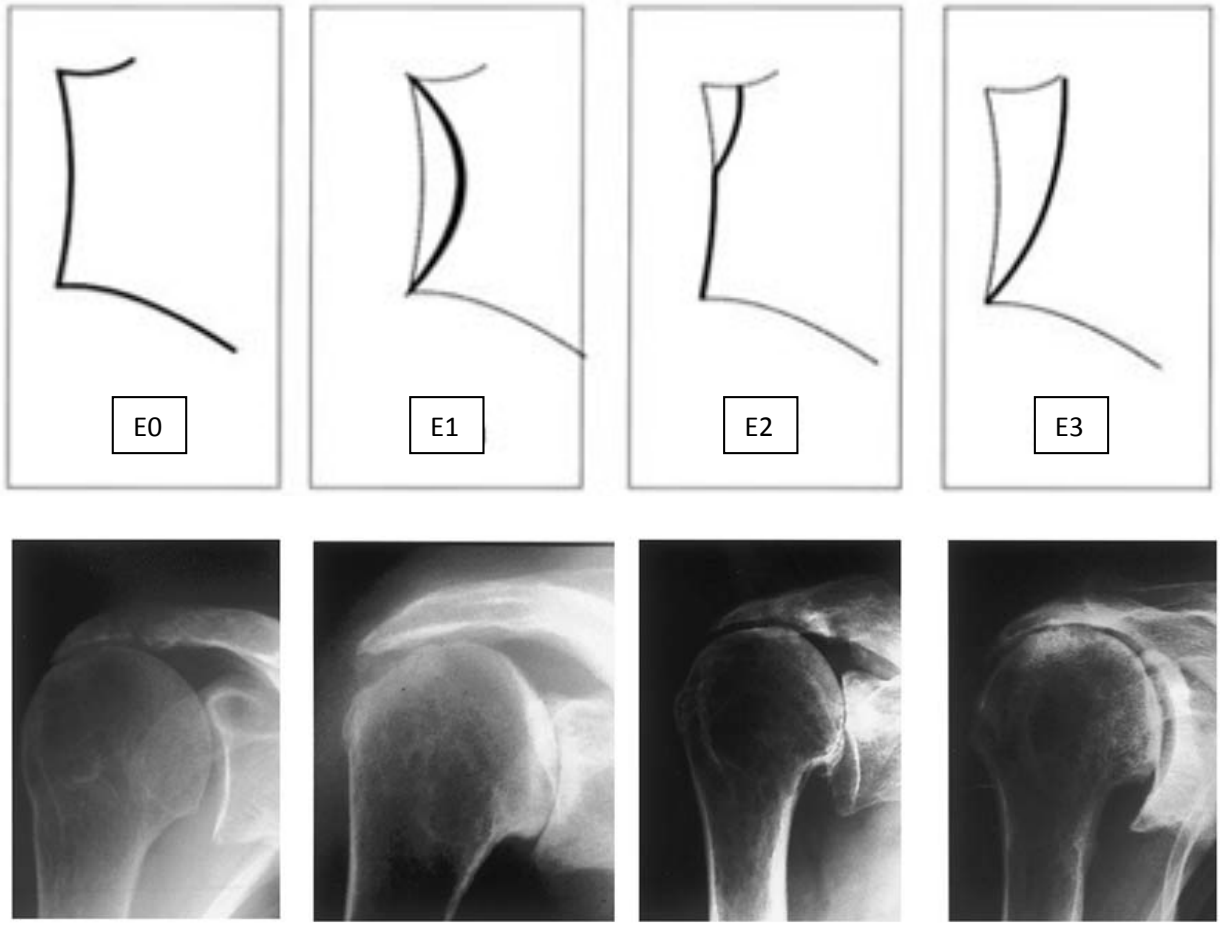

Figure 2. Glenoid erosion in osteoarthritis of the shoulder with massive rotator cuff rupture. (Top: diagrams of erosion classification. Bottom: shoulder radiographs illustrating erosion types.) Type E0 is characterized by upward migration of the humeral head without erosion of the glenoid. Type E1 is defined by concentric erosion of the glenoid, and type E2 by erosion of the superior part of the glenoid. In type E3, the erosion extends to the inferior part of the glenoid[14].

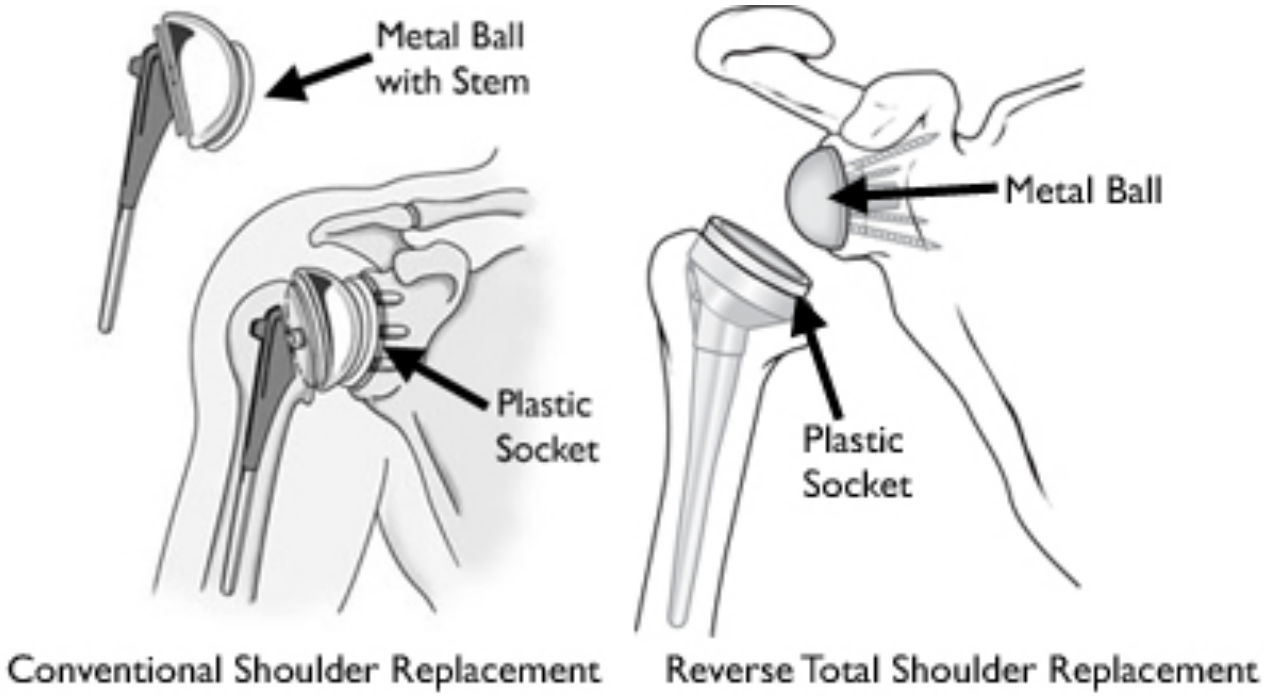

Figure 3. Conventional TSA prosthesis and reverse TSA prosthesis. (Left) A conventional total shoulder arthroplasty mimics the normal anatomy of the glenohumeral joint. (Right) A reverse total shoulder arthroplasty exchanges the humeral head and glenoid components, inserting the plastic cup on the humerus and the metal ball onto the glenoid[16].

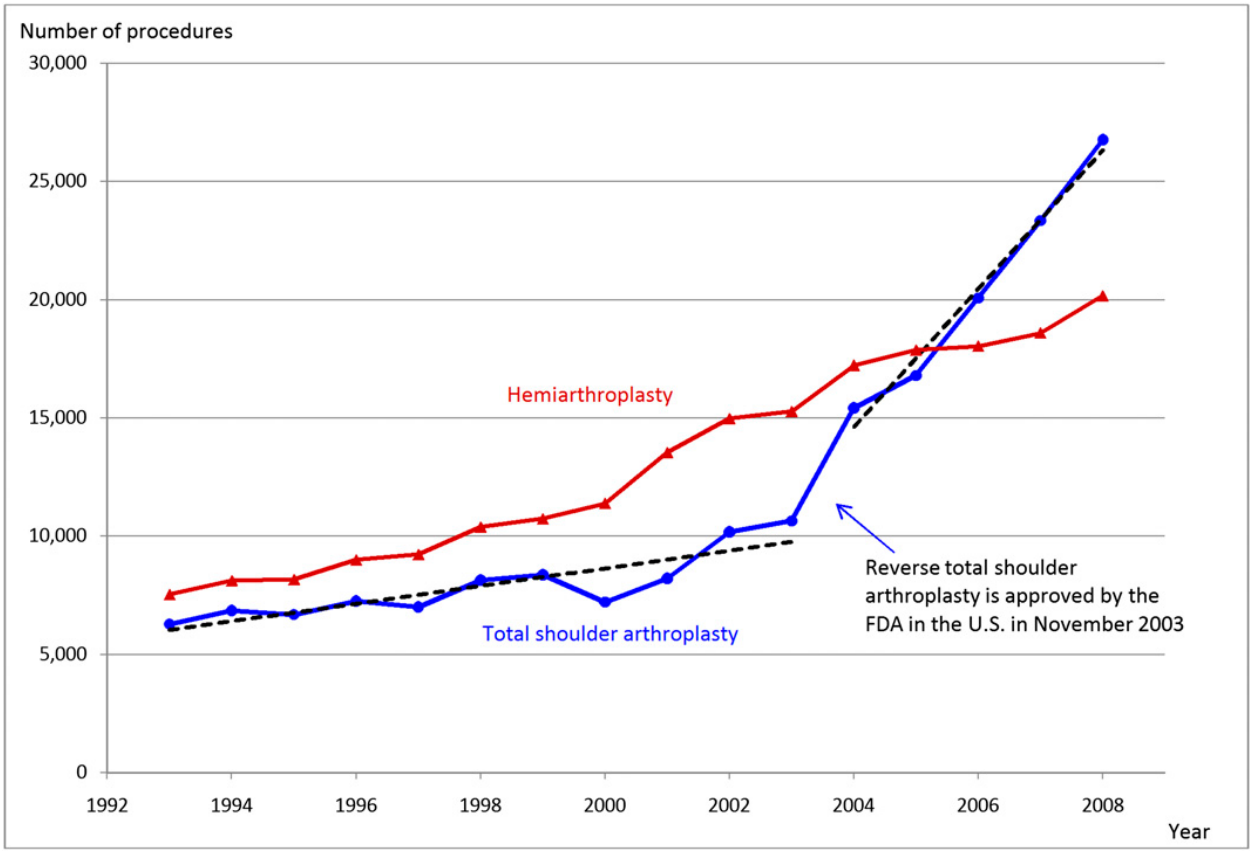

Figure 4. Increasing incidence of total shoulder arthroplasty and hemiarthroplasty in the United States between 1993 and 2008. The dashed line indicates the fitted line of piecewise linear regression[19].

more widespread use of the reverse TSA and recent suggestions of its superior function and longevity over the hemiarthroplasty[4,19]. In 2008, approximately 27,000 TSAs and 20,000 hemiarthroplasties were performed. The most common primary diagnosis leading to TSA was osteoarthritis (77% of TSA cases and 43% of hemiarthroplasty cases), while the second most common indication for hemiarthroplasty was proximal humeral fracture[19].

Patient registries, databases, and outcomes studies

With any surgery or medical intervention, it is important to assess the improvement in quality of life and cost efficacy of the procedure. Because arthroplasty is an elective pain-relieving procedure intended to last for the duration of the patient's life, the long-term durability of the implant is also an important consideration. Outcomes programs and patient database development have been gaining popularity and their usefulness has been appreciated in recent years. By utilizing orthopaedic database information, surgical techniques and procedures may be validated, best practices may be noted, standards of care may be updated, and further areas in need of clinical research may be acknowledged.

In 1977, the first total hip replacement registry began in Sweden with the aims of describing the epidemiology of hip replacement surgery and to identify risk factors for poor outcomes related to the patient, implant, and surgical technique. The first report on the registry by Ahnfelt et al. described the importance of continuous registration of complications in order to refine surgical techniques and improve quality over time[20,21]. Today, thanks to voluntary cooperation by all Swedish clinics and hospitals, participation is nearly 100%[22]. Herberts & Malchau have attributed many improvements in hip arthroplasty trends in Sweden to widespread awareness and utilization of information from this registry[22]. These include improvements in surgical techniques and implants that have resulted in significantly fewer revision arthroplasties secondary to mechanical failure, and confirmation that cement application by retrograde filling decreases the risk for later revision[22]. One of many advantages of such a registry is the fact that results were obtained from all types of institutions and not solely from one specialist, allowing the results to be generalized to the average surgeon and

hospital[23]. Similar registries have been developed in the UK, Finland, Norway, New Zealand, Denmark, and Australia for arthroplasties of multiple joints including hip, shoulder, elbow, and knee[24,25].

In a database, patient-centered information gleaned from validated questionnaires can be combined with more objective measurements and calculations relating to implant development and longevity, surgical techniques, and postoperative evaluation. Such a database can accumulate cases and feed numerous studies, allowing the identification of trends that may inform future practices. Prior to the more widespread creation of arthroplasty registries, the primary methodologies for studying the performance of implants were randomized clinical trials, meta-analyses, and retrospective case series. Maloney asserted that these designs are not conducive to ascertaining important information about joint replacement procedures due to the number of manufacturers and implant types, the lack of randomized studies that can feed into a meta-analysis, and bias associated with single-surgeon and single-center retrospective studies[26]. For example, it is estimated that 50% of hip arthroplasties performed in the US are performed by surgeons who do less than ten per year and likely are not actively involved in research themselves. This means the results obtained from a retrospective study of cases performed by a high-volume expert in a specific subspecialty may not be widely applicable. The continued evaluation of implants and the timely delivery of information to these surgeons is imperative and underscores the need for a national arthroplasty registry in this country, as exists in so many others[27].

Outcomes databases are ideal instruments for providing regularly updated information pertaining to the success of different surgical implants and techniques. Furthermore, technological advances and the more mainstreamed adoption of electronic medical record (EMR) systems facilitate more timely data collection and aggregation. In his commentary on the 2004 article by Röder, Maloney points out that a registry requires widespread use to be valid and minimize the risk of bias[27]. However, because many arthroplasty procedures performed in the US are done so by general orthopaedists who may not participate in clinical research and have a lower volume of arthroplasty cases, and because guidelines of the Health

Insurance Portability and Accountability Act (HIPAA) present obstacles to tracking information, unique challenges exist in the development of a centralized nationwide arthroplasty registry in the United States[27,25].

Patient-centered outcomes

Important variables to include in patient registries and scrutinize in outcomes studies are those factors which matter most to the patient. For example, numerical values commonly assessed in medical studies include those indicating hypertension (systolic and diastolic blood pressure) and hyperlipidemia (LDL, HDL, total cholesterol, etc.). Without context, these values mean little to the patient, but when put into terms such as increased risk of stroke or heart attack, the patient may gain understanding of the true implications of his condition. Studies evaluating patient-centered outcomes and quality of life have been gaining popularity, and the measurement of these outcomes has become the preferred approach of health care organizations for assessing quality of care[28]. Furthermore, results from patient-centered outcome, preoperative expectation, and postoperative satisfaction studies may be included in informed consent discussions, promoting realistic expectations in future arthroplasty patients[29].

A number of outcome tools have been developed to measure quality of life in patients with shoulder pathologies[30]. Two questionnaires that are commonly used to assess shoulder function are the American Shoulder and Elbow Surgeons (ASES) evaluation form and the Disabilities of the Arm, Shoulder and Hand Measurement tool (DASH) (and its modified, more concise version, the QuickDASH). The ASES form was developed in 1993 by the Society of the American Shoulder and Elbow Surgeons in order to create a standardized tool which would better facilitate communication among investigators and encourage multicenter studies[31,30]. The creators of the ASES tool sought to develop a system that is easy to use, assesses activities of daily living (ADLs), and includes both physician assessment and patient self-evaluation components. The physician assessment consists of a physical exam for range of motion (ROM), strength, stability, and demonstration of specific physical exam findings, e.g. the “Hornblower’s

sign". The patient-completed section includes a visual analog scale for pain along with a 10-item questionnaire assessing ADLs[31].

Introduced in 1996, the DASH was developed by the American Academy of Orthopaedic Surgeons, the Council of Musculoskeletal Specialty Societies, and the Institute for Work & Health (Toronto, Ontario) for use in any condition of any upper extremity joint[32]. The DASH is a 30-item questionnaire designed to assess functional status of the affected upper extremity and associated symptoms (including pain, weakness, stiffness, and tingling/numbness). Numerous and varied activities are assessed, including house/yard chores, shopping and other errands, recreational activities, self-care and dressing, eating, sexual activities, sleep, and sports/performing arts. Other evaluated concepts include social function and psychological function (self-image). The broad scope of this tool, along with criticisms of redundancy, led to the development of a shorter form, the QuickDASH, an eleven-item questionnaire which excluded the DASH domains of weakness, stiffness, family care, sexual activities, and self-image[33]. The QuickDASH offers efficiency in quantifying patient outcomes while retaining the validity and reliability of the original DASH. It has since been translated into additional languages, including French and Turkish[33,34,35].

SCOOP database at SCORE

The Shiley Center for Orthopaedic Research and Education (SCORE) at Scripps Clinic conducts research in preclinical, clinical, biomechanical, and outcomes topics relating to the field of orthopaedics. SCORE also maintains several outcomes databases under the umbrella of the Scripps Clinic Orthopaedic Outcomes Program (SCOOP)[36]. This program began with data collection relating to hip and knee arthroplasties but since has expanded to include data on a number of orthopaedic procedures, including osteochondral allografting of the knee and ankle, anterior cruciate ligament reconstruction, finger and great toe arthroplasties, spine surgery, and, as this thesis will discuss, shoulder arthroplasty. The TSA and reverse TSA database formation began in 2006, with approximately forty patients from one participating surgeon being added annually. Data collection for these patients consists of demographic variables;

patient comorbidities; preoperative, intraoperative, and postoperative evaluations performed by orthopaedic surgeons and nurses; patients questionnaires regarding pain, function, and satisfaction; and scores calculated by validated outcomes measures such as the Constant Murley shoulder assessment[37], ASES subjective shoulder scale[31] and DASH[32].

Purpose and goals of current study

The goals of our study are to address the following specific questions regarding the TSA, reverse TSA, hemiarthroplasty, and humeral head resurfacing procedure: (a) Is restoration of range of motion (ROM) the primary factor of importance to the patient when assessing the success of shoulder arthroplasty (i.e., does this lead to increased patient satisfaction)? (b) How is ability to carry out ADLs influenced by ROM? (c) How does ADL performance correlate with patient satisfaction? The primary purpose of this study is to correlate ROM with patient-reported levels of satisfaction regarding the shoulder. The secondary outcomes of this study are to evaluate the correlation between ADLs and ROM and to evaluate the correlation between ADLs and patient satisfaction. We hypothesize that more "normal" ROM following TSA leads to increased patient satisfaction and better performance of ADLs.

Materials and Methods

Demographics

Following IRB approval, all patients undergoing shoulder arthroplasty at SCORE were prospectively enrolled in a shoulder arthroplasty database for collection of data elements including passive ROM, strength, pain, and ability to complete activities of daily living (ADLs) as measured by validated scoring systems: ASES and ASES Constant 10, QuickDASH, and Constant-Murley. Data involving patient medical history, intraoperative techniques and implants utilized, radiographic assessments, and other patient-centered questionnaires were also collected and included in the database but not considered in this study. Exclusion criteria for participation in the registry were patients who declined to participate and pregnant females (of which there were none). Female candidates of reproductive age who consented to participation were given urine pregnancy tests to ensure they were not pregnant.

For this study, all patients included in the registry who underwent TSA, reverse TSA, hemiarthroplasty, or humeral head resurfacing who had a 6-month follow-up visit were included in the data analysis. Exclusion criteria for this study were patients who underwent hemiarthroplasty for fracture and patients who underwent revision arthroplasty for infection.

Patients underwent the above procedures, depending on their preoperative diagnosis and the accepted indications for each procedure at the time of surgery (e.g. reverse TSA for rotator cuff arthropathy). In general, anatomic TSA is performed for pain due to osteoarthritis or inflammatory arthritis in a shoulder with an intact rotator cuff[38]. Hemiarthroplasty is performed for three- and four-part proximal humerus fracture and, occasionally, for rotator cuff arthropathy[38]. Reverse TSA procedures are performed for rotator cuff arthropathy in older patients with fewer physical demands on the shoulder. For younger, motivated patients with rotator cuff arthropathy but heavier physical demands, hemiarthroplasty or humeral head resurfacing have generally been the preferred interventions. Most patients (*n*=139) underwent primary operations, though 14 patients underwent reoperation procedures or revision surgery from a previous arthroplasty to one of a different type (e.g., TSA to reverse TSA, or

hemiarthroplasty to TSA). All procedures were performed by a single surgeon (HH) at the Scripps Clinic between the dates of February 2007 and July 2011.

Operative procedure

All surgeries were performed under general anesthesia with an interscalene block and all patients received 24 hours of perioperative intravenous antibiotics. Patients were positioned in a semi-seated position and a hydraulic positioning device (Spyder, Tenet Medical Engineering, Inc., Calgary, Canada) was used to hold the arm. A standard deltopectoral approach to the shoulder was performed. The subscapularis tendon was osteotomized with a thin slice of bone from the lesser tuberosity to access the joint. Humeral head and neck osteophytes were removed and the humeral head was sized for the appropriate prosthesis. After humeral head resection and preparation of the humeral canal, the trial prosthesis (Ascend, Tornier, Inc., Edina, MN) was placed. The trial prosthesis was left in place while the glenoid was exposed. The anterior, inferior, and posterior labrum, and capsule were released from the glenoid to gain adequate exposure. Preparation of the glenoid was performed in a standard manner and the glenoid prosthesis was cemented into place. Attention was then turned back to the humerus, where non-absorbable #5 Ethibond sutures were placed through the biceps groove out anteriorly into the lesser tuberosity and humeral canal for later subscapularis repair. The trial humeral head prosthesis was removed and the canal was copiously irrigated. The actual prosthesis was assembled according to the manufacturer's instructions and impacted into place. The subscapularis was then repaired. Satisfactory external rotation, internal rotation to the stomach, full overhead elevation with good stability and a smooth articulation was achieved in all patients prior to closure. The deltopectoral interval was then approximated subcutaneously and skin closed using staples.

The Tornier Aequalis Ascend™ Shoulder System was used for all cases of anatomic TSA; for all reverse TSA, the Tornier Aequalis™ Reversed prosthesis implant was used. For the hemiarthroplasty procedures, the Tornier Aequalis Ascend™ Shoulder System was used for the humeral head.

All patients were admitted one to two nights to the hospital for pain control and training in ADLs by Occupational and Physical Therapy. Cutaneous staples were removed two weeks postoperatively. A sling was used for two to four weeks and the patient was instructed not to bear weight through the arm or to externally rotate at the shoulder, and to limit forward flexion at the shoulder to 90 degrees. Gentle ROM and stretching exercises were commenced in the first two days postoperatively and included Codman/pendulum exercises to increase passive flexion to 90 degrees, elbow and wrist ROM and stretching, scapular squeezes, and easy walking. Activity was increased after the fourth postoperative week to include progressive external rotation as tolerated and gentle internal rotation. Once cleared by a physician after postoperative week 6, patients could begin active ROM and use of up to five pounds of weight as tolerated. Beyond three months (and with clearance by a physician), patients could utilize light weight machines.

Postoperative evaluation

Data were collected preoperatively and 3 months, 6 months, and 1 year postoperatively and yearly thereafter. Upon arriving to each appointment, patients were given a questionnaire (Appendix 1) which was completed prior to consultation with the surgeon. Loss to follow-up was considerable at 1 year and beyond (145/256, 56.6%); thus, the decision was made to analyze progress at the 6-month follow-up and evaluate early postoperative passive ROM, ADLs, pain, and overall patient satisfaction.

Once the questionnaire was completed, the patient underwent a standard physical exam, performed by the operative surgeon, an orthopaedist colleague, or an orthopaedic sports medicine fellow. The exam began with inspection of the shoulder for atrophy, skin breakdown or scarring, and gross deformity, along with palpation of anatomic landmarks to assess tenderness. This was followed by passive testing of five types of ROM: forward elevation (flexion), lateral elevation (abduction), cross-body adduction, external rotation, and internal rotation. The first four elements were noted both in absolute values estimated by the evaluator and in incremented 30-degree ranges (e.g., 90°-120°, 121°-150°, 151°-180°), while

internal rotation was quantified by attainable positioning of the upper extremity, ranging from "dorsum of hand to lateral thigh" (least internal rotation) to "dorsum of hand to interscapular region" (greatest internal rotation). Following ROM testing, the patient also underwent measurements of strength with flexion and abduction, stability testing, the Belly-Press and Lift-Off tests (measures of subscapularis integrity), Neer and Hawkins Impingement signs (the presence of which indicate subscapularis tendinopathy and impingement), and Hornblower's sign (the absence of which demonstrates teres minor integrity). These measures were not included in our study as they were variably recorded and difficult to standardize. All points of the physical exam were carried out on both the operated and contralateral sides, and the preoperative form or progress note (depending on particular visit) was completed by the evaluating surgeon (Appendices 2 & 3).

A PubMed search of the English language literature was commenced using the following key words: shoulder arthroplasty outcomes (394 results), reverse total shoulder arthroplasty (221 results), shoulder arthroplasty epidemiology (151 results), arthroplasty outcomes databases (193 results), arthroplasty outcomes registries (133 results), patient satisfaction arthroplasty (105 results) and arthroplasty patient centered outcomes (28 results). Articles found in this fashion were reviewed and cross-referenced. Following these initial searches, PubMed continued to be utilized to find specific articles cited in those we found relevant to our topic of study, culminating in the 70 articles cited in this thesis.

Statistical analysis

For data analysis, the measurements obtained in 30-degree ranges were utilized; absolute values were used in only a few instances to inform the range for a case in which the absolute value was noted but the range was missing. The absolute values were used in this fashion due to the overwhelming lack of data in these fields (77/155 or 49.7% of forward flexion, 77/155 or 49.7% of abduction, 83/155 or 53.6% of adduction, and 93/155 or 60.0% of external rotation data were absent). Each of the five range of motion measurements were categorized as "normal" (same) if the operative shoulder had the same degree of motion

(within the same 30-degree range) as the contralateral shoulder. Conversely, they were categorized as "abnormal" (different) when the degree of motion differed from the contralateral side. The percentage of range of motion measurements that were achieved as normal was calculated for each patient, ranging from 0% (0 out of 5 measurements normal (same)) to 100% (5 out of 5 measurements normal (same)).

As the objective of this project was to assess the relationships between patient satisfaction, ROM, and ability to perform ADLs, only ROM measurements, the ADL subscales from the ASES and QuickDASH scores in the patient questionnaire (Appendix 1), and the answer to the patient question “Are you satisfied with the results of surgery?” were included for analysis. We chose to use the ADL subscales from both the ASES and QuickDASH questionnaires because with the exception of one question, the questionnaires assessed a range of ADLs and the outcomes measures have been shown to be valid and responsive in the shoulder arthroplasty population[30,39]. This resulted in a 15-question modified composite subscale of the two (Figures 5 & 6). Each question ascertained the patient’s ability to complete a specific everyday task and the ease with which it was performed on a scale of 1 to 5. Not all patients answered every question, so rather than summing these values, an average ADL score was computed for each patient. ADL scores were derived from two standardized questionnaires, the ASES evaluation form and the QuickDASH form. The scoring systems of these two assessment tools differ in that ASES is a four-point scale and QuickDASH is five-point. In order to create a hybrid of these two systems, the ASES scale was converted to five-point by changing the point values of 1, 2, 3, and 4 to 1, 2.5, 4, and 5, as “somewhat difficult” was considered a combination of “mild” and “moderate” difficulty (Figure 5). Frequently, individual ADL questions were left unanswered by patients; in order to obtain a meaningful ADL score, the mean of a patient’s total answered questions was calculated. Lower values reflected better functional ability, while greater values meant greater difficulty with activities and worse functional ability.

Figure 5. ASES-derived questions[31] assessing activities of daily living (ADL) performance used in ADL score.

	Operated				Contralateral			
1. Put on a coat*	1	2†	3	4	1	2	3	4
2. Sleep on your painful or affected side	1	2	3	4	1	2	3	4
3. Manage toileting	1	2	3	4	1	2	3	4
4. Comb hair	1	2	3	4	1	2	3	4
5. Reach a high shelf	1	2	3	4	1	2	3	4
6. Lift 10 lbs above the shoulder	1	2	3	4	1	2	3	4
7. Throw a ball overhead	1	2	3	4	1	2	3	4

***For questions 1-7:**
Score 1 = not difficult Score 2 = somewhat difficult Score 3 = very difficult Score 4 = impossible

†For data analysis and creation of an ASES/QuickDASH hybrid questionnaire, an ASES score of 2 was counted as 2.5 (and "somewhat difficult" considered a combination of "mild difficulty" and "moderate difficulty" in the QuickDASH 5-point scale; an ASES score of 3 was counted as 4, and an ASES score of 4 was counted as 5.

Figure 6. QuickDASH-derived questions[33] assessing activities of daily living (ADL) performance used in ADL score.

	Operated					Contralateral				
8. Open a tight or new jar*	1	2	3	4	5	1	2	3	4	5
9. Do heavy household chores (e.g., wash walls, floors)	1	2	3	4	5	1	2	3	4	5
10. Carry a shopping bag or briefcase	1	2	3	4	5	1	2	3	4	5
11. Wash your back	1	2	3	4	5	1	2	3	4	5
12. Use a knife to cut food	1	2	3	4	5	1	2	3	4	5
13. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.)	1	2	3	4	5	1	2	3	4	5
14. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?†	1	2	3	4	5	1	2	3	4	5
15. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?‡	1	2	3	4	5	1	2	3	4	5

***For questions 8-13:**
Score 1 = no difficulty Score 2 = mild difficulty Score 3 = moderate difficulty
Score 4 = severe difficulty Score 5 = unable

†For question 14:
Score 1 = not at all Score 2 = slightly Score 3 = moderately
Score 4 = quite a bit Score 5 = extremely

‡For question 15:
Score 1 = not limited at all Score 2 = slightly limited Score 3 = moderately limited
Score 4 = very limited Score 5 = unable

Patients were asked to rate how satisfied they were with the results of the shoulder arthroplasty on a Likert scale (very satisfied, satisfied, dissatisfied, very dissatisfied). Of the 82 patients who had satisfaction data available, only 5 patients responded that they were “dissatisfied” or “very dissatisfied”. Because of the low sample size, these patients were excluded from the analysis of patient satisfaction. We therefore compared the two groups of satisfied patients, those who were "satisfied" and those who were "very satisfied." These patients were still included in analysis of ROM and ADL performance and were further analyzed separately to see if a variable could be identified which might explain their dissatisfaction.

The association between ROM and patient satisfaction was tested using Fisher's exact test (external rotation) and chi-square tests (internal rotation, forward flexion, abduction, adduction, and total percentage achieved as normal). The level of statistical significance was set at $P \leq .05$. The association between ROM and ADL was tested using the Mann Whitney U test. A one way analysis of variance (ANOVA) was used to assess the association between the total percentage of ROM achieved as normal and ADL.

Results

Demographics

In total, the shoulder arthroplasty database enrolled 256 primary, revision, or conversion procedures, and included TSA, reverse TSA, hemiarthroplasty, and humeral head resurfacing. Of the 256 shoulders initially enrolled, there were 155 with available 6-month follow-up data that were included in the study (Table 1). The final analysis included 82 (52.9%) females and 73 (47.1%) males, with an average age of 70.9 (range 20.3-89.1, SD 11.7), and diagnoses of primary glenohumeral arthrosis (*n*=35), secondary glenohumeral arthrosis (*n*=16), and unknown diagnosis (*n*=104). Of these 155 shoulders, 139 (89.7%) were primary arthroplasty procedures, 14 (9.0 %) were reoperations, and 2 were unknown (1.3%). Of the primary procedures, 97 (69.8%) were traditional TSA, 29 (20.9%) were reverse TSA, 9 (6.5%) were hemiarthroplasties, and 3 (2.2%) were resurfacing of the humeral head. Reoperations included 9 (64.3%) conversion procedures (4 TSA to reverse TSA, 5 hemiarthroplasty to reverse TSA), 3 (21.4%) TSA revisions, 1 (7.1%) reverse TSA revision, and 1 (7.1%) resection. Procedures were performed on the patient's dominant arm in 73 cases and non-dominant in 48 cases; the remaining 34 were unknown. Diagnoses included 35 with primary glenohumeral arthrosis, 16 with secondary glenohumeral arthrosis, with the remaining 104 diagnoses unknown. Intraoperative complications occurred in 5 cases and included 2 fractures (1 glenoid, 1 humerus), 1 nerve injury (repaired), 1 superior base plate hole due to broken drill bit, and 1 deltoid mid-substance tear (repaired).

ROM and satisfaction

Only 82 of the 155 6-month follow-up patients answered the question regarding satisfaction (52.9%). Of these 82 patients, 5 (3.2%) answered that they were either "dissatisfied" or "very dissatisfied". This, in combination with the significant loss to follow-up resulted in a sample size of dissatisfied patients that was too small to appropriately include in the statistical analysis. As such, the dissatisfied patients were excluded from the analysis

Table 1. Demographics of database patients included in study.

	Number of cases	Percent of total	Cumulative percent
Procedure type			
Primary	139	89.7	89.7
Reoperation	14	9.0	98.7
Missing	2	1.3	100.0
Female	82	52.9	52.9
Male	73	47.1	100.0
Primary type			
TSA	97	69.8	69.8
Reverse TSA	29	20.9	90.7
Hemiarthroplasty	9	6.5	97.2
Resurfacing head	3	2.2	99.4
Missing	1	0.7	100.0
Reoperation type			
Conversion	9	64.3	64.3
TSA revision	3	21.4	85.7
Reverse TSA revision	1	7.1	92.9
Resection	1	7.1	100.0
Conversion type			
TSA to Reverse TSA	4	44.4	44.4
Hemi to Reverse TSA	5	55.6	100.0

comparing satisfaction to both ROM and ADL function but were still included in the analysis of performance in ADL versus ROM. This left a total of 77 patients who were either satisfied or very satisfied with their shoulder and who were included in the statistical analysis.

Postoperative ROM was associated with the degree of patient satisfaction for three of the five measurements. Patients who achieved normal forward flexion, adduction, and external rotation were more likely to be very satisfied postoperatively (Table 2). Although patients who achieved normal internal rotation and abduction tended to rate themselves as very satisfied compared to just satisfied, this association was not statistically significant. The percentage of normal (same) range of motion measurements that patients achieved was also associated with satisfaction. The higher the percentage of normal (same) achieved, the more satisfied, demonstrating a "dose-response" relationship (Table 3).

The 5 dissatisfied patients were considered separately to see if any discerning characteristics could be identified among this group that might explain their atypical outcomes (Table 4). Among those “dissatisfied” or “very dissatisfied”, 3 were males, 2 were females, with mean age of 76.1 (range 61.5-84.8). There were 2 primary procedures (1 TSA, 1 hemiarthroplasty), 2 reoperations (1 conversion hemiarthroplasty to reverse TSA, 1 TSA revision), and 1 unknown. Mean ADL score was 3.57 (range 2.80-4.93). Unfortunately data was incomplete for perioperative complications for 4/5 patients; 1 patient indicated he had experienced no complications. That same patient reported “normal” (same) ROM in 3/5 (60%) of measurements, but the other four patients’ ROM data was missing.

ROM and ADL

Eleven patients were omitted from the ADL data analysis because answers were unknown for all ADL questions. Of the remaining 144 patients, postoperative ROM was associated with improved function in ADLs for four of the five measurements (Table 5) ($P \leq .05$). Mean ADL scores were higher for patients who achieved normal ROM compared to those who didn't. Forward flexion was the only measurement that did not show a statistically significant association ($P=.207$). ADL scores improved in patients who had higher percentages

Table 2. Association of ROM and satisfaction.

ROM	Satisfied	Very satisfied	Total
	Internal rotation (P=0.567)[*]		
Same	10	22	32 (46.4%)
Different	14	23	37 (53.6%)
Total	24 (34.8%)	45 (65.2%)	69
	Forward flexion (P=0.001)[†]		
Same	6	32	38 (55.1%)
Different	17	14	31 (44.9%)
Total	23 (33.3%)	46 (66.7%)	69
	Abduction (P=0.315)[‡]		
Same	15	36	51 (72.9%)
Different	8	11	19 (27.1%)
Total	23 (32.9%)	47 (67.1%)	70
	Adduction (P=0.021)[§]		
Same	11	37	48 (73.8%)
Different	9	8	17 (26.2%)
Total	20 (30.8%)	45 (69.2%)	65
	External rotation (P=0.006)[£]		
Same	9	35	44 (75.9%)
Different	9	5	14
Total	18 (31.0%)	40 (69.0%)	58

[*] *Internal rotation:* *P* = .567 (Pearson Chi-Square)
[†] *Forward flexion:* *P* = .001 (Pearson Chi-Square)
[‡] *Abduction:* *P* = .315 (Pearson Chi-Square)
[§] *Adduction:* *P* = .021 (Pearson Chi-Square)
[£] *External rotation:* *P* = .006 (Fisher's Exact Test)

Table 3. Proportion of ROM measurements the same associated with patient satisfaction.

ROM same (/5)	Satisfied	Very satisfied	Total
P=0.009 (Pearson Chi-Square)			
1 out of 5 same (20%)	3 (100.0%)	0 (0%)	3
2 out of 5 same (40%)	7 (50.0%)	7 (50.0%)	14
3 out of 5 same (60%)	1 (10.0%)	9 (90.0%)	10
4 out of 5 same (80%)	3 (20.0%)	12 (80.0%)	15
5 out of 5 same (100%)	1 (12.5%)	7 (87.5%)	8
Total	15 (30.0%)	35 (70.0%)	50

Patient	Age	Sex	Surgery	Implant	Complications	ROM	ADL
Dissatisfied A	84.8	F	Primary	TSA	Unknown	Unknown	2.81
Dissatisfied B	69.8	F	Reoperation Conversion	Hemi to RSA	Unknown	Unknown	4.93
Dissatisfied C	61.5	M	Reoperation Revision	TSA	No	3/5 (60%)	2.81
Very dissat A	81.5	M	Primary	Hemi	Unknown	Unknown	3.73
Very dissat B	83.0	M	Unknown	Unknown	Unknown	Unknown	3.60

Table 4. Demographics of dissatisfied and very dissatisfied patients.

Table 5. Association of ROM and mean ADL score.

ROM	N	Mean ADL	Std. Deviation
	Internal rotation (P=0.038)		
Same	54	2.04	0.82
Different	73	2.30	0.75
	Forward flexion (P=0.207)		
Same	60	2.10	0.80
Different	71	2.27	0.83
	Abduction (P=0.040)		
Same	72	2.04	0.72
Different	57	2.39	0.89
	Adduction (P=0.048)		
Same	88	2.07	0.73
Different	38	2.36	0.74
	External rotation (P=0.000)		
Same	83	1.96	0.69
Different	31	2.72	0.72

of normal ROM measurements achieved (Table 6) (*P*=.003). The greatest improvement was seen when a patient was able to achieve "normal" (same) ROM for at least 3 out of 5 (60%) ROM measurements (Figure 7).

ADL and satisfaction

The patients who reported that they were "satisfied" (*n*=26) had a mean ADL score of 2.50, and those that reported they were "very satisfied" (*n*=50) had a mean ADL score of 1.93 (Table 7). These results demonstrated a significant association between improved ADLs and higher patient satisfaction (*P*=.004).

Table 6. Percentage of ROM measurements the same associated with mean ADL score.

ROM same (/5)	N	Mean ADL	Range
P=0.003			
0 out of 5 same (0%)	5	2.35	1.43-3.27
1 out of 5 same (20%)	15	2.55	1.47-3.40
2 out of 5 same (40%)	22	2.57	1.32-4.25
3 out of 5 same (60%)	21	1.92	1.10-3.13
4 out of 5 same (80%)	25	2.02	1.00-3.54
5 out of 5 same (100%)	12	1.79	1.17-3.03
Total	100	2.19	1.00-4.25

Figure 7. Mean average ADL score as a function of percentage of normal ROM measurements.

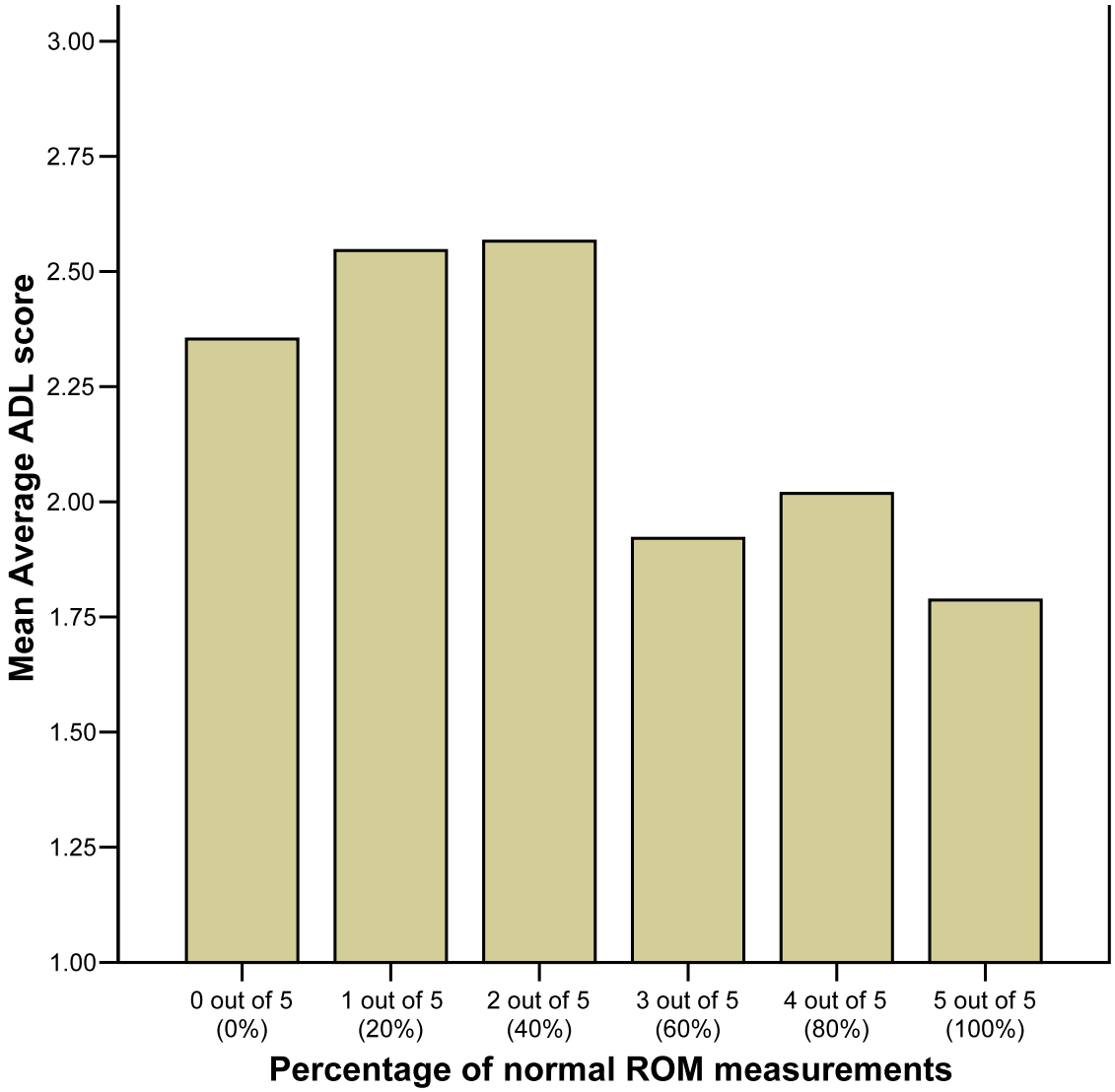

Table 7. Association between mean ADL score and patient satisfaction.

Satisfaction	N	Mean ADL	Std. dev.
P=0.004			
Satisfied	26	2.50	0.87
Very satisfied	50	1.93	0.73

Discussion

Results and findings

Glenohumeral arthrosis is a considerable cause of disability in the United States, especially among the elderly[19]. The aging population in the US and the increasing incidence of shoulder arthroplasty procedures together create the need to analyze the longevity and patient-perceived success of arthroplasty prostheses and surgical techniques. As joint replacement procedures are elective surgeries, information about long-term patient-centered outcomes will assist in the decision-making for future surgical candidates[40]. The predominant goals of TSA surgery are pain relief and restoration of ROM, with is thought to result in improved ability to perform ADLs. It is, however, important to ascertain the specific goals of the individual preoperatively and to assess postoperative patient satisfaction. While previous studies have been focused mainly on measuring the objective outcomes of success or failure of a procedure or implant, disassociation of structural findings on imaging studies and patient symptoms has supported greater consideration of patient-reported health assessments[41,42]. The increasing use of multicenter joint registries allows conclusions to be drawn from larger patient populations under the care of hundreds or even thousands of different surgeons. This makes the extracted conclusions more likely to be representative of true correlations and intrinsic characteristics of arthroplasty prostheses. Furthermore, while some national registries such as the New Zealand registry have included patient-reported outcomes for some time, the importance of including this data in joint registries is becoming more widely recognized as an important consideration in quantifying optimal outcomes as defined by the patient[25].

The primary purpose of this study was to assess the relationship between ROM and patient satisfaction following shoulder arthroplasty, including TSA, reverse TSA, hemiarthroplasty, and humeral head resurfacing. Secondarily, the relationships between ROM and function in ADLs as well as between ADLs and patient satisfaction were evaluated. High loss to follow-up dictated the 6-month timeline for postoperative evaluation of patients, however, multiple studies have shown the typical recovery pattern of total joint replacement patients to be one of significant improvement within the first few weeks after surgery, with the

largest gains seen within the first 3 to 6 months[43,44,45,46,47,40]. Therefore, analysis of results at six months post-joint replacement surgery is appropriate and further follow-up is unlikely to dramatically change results. Of the patients that could be evaluated, satisfaction improved for patients who had more normal forward flexion, adduction, and external rotation. Furthermore, there was a "dose-response" relationship between the percentage of normal ROM achieved across all planes of motion and patient satisfaction. There was also a significant increase in ADL functioning when at least 3 of the 5 ROM measurements were restored to "normal", with "normal" referring to equal ROM of the operative and contralateral shoulders.

Postoperative ROM, while a fairly straightforward factor to measure, is a complex variable in terms of the variety of components influencing it, including preoperative ROM, body mass index, prosthetic design, postoperative pain, and overall activity[48,49,50,40]. It should be noted, however, that the vast majority of studies on post-arthroplasty ROM have analyzed these relationships as they pertain to arthroplasty of the hip and knee, not shoulder. Jones also noted that many of these studies fail to statistically control for other variables such as comorbidities and contralateral joint involvement, meaning that the direct effects of postoperative ROM achievement on long-term functional outcomes remain ambiguous, and the effects of comorbidities are also difficult to quantify[40]. The association between ROM and patient satisfaction may be inferred from that of ADL and patient satisfaction, as ROM along with pain greatly influence ADL performance. For this reason, ROM may be an objective variable with direct consequences on patient-centered outcomes.

A recent trend in orthopaedic literature is the promotion of patient-centered, or patient-reported, outcomes. Some physicians have questioned the ability of traditional objectives measures such as strength and ROM to accurately reflect outcomes as perceived by the patient[51,52]. Additionally, studies have demonstrated the tendency of physicians to rate their patients' functioning as better than the same patients would rate themselves, a discrepancy which increased when the patient was not satisfied with the outcome[53,51]. Sasaki et al. reported poor correlation between patient-reported quality of life and surgeon satisfaction surveys measuring the postoperative feeling of the surgeon according to diagnostic

impression and post-operative radiographs, which were considered to represent "objective" data[54]. These points highlight the important of assessing the patients' attitudes regarding their health and health care. On the other hand, Harreld et al. points out that, although patient-reported measures capture the social and personal context of the patient and disease and are thus thought to be more representative, they are still susceptible to error, because the potential bias is shifted from the physician to the patient[52]. For example, a potential cause of discrepancy between objective and patient-reported measurements is the possibility that acceptance of chronic functional limitations in the face of persisting disability might allow for higher patient satisfaction[52]. For this reason, outcomes studies employing both objective and patient-reported measures may be the most beneficial.

The lack of correlation between objective and subjective measures of assessing outcomes hints at the complexity of the concept of patient satisfaction. Patient expectations and emotional states, recall bias, like or dislike of the physician, and social context of the disease (including ongoing litigation and worker's compensation status) are several factors that influence patient reports of their pain, function, and overall satisfaction[52]. Interest in patient satisfaction has been growing since the 1970s and 80s, as health care providers and consumers have become more critical of the costs and quality of care and patients have taken on a more active role in the planning and evaluation of health services[55]. This shift was accompanied by the concern of the increasing presence of the consumerist ideology in medicine and the redefinition of "patient" as "consumer" or even "customer"[55]. The complexity of patient satisfaction was elegantly discussed by Sitzia & Wood in a 1997 article which, among other points, asserted that a primary issue with the emergence of patient satisfaction studies is the fact that the "patient satisfaction" construct failed to truly be defined and its conceptual and theoretical issues discussed before its measurement in health care. Citing Ware, Sitzia explained, "Satisfaction *ratings*, it was argued, reflect three variables: the personal preferences of the patient, the patient's expectations, and the realities of the care received, satisfaction with the last affected by many different components of that care. In this way, a satisfaction rating is both a measure of care and a reflection of the respondent"; satisfaction *reports*, on the other hand, are more factual and objective, judging factors such as length of wait[56,55]. Sitzia

also categorized variables of patient satisfaction into *determinants*, or the "patient" variables, and *components*, the "care" variables, for the purpose of discussing previous studies of patient satisfaction factors. He points out that Fitzpatrick, however, disagreed that satisfaction could be viewed as a single concept composed of several *determinants* and instead identified three independent models of satisfaction. The first was termed "the need for the familiar" and argued that socially created expectations are the primary determinant of satisfaction, including cultural influences. The second model, "the goals of help-seeking" proposed that most patients seek some degree of resolution to their health problems rather than explicit "satisfaction", and that this may not be achieved in situations where patients' perceptions of health status are not addressed. The third model, "the importance of emotional needs", stressed the influences of emotions such as uncertainty and anxiety along with the idea that patients may only feel able to judge the competence of health professionals by their communications skills and affective behavior, rather than technical aspects of care[57,55]. There is much controversy and complexity in literature on patient satisfaction, making this variable a challenging one to study, translate, and manipulate. Interestingly, some researchers are narrowing the scope of patient satisfaction and measuring very specific areas of satisfaction, such as a recent study assessing the effect of total knee arthroplasty on patient socioeconomic parameters and quality of sexual life[58].

As noted previously, the significant loss to follow-up suffered in our study eliminates the capability to generalize results to the overall population receiving these procedures, however, the high satisfaction rate following TSA and reverse TSA (93.9% satisfied or very satisfied in our study) is not unlike the rate found in other studies. A recent study of 93 TSA and 81 reverse TSA patients found a patient satisfaction score of 5 or more on a 10-point visual analog scale (PTSAT) in 89% of patients and found that patient satisfaction correlated more with subjective than objective measures[52]. Muh et al. found the literature on reverse TSA patients to support a 68-96% rate of positive patient satisfaction in studies of the past decade and reported 81% of reverse TSA patients were either satisfied or very satisfied in their own published data[59]. Interestingly, they also found a significant association between postoperative active forward elevation and patient satisfaction, reporting that subjective postoperative satisfaction scores

showed that 92.7% of patients who had forward elevation (flexion) of at least 100° were either satisfied or very satisfied versus only 25% of patients with less than 100° of forward elevation[59].

The correlation between ROM and ADLs confirmed our hypothesis that more normal ROM would correlate with improved ADL function for at least four of five measured planes of motion. Still, it should be noted that our measurement of "normal" was defined by equal ROM in the operated side as the contralateral; in many cases, concomitant pathology in the contralateral shoulder may have skewed the results to make the ROM attained postoperatively seem "normal" even if it was still severely limited. Somewhat surprisingly, we observed no correlation between "normal" forward flexion and ADL. This may be because forward flexion is specific to certain recreational activities including basketball, swimming, and tennis as well as occupational activities like painting and carpentry, which may be of lesser importance to elderly patients. In addition, forward flexion is not as crucial a movement for health and hygiene as the others considered in this study; Wylde et al. found hygiene has been found to be the most important activity by patients, healthy controls, and healthcare professionals[42]. It has also been observed that patients with osteoarthritis spend longer on hygiene than healthy controls[60,42]. The fact that we observed a strong correlation between forward flexion and patient satisfaction, however, suggests that further study to clarify these points is warranted. Furthermore, the results recently noted by Muh et al. strongly support the idea that increased forward flexion strongly correlates with patient satisfaction[59]. The most crucial type of motion for complete ADL function in our study seemed to be external rotation, which showed the most statistically significant correlation to mean ADL score. Attaining full external rotation allows the individual to reach overhead to the posterior aspect of the body. Of the 15 ADL items in the patient questionnaire, several are associated with external rotation; this motion is specifically important in washing one's upper back, combing one's hair, and throwing a ball overhead. While the importance of external rotation in ADLs itself is not surprising, what is peculiar is that internal rotation did not seem to correlate as closely with ADL. Internal rotation is instrumental in dressing oneself, managing toileting, and also for throwing a ball overhead. It is interesting that the act of throwing an object requires both internal and external rotation. Throwing is

actually extremely complex when types of motion and biomechanical forces at the shoulder are considered[61,62].

Study limitations

The greatest limitation of this study was the low final sample size due to missing data. We did not perform an *a priori* power analysis and respective sample size calculation, but we are likely underpowered for the associations we tested, which may have resulted in a Type II error.

While at first glance, it may seem pleasing to a surgeon to have a low number of dissatisfied patients, the loss to follow-up and missing data may misrepresent the proportions of satisfied and dissatisfied patients. In our study, just over half of the patients answered the question regarding satisfaction. It is possible that dissatisfied or disgruntled patients refused to return for follow-up visits and sought care elsewhere or failed to note postoperative complications, skewing the results to show an overwhelmingly satisfied patient base. Aside from error caused by loss to follow-up, lack of response variability itself has been described as a problem for researchers, often forcing them to compare positive with less positive responses[55]. This may be a phenomenon caused by the wording of the questions themselves, as there is continued debate over the benefits of open-ended versus more structured questions. More detailed questions have been found to produce more critical results than general ones, as patients often are less satisfied and more opinionated regarding a specific care-related issue such as waiting times, hospital catering, and privacy in a health care setting[55]. Additionally, rating patient satisfaction on a 4-point scale would be expected to produce less variability than the 10-point satisfaction VAS utilized by Harreld et al.[52], though this factor is less likely to be problematic than general question content. Whatever the hypothetical effects, the omission of dissatisfied patients from statistical analysis had a negative impact on our ability to draw conclusions from the results that could be generalized to the larger population of patients undergoing shoulder arthroplasty.

Perhaps the true but unintended learning point that can be drawn from this study involves both the importance of a structured but concise method of data collection and data entry as well as the need for a larger all-inclusive registry of shoulder arthroplasty patients.

Recent studies analyzing the issue of lack of initial and continued participation of potential registry inductees have recommended the use of questionnaire interfaces on familiar devices such as electronic tablets (e.g., Apple iPad)[63]. The use of such devices allows the participant to answer questions in a format already conducive to data analysis, such as multiple choice. Programs may be engineered to force the participant to choose the best response and to do so before being allowed to move on to subsequent questions, ensuring more complete data collection. Additionally, data can be electronically transferred to a database for collection, analysis, and utilization, avoiding the need for manual data input and the potential for missing or incorrectly entered data. In this study, the "objective" measurement of ROM was estimated by the evaluating physician; by using a digital goniometer to and video-recording physical examinations, inter-observer reliability could be improved and ROM measurements could be made more accurate[52].

An issue faced in our study was that of limited financial resources. As a result, volunteer summer interns were responsible for organizing and entering the data from the paper forms. Further financial assistance could have facilitated hiring a research assistant to administer the questionnaires before each appointment, to fully explain their usefulness in medical advances, and to ensure full completion of the questionnaires. Finally, the length and redundancy of the physical exam forms to be completed by each evaluating surgeon presented an overwhelming amount of paperwork for a busy orthopaedic sports medicine practice, leading the participating surgeons to complete the forms haphazardly. This resulted in fields that were left blank, extra notes written in non-free text fields, ambiguous answers, and correctly completed forms that were plagued by illegible handwriting.

Future directions

Though the data in the shoulder arthroplasty registry was incomplete, the registry organizers attempted to collect a wide variety of perioperative data points, all of which individually may contribute to the success or failure of a single shoulder arthroplasty procedure. Due to the size of the database, not all variables would be considered in a single study, but each could represent a future area of focus in shoulder arthroplasty outcomes research. For example, one of the primary indications for shoulder arthroplasty is intractable pain. Pain likely correlates closely with ROM, ADL performance, and patient satisfaction, and is a variable worthy of focused study. Other important patient-specific factors may be the preoperative diagnosis or patient's comorbidities. In fact, there have been studies that observed an effect of preoperative diagnosis on postoperative functional outcomes[64,65]. Additionally, trends and recommendations in treatment based on specific diagnoses are constantly shifting; recent studies have promoted the use of reverse TSA over hemiarthroplasty even in younger, healthy adults with rotator cuff arthropathy[66,67,3,68]. Although the rehabilitation protocols should have been similar for most of these patients, physical therapy and preoperative activity level may lead to better or worse functional results. This factor is complex and has many potentially confounding factors, including patient motivation, compliance, or even injury sustained in rehabilitation[69]. Finally, preoperative expectations were not obtained for our registry, but these have also been found to influence postoperative patient satisfaction[70].

Summary

The correlations between ROM, ADLs, and patient satisfaction that were observed in this study are encouraging and interesting findings relating to the patients' perceived success of shoulder arthroplasty. Unfortunately, the sheer amount of missing data and loss to follow-up limit any generalizability of this study. As such, studies with more complete data collection and a minimum of 2-year follow-up are needed to confirm these findings. Future directions include similar studies utilizing validated outcomes scores with data collected in either an electronic or professionally-administered format. Additionally, the impact of other patient-focused variables like preoperative diagnosis, medical comorbidities, pain, and postoperative rehabilitation on

patient satisfaction, ROM, and ADLs could also be studied and would provide valuable information. The increasing incidence of large joint arthropathy (including that of the glenohumeral joint) due to an aging population and growing prevalence of obesity warrant a continued search for factors contributing to patient satisfaction and artificial joint longevity. The creation and utilization of patient registries in countries around the world and the growing interest in patient-centered outcomes have demonstrated the power to contribute to great strides in this area of medicine and to promote better quality of care in total joint replacement procedures.

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Appendix 1

Patient Name: _____
MRN: _____
Date: _____

PATIENT QUESTIONNAIRE

Date of Birth: _____ **Gender:** □ Male □ Female

Operative Site: □ Left □ Right □ Bilateral **Since Surgery:** □ Preoperative □ 3 months □ 6 months □ 1 year □ 2 years □ 5 years □ 10 years

I am: □ **RIGHT** Handed □ **LEFT** Handed □ **Ambidextrous**

In your opinion, what caused your shoulder problem?
□ A motor vehicle accident
□ A recreational injury
□ A work injury
□ Repetitive use at work
□ Aging
□ Other:_____

Do you have a metal allergy to nickel? □ Yes □ No

Are you currently using steroids (prednisone)? □ Yes □ No

Do you smoke?
□ Never □ Current smoker □ Used to smoke: quit date:_____
For current and previous smokers: # Packs per day: _____ # Years smoking:_____

Do you use chewing tobacco? □ Yes □ No

Do you have a history of any of the following? Please check all that apply.
□ Anemia or other blood disease □ Diabetes □ Kidney Disease
□ Back Pain □ Diet □ Liver Disease
□ Cancer □ Oral □ Lung Disease
□ Depression □ Insulin □ Osteoarthritis or Degenerative Arthritis
□ Heart Disease □ Rheumatoid Arthritis
□ High blood pressure □ Ulcer or Stomach Disease

How satisfied are you with your shoulder?
□ Very satisfied □ Satisfied □ Dissatisfied □ Very Dissatisfied

Before my shoulder problem began I was:
□ Employed, and I performed:
- □ Mostly heavy labor
- □ Frequent heavy lifting
- □ Occasional heavy lifting
- □ Mostly desk work

□ A home maker
□ A student
□ Unemployed
□ Retired
□ Disabled

Now, I am:

- Employed, and I performed:
  - Mostly heavy labor
  - Frequent heavy lifting
  - Occasional heavy lifting
  - Mostly desk work
- A home maker
- A student
- Unemployed
- Retired
- Disabled

At what level can you use your arm normally?

Overhead At head level At neck level At chest level At waist level Below the waist only

Are you having pain in your shoulder? □ **yes** □ **no**

Do you have pain in your shoulder at night? □ **yes** □ **no**

Do you take pain medication (Aspirin, Advil, Tylenol, etc.) for your shoulder? □ **yes** □ **no**

Do you take narcotic pain medication (codeine or stronger) for your shoulder? □ **yes** □ **no**

How many narcotic pain pills do you take each day (average)? _____ **pills**

How bad is your pain today? (mark field):

no pain at all	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**pain as bad as it can be**

Does your shoulder feel unstable (as if it is going to dislocate)? □ **yes** □ **no**

How unstable is your shoulder? (mark field):

very stable	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**very unstable**

When do you have shoulder pain?

- Rarely
- Only when I use my shoulder during heavy activity
- When I use my shoulder at all
- Pain is always present

How would you rate your shoulder today as a percentage of normal?
(0 to 100% scale with 100% being normal)

_____%

Please complete the following questions regarding BOTH arms. Mark the field that best represents how you manage to perform the following tasks/activities:

	Right arm				Left arm			
	not possible	very difficult	somewhat difficult	not difficult	not possible	very difficult	somewhat difficult	not difficult
1. Put on a coat	□	□	□	□	□	□	□	□
2. Sleep on your painful or affected side	□	□	□	□	□	□	□	□
3. Wash back / do up bra in back	□	□	□	□	□	□	□	□
4. Manage toileting	□	□	□	□	□	□	□	□
5. Comb hair	□	□	□	□	□	□	□	□
6. Reach a high shelf	□	□	□	□	□	□	□	□
7. Lift 10 lbs above the shoulder	□	□	□	□	□	□	□	□
8. Throw a ball overhead	□	□	□	□	□	□	□	□
9. Do usual work **Please list your usual work:**	□	□	□	□	□	□	□	□
10. Do usual sport **Please list your usual sport:**	□	□	□	□	□	□	□	□

Pain, Activities of Daily Life:

RIGHT SIDE	**LEFT SIDE**
Pain (highest intensity within 24 hrs) □ none □ mild □ moderate □ severe	□ none □ mild □ moderate □ severe
Ability to do work □ 0% □ 25% □ 50% □ 75% □ 100%	□ 0% □ 25% □ 50% □ 75% □ 100%
Recreation/sport □ not possible □ limited a little □ very much limited □ not limited at all □ moderately limited	□ not possible □ limited a little □ very much limited □ not limited at all □ moderately limited
Unaffected sleep (Indicate how often you are able to sleep ***without*** shoulder pain) □ never □ sometimes □ always	□ never □ sometimes □ always

DATE: **SIGNATURE:**

Appendix 2

Patient Name: _____
Medical Record No.: _____
Date of Surgery: _____

PRE-OPERATIVE ANALYSIS

Date of Service:_____ **Gender:** □ Male □ Female

Height _____ **Weight** _____ **Operative Site:** □ Left □ Right

Dominant side
 left
 right
 none

Duration of symptoms
_____(years)_____(months)

Medication
 none
 occasional analgesics (dose:_____)
 regular analgesics (dose: _____)
 NSAID (dose: _____)
 DMARD (dose: _____)
 other: _____

Surgical History – Shoulder related

Operative Side	Contralateral Side		Date
		Brachial Plexus / Axillary Dissection	_____
		Cervical Procedure	_____
		Lymph node biopsy	_____
		Mastectomy / with Radiotherapy? Yes	_____
		Radical Neck	_____
		Other _____	_____

Surgical History – Shoulder Specific

Operative Side	Contralateral Side		Date
		Acromio-humeral ligament release	_____
		Acromioplasty	_____
		Alteration of glenoid version	_____
		Arthroplasty- Hemi	_____
		Arthroplasty- Total	_____
		Arthroscopy	_____
		Biological resurfacing of the glenoid	_____
		Capsulorraphy	_____
		Coraco-humeral ligament release	_____
		Coracoidplasty	_____
		Cuff repair	_____
		Glenoid bone graft	_____
		Greater tuberosity osteotomy	_____
		Hardware removal	_____
		Humeral bone graft	_____
		Lengthen subscap with juxtaglenoid capsulotomy	_____
		Lengthen subscap with Z-plasty	_____
		Lesser tuberosity osteotomy	_____
		Muscle transfer for cuff deficiency	_____
		Osteosynthesis	_____
		Osteotomy (double osteotomy? Yes)	_____
		Resection of lateral cm of the clavicle	_____
		Subscapularisplasty: pectoral major / other	_____
		Synovectomy	_____
		Tenodesis / Tenotomy long head of biceps	_____

General risk factors
- ☐ none
- ☐ malignoma, tumor
- ☐ diabetes
- ☐ endocrine disease
- ☐ cardiovascular disorder
- ☐ previous DVT
- ☐ neurological disease
- ☐ alcohol or drug abuse
- ☐ renal disease
- ☐ pulmonary embolism

Local risk factors
- ☐ none
- ☐ post infection
- ☐ latent infection
- ☐ other: _____

Atrophy:	**Operative Side** □ **No** □ **Yes – location:**	**Contralateral Side** □ **No** □ **Yes – location:**
Deltoid	☐ None ☐ Mild ☐ Moderate ☐ Severe	☐ None ☐ Mild ☐ Moderate ☐ Severe
Supraspinous Fossa	☐ None ☐ Mild ☐ Moderate ☐ Severe	☐ None ☐ Mild ☐ Moderate ☐ Severe
Infraspinous Fossa	☐ None ☐ Mild ☐ Moderate ☐ Severe	☐ None ☐ Mild ☐ Moderate ☐ Severe
Biceps Deformity	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A
Subscapularis	☐ No ☐ Partial ☐ Complete	☐ No ☐ Partial ☐ Complete

Tenderness to Palpation:

		Check if YES:
Operative Side:	☐ Greater tuberosity ☐ Biceps Groove ☐ Coracoid	☐ Palp RC Defect ☐ Ant Acromion ☐ ACJ ☐ Ant GH joint ☐ Post GH joint ☐ Trap ☐ Clav shaft ☐ Scapula
Contralateral Side:	☐ Greater tuberosity ☐ Biceps Groove ☐ Coracoid	☐ Palp RC Defect ☐ Ant Acromion ☐ ACJ ☐ Ant GH joint ☐ Post GH joint ☐ Trap ☐ Clav shaft ☐ Scapula

PAIN, RANGE OF MOTION, AND STRENGTH

Positioning (pain free)

Operative Side	**Contralateral Side**
☐ up to waist	☐ up to waist
☐ up to xiphoid	☐ up to xiphoid
☐ up to neck	☐ up to neck
☐ up to top of head	☐ up to top of head
☐ above head	☐ above head

_____ º	_____ º Forward Elevation (flexion)
_____ º	_____ º Lateral Elevation (abduction)
_____ º	_____ º Cross-body Adduction (antecubital fossa to the opposite acromion)

Positioning – Operative Side		**Positioning – Contralateral Side**	
hand behind head with elbow forward	☐ yes (2) ☐ no	hand behind head with elbow forward	☐ yes (2) ☐ no
hand behind head with elbow back	☐ yes (2) ☐ no	hand behind head with elbow back	☐ yes (2) ☐ no
hand on top of head with elbow forward	☐ yes (2) ☐ no	hand on top of head with elbow forward	☐ yes (2) ☐ no
hand on top of head with elbow back	☐ yes (2) ☐ no	hand on top of head with elbow back	☐ yes (2) ☐ no
full elevation from top of head	☐ yes (2) ☐ no	full elevation from top of head	☐ yes (2) ☐ no

Operative Side

Internal Rotation

dorsum of hand to lateral thigh	☐ yes (0) ☐ no
dorsum of hand to buttock	☐ yes (2) ☐ no
dorsum of hand to lumbosacral junction	☐ yes (4) ☐ no
dorsum of hand to waist (3rd lumbar vert)	☐ yes (6) ☐ no
dorsum of hand to 12th dorsal vertebra	☐ yes (8) ☐ no
dorsum of hand to interscap. region (DV7)	☐ yes (10) ☐ no

External Rotation

_____ º

External Rotation Lag Sign (Arm at side)

☐ positive ☐ negative

Hornblower's Sign (Arm abducted)

☐ positive ☐ negative

Impingement

Neer: ☐ positive ☐ negative

Hawkins: ☐ positive ☐ negative

Subscap Strength:

Lift Off ☐ Not testable/stiff

☐ positive ☐ negative

Belly-Press Test ☐ Not testable/stiff

☐ positive ☐ negative

Strength of Abduction: active motion, pain free

Measurement	1	2	3	points
at 90º	___kg	___kg	___kg	_____
at ____º	___kg	___kg	___kg	_____

Contralateral Side

Internal Rotation

dorsum of hand to lateral thigh	☐ yes (0) ☐ no
dorsum of hand to buttock	☐ yes (2) ☐ no
dorsum of hand to lumbosacral junction	☐ yes (4) ☐ no
dorsum of hand to waist (3rd lumbar vert)	☐ yes (6) ☐ no
dorsum of hand to 12th dorsal vertebra	☐ yes (8) ☐ no
dorsum of hand to interscap. region (DV7)	☐ yes (10) ☐ no

External Rotation

_____ º

External Rotation Lag Sign (arm at side)

☐ positive ☐ negative

Hornblower's Sign (Arm abducted)

☐ positive ☐ negative

Impingement

Neer: ☐ positive ☐ negative

Hawkins: ☐ positive ☐ negative

Lift-Off ☐ Not testable/stiff

☐ positive ☐ negative

Belly-Press Test ☐ Not testable/stiff

☐ positive ☐ negative

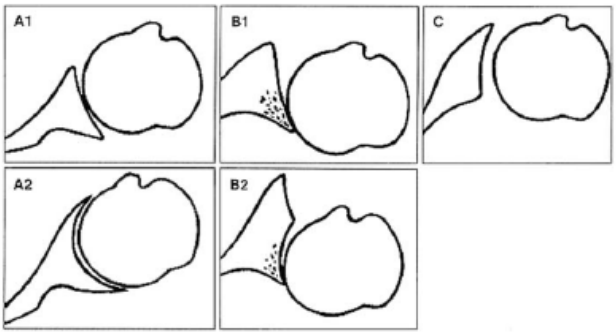
Strength of Abduction: active motion, pain free

Measurement	1	2	3	points
At 90º	___kg	___kg	___kg	_____
at ____º	___kg	___kg	___kg	_____

IMAGING:

Glenoid **Assessed?** ☐ Yes ☐ No

Glenoid Imaging Method: ☐ X-ray ☐ CT ☐ MRI



Walch et al. J Arthroplasty. 1999

Axial Glenoid Morphology:

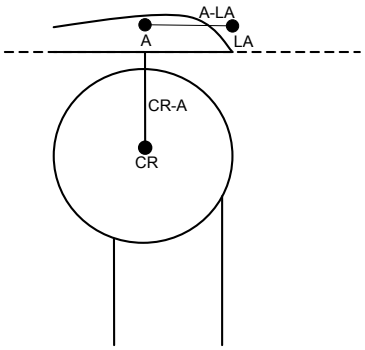
Operated Side
- ☐ A1 – Well balanced stress distribution
- ☐ A2 – Well balanced stress distribution with concentric wear
- ☐ B1 – Asymmetric stress distribution with subluxation
- ☐ B2 – Asymmetric stress distribution with biconcavity
- ☐ C

Contralateral Side
- ☐ A1 – Well balanced stress distribution
- ☐ A2 – Well balanced stress distribution with concentric wear
- ☐ B1 – Asymmetric stress distribution with subluxation
- ☐ B2 – Asymmetric stress distribution with biconcavity
- ☐ C

Measurements Preop

Operated Side
CR to A (mm) _____
A to LA (mm) _____
L (mm) _____

Contralateral Side
CR to A (mm) _____
A to LA (mm) _____
L (mm) _____



Rotator Cuff **Assessed?** ☐ Yes ☐ No

Rotator Cuff Imaging Method: ☐ X-ray ☐ CT ☐ MRI

Operated Side

Subscapularis
- ☐ N/A
- ☐ Intact
- ☐ Partial tear
- ☐ Complete tear

Long head biceps
- ☐ N/A
- ☐ Normal
- ☐ Inflamed but located
- ☐ Subluxed
- ☐ Dislocated
- ☐ Partially torn / frayed
- ☐ Pre-rupture
- ☐ Complete rupture

Supraspinatus
- ☐ N/A
- ☐ Intact
- ☐ Deep partial tear
- ☐ Bursal partial tear
- ☐ Complete tear

Infraspinatus
- ☐ N/A
- ☐ Intact
- ☐ Partial tear
- ☐ Complete tear

Teres Minor
- ☐ N/A
- ☐ Torn
- ☐ Can't say

Contralateral Side

Subscapularis	Long head biceps	Supraspinatus	Infraspinatus	Teres Minor
☐ N/A	☐ N/A	☐ N/A	☐ N/A	☐ N/A
☐ Intact	☐ Normal	☐ Intact	☐ Intact	☐ Torn
☐ Partial tear	☐ Inflamed but located	☐ Deep partial tear	☐ Partial tear	☐ Can't say
☐ Complete tear	☐ Subluxed	☐ Bursal partial tear	☐ Complete tear	
	☐ Dislocated	☐ Complete tear		
	☐ Partially torn / frayed			
	☐ Pre-rupture			
	☐ Complete rupture			

Diagnosis

☐ primary omarthrosis ☐ secondary omarthrosis ☐ Trauma sequelae*

		Operative	Contralateral
Acute Trauma*	Proximal humerus fracture		
	Acute Rotator cuff tear		
Glenohumeral Arthritis	Primary OA		
	Primary OA with history of previous RC surgery (ie SAD, calcific deposit removal, RCR)		
	OA + Massive RCT/CTA*		
	OA + Massive RCT/CTA with prior Non-arthroplasty surgery*		
	Instability OA / Capsulorrhaphy Arthropathy*		
	Associated Neurologic Pathology (hemiplegia, paraplegia, MS, epilepsy, polio, nerve lesion)		
	Parkinson's Disease		
	Previous radiotherapy (ie breast cancer, Hodgkin's)		
Atraumatic Avascular Necrosis*			
Failed Prior Arthroplasty			
Inflammatory glenohumeral arthropathy	Others (Alkalosing spondylitis, Psoriasis, SLE)		
	Rheumatoid Arthritis*		
Locked posterior dislocation	Acute		
	Chronic		
Massive Cuff Tear, no arthritis			
Post-infectious arthritis			
Post Traumatic Arthritis	Chondral injury		
	Malunion proximal humerus fracture		
	Nonunion proximal humerus fracture		
	Post Traumatic Avascular necrosis		
Tumor			
Other:			

*** Fill out *Diagnosis Specific Form (back of packet):***

- **Trauma sequelae – s/p fractures, s/p dislocations, locked dislocations, and post traumatic DJD without bony deformation**
- **RA**
- **Nontraumatic AVN**
- **Massive rotator cuff tear DJD / Rotator cuff Arthropathy**
- **Instability Arthritis / Capsulorrhaphy Arthropathy**

ASES PHYSICIANS ASSESSMENT SIGNS

Sign	right				left			
Supraspinatus/greater tuberosity tenderness	0	1	2	3	0	1	2	3
Acromioclavicular joint tenderness	0	1	2	3	0	1	2	3
Biceps tendon tenderness (or rupture)	0	1	2	3	0	1	2	3
Other tenderness-list:	0	1	2	3	0	1	2	3
Impingement I (passive forward elevation in slight internal rotation)	yes		no		yes		no	
Impingement II (passive internal rotation with 90 degrees of flexion)	yes		no		yes		no	
Impingement III (90 degrees of active abduction-classic painful arc)	yes		no		yes		no	
Subacromial crepitus	yes		no		yes		no	
Scars-location:	yes		no		yes		no	
Atrophy-location:	yes		no		yes		no	
Deformity-describe:	yes		no		yes		no	

ASES PHYSICIANS ASSESSMENT: STRENGTH (RECORD MRC GRADE)

0 = none contraction; 1 = flicker; 2 = movement with gravity eliminated;
3 = movement against gravity; 4 = movement against some resistance; 5 = normal power

	right						left					
Testing affected by pain?	yes			no			yes			no		
Forward elevation	0	1	2	3	4	5	0	1	2	3	4	5
Abduction	0	1	2	3	4	5	0	1	2	3	4	5
External rotation (arm comfortably at side)	0	1	2	3	4	5	0	1	2	3	4	5
Internal rotation (arm comfortably at side)	0	1	2	3	4	5	0	1	2	3	4	5

ASES PHYSICIANS ASSESSMENT: INSTABILITY

0= none; 1 =mild (0-1 cm translation);
2 = moderate (1-2 cm translation or translates to glenoid rim); 3 = severe (>2 cm translation or over rim of glenoid)

	right				left			
Anterior translation	0	1	2	3	0	1	2	3
Posterior translation	0	1	2	3	0	1	2	3
Interior translation (sulcus sign)	0	1	2	3	0	1	2	3
Anterior apprehension	0	1	2	3	0	1	2	3
Reproduces symptoms?	yes		no		yes		no	
Voluntary instability?	yes		no		yes		no	
Relocation test positive?	yes		no		yes		no	
Generalized ligamentous laxity?	yes		no					
Other physical findings:								

Comments/Notes

_____

_____

_____

DATE: _____ **SIGNATURE:** _____

DIAGNOSIS SPECIFIC FORMS (complete only if applicable)

Instability Osteoarthritis / Capsulorrhapy Arthropathy

Direction of Instability

Operative Side	**Contralateral Side** (No instability)
Anterior	Anterior
Posterior	Posterior
Multidirectional	Multidirectional

Date of first dislocation

Operative Side _____ **Contralateral Side** _____

Number of Dislocations

Operative Side ____ **Contralateral** ____

Surgical Procedures for Instability:

Operative Side:	Date	Procedure
	_____	_____
	_____	_____
	_____	_____
Contralateral:		
	_____	_____
	_____	_____
	_____	_____

Nontraumatic Avascular Necrosis

Risk Factors Present:

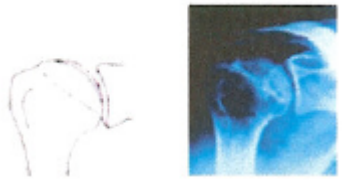
Steroid Treatment Amount :
- ☐ Intravenous _____
- ☐ Intramuscular _____
- ☐ Oral _____
- ☐ Inhaled _____

☐ Alcohol ingestion
☐ Dysbaric Disorder (Deep Sea Diver)
☐ Gaucher's Disease
☐ Sickle Cell Anemia
☐ Radiation Therapy
☐ SLE
☐ Lipid Metabolism Disorder
☐ Fatty Liver
☐ Pancreatitis
☐ Kidney transplant
☐ Osteomalacia
☐ Lymphoma
☐ Asthma / COPD
☐ Neurologic
☐ Clotting Disorder
☐ History of Thrombosis
___ MI ___ DVT ___ CVA

Radiographic Stage:

	Operative Side	Contralateral Side
1. Pain, but plain radiographs are normal. MRI may show change. **NORMAL X-RAYS**	☐	☐
2. Localized zone of osteoporosis and sclerosis. No collapse.	☐	☐

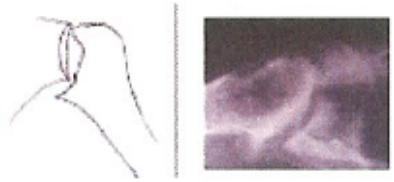
3. Subchondral fracture with crescent sign. Sphericity of head is still normal.	☐	☐



4. Collapse of the humeral head with loss of sphericity. GH joint space preserved.	☐	☐

5. Collapse with associated narrowing of glenohumeral joint and involvement of glenoid.	☐	☐

6. Stage 5 with advanced collapse and impaction.	☐	☐



Arthritis and Massive Rotator Cuff Tear Arthropathy

Is there a suspicion of metabolic disease or crystalline arthropathy (e.g. chondrocalcinosis, hyperuricemia)?

 Yes No Not Sure

Radiographic Analysis (True AP view with arm in neutral rotation):

Acromion

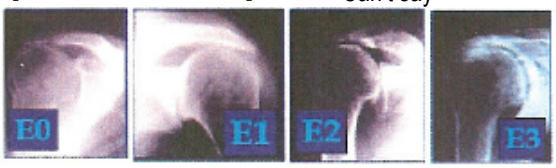
Operative Side	Contralateral Side	
		1) Normal/slight sclerosis
		2) Mild erosion into acromion
		3) Hypertrophic acetabularization
		4) Fx/Osteolysis
		5) Can't say

Humeral Head

Operative Side	Contralateral Side	
		1) Normal
		2) Greater tuberosity rounded off
		3) Osteopenic without necrosis
		4) Partial necrosis
		5) Total necrosis or osteolysis
		6) Can't say

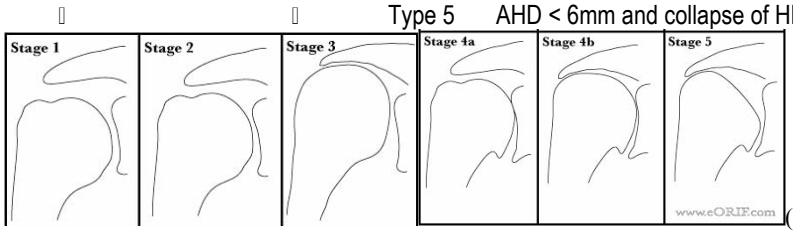
Erosion of Glenoid on AP X-ray

Operative Side	Contralateral Side	
		E0 Normal glenoid
		E1 Central erosion
		E2 Superior erosion with Bi-concavity
		E3 Severe superior erosion with superiorly oriented concavity [pseudo acetabulum]
		Can't say



Glenohumeral Arthritis (*Hamada*)

Operative Side	Contralateral Side	
		Type 1 massive RCT with AHD . 6mm
		Type 2 massive RCT with AHD < 6mm
		Type 3 massive RCT with AHD < 6mm with acetabulization (concavity deformation) of the inferior acromion
		Type 4A AHD < 6mm and GH joint narrowing (no acetabulization)
		Type 4B AHD < 6mm, GH joint narrowing and acetabulization of the acromion
		Type 5 AHD < 6mm and collapse of HH

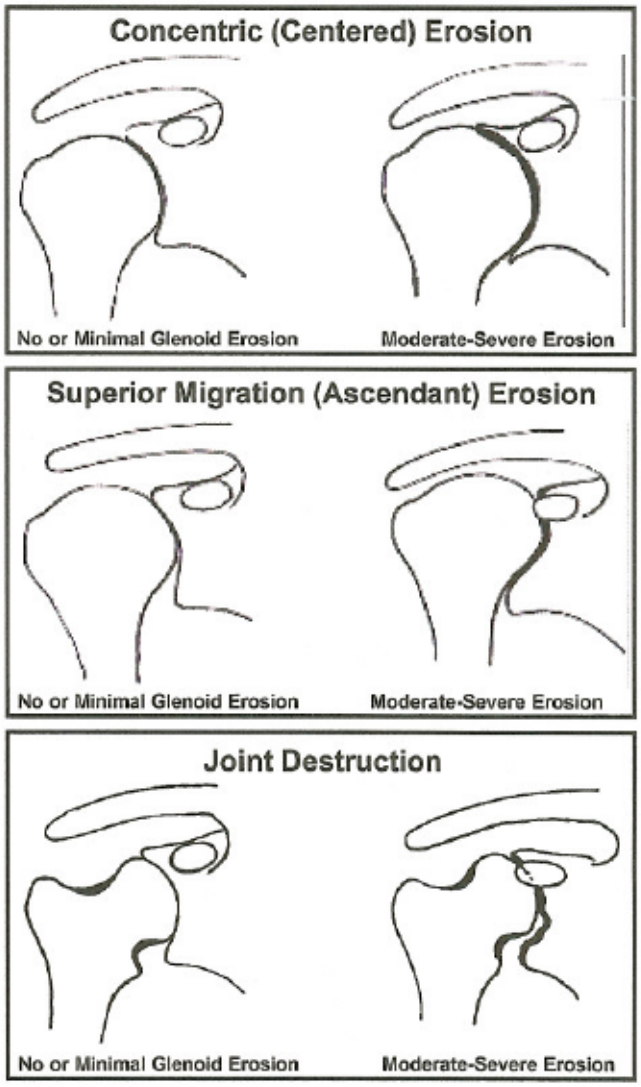


(Hamada K, CORR 1990; 254:92)

Rheumatoid Arthritis

Year Diagnosed: _____ **Time elapsed since diagnosis (years):** _____

Operative Side	Contralateral Side	
_____	_____	Number of shoulder radio-isotope injections
☐	☐	Radiotherapy
		Other areas involved:
☐	☐	Shoulders
☐	☐	Elbows
☐	☐	Wrists
☐	☐	MCP/IP's
☐	☐	CSpine
☐	☐	Hips
☐	☐	Knees
☐	☐	Ankle/Feet



X-Ray Classification

Type of Joint Erosion (*Levigne and Franceschi 1996)*

Operative Side	Contralateral Side	
☐	☐	Concentric erosion
☐	☐	Superior migration
☐	☐	Joint destruction
☐	☐	Can't tell

Amount of glenoid erosion

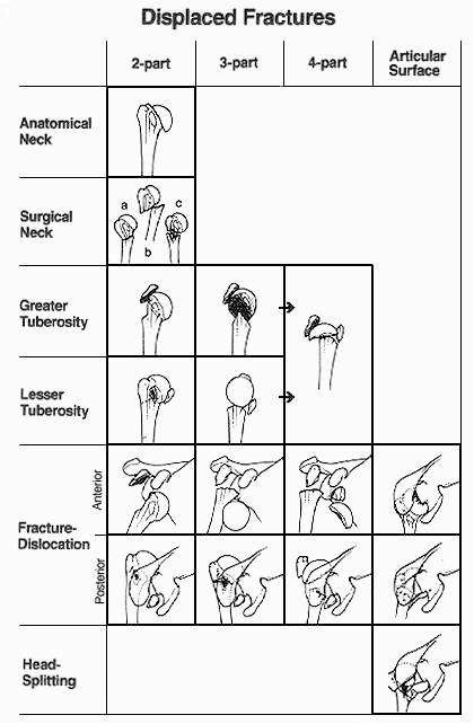
Operative Side	Contralateral Side	
☐	☐	No or minimal erosion
☐	☐	Moderate to Severe erosion

Acromiohumeral Distance (mm)

Operative Side	Contralateral Side
_____ **mm**	_____ **mm**

Trauma / Fracture Sequelae
(fractures, dislocations, post traumatic arthrosis without any clear bony deformation)

Date of fracture _____
Type of initial fracture (AO): _____-_____-_____



Type of initial fracture (Neer):
- ☐ One part (Minimally displaced)
- ☐ Two part anatomic neck
- ☐ Two part surgical neck
- ☐ Two part greater tuberosity
- ☐ Two part lesser tuberosity
- ☐ Three part greater tuberosity
- ☐ Three part lesser tuberosity
- ☐ Four part
- ☐ Valgus impacted four part
- ☐ Isolated head split / Impaction fx
- ☐ N/A
- ☐ With dislocation- anterior
- ☐ With dislocation- posterior
- ☐ With head split: ☐ Yes ☐ No

Original Treatments (list all:)

1) Date: _____ ☐ Non-Operative ☐ CRPP ☐ ORIF ☐ I&D ☐ Arthroscopy ☐ Arthrolysis ☐ Cuff Repair
2) Date: _____ ☐ Non-Operative ☐ CRPP ☐ ORIF ☐ I&D ☐ Arthroscopy ☐ Arthrolysis ☐ Cuff Repair
3) Date: _____ ☐ Non-Operative ☐ CRPP ☐ ORIF ☐ I&D ☐ Arthroscopy ☐ Arthrolysis ☐ Cuff Repair

Classification of the Fracture Sequelae: (check subtype(s) that best apply)

- ☐ **Type 1A: *Valgus* impacted surgical neck malunion, with minimal tuberosity malunion**
  - ☐ Valgus impacted malunion (MU) with *arthritis* only (no necrosis)
  - ☐ Valgus impacted MU with necrosis only
  - ☐ Valgus impacted MU with necrosis AND arthritis, but NO collapse
  - ☐ Valgus impacted MU with necrosis AND head collapse
- ☐ **Type 1B: *Varus* impacted surgical neck malunion, with minimal tuberosity malunion**
  - ☐ Varus impacted malunion (MU) with *arthritis* only (no necrosis)
  - ☐ Varus impacted MU with necrosis only
  - ☐ Varus impacted MU with necrosis AND arthritis, but NO collapse
  - ☐ Varus impacted MU with necrosis AND head collapse
- ☐ **Type 2A: Locked posterior dislocation**
- ☐ **Type 2B: Locked posterior fracture dislocation**
- ☐ **Type 3A: Surgical neck nonunion (2 part)**
- ☐ **Type 3B: Surgical neck nonunion (3 or 4 parts)**
- ☐ **Type 4: Nonunion OR severe malunion of the tuberosities**
- ☐ **Type 5A: Post traumatic arthritis without collapse**
- ☐ **Type 5B: Post traumatic arthritis with collapse**
- ☐ **PTA: Post traumatic arthritis with clear deformation**
- ☐ **GHA: GH arthritis after humeral diaphyseal fracture**
- ☐ **Other**_____

Appendix 3

Patient Name: _____
Medical Record No.: _____
Date of Surgery: _____

PROGRESS NOTE - TSA

Date of Service:_____ **Follow up:** □ 3 mo. □ 6 mo. □ 1 yr □ 2 yrs □ 5yrs □ 10yrs

Operative Site: □ Left □ Right

Atrophy:	**Operative Side**	**Contralateral Side**
Deltoid:	None Mild Moderate Severe	None Mild Moderate Severe
Supraspinous Fossa	None Mild Moderate Severe	None Mild Moderate Severe
Infraspinous Fossa	None Mild Moderate Severe	None Mild Moderate Severe
Biceps Deformity	No Yes N/A	No Yes N/A
Subscapularis	No Partial Complete	No Partial Complete

Tenderness to Palpation:

Operative Side:
- None
- Greater tuberosity
- Coracoid
- Biceps Groove

Check if tenderness:
Palp RC Defect Ant Acromion ACJ
Ant GH joint Post GH joint Trap
Clav shaft Scapula

Contralateral Side:
- None
- Greater tuberosity
- Coracoid
- Biceps Groove

Check if tenderness:
Palp RC Defect Ant Acromion ACJ
Ant GH joint Post GH joint Trap
Clav shaft Scapula

PAIN, RANGE OF MOTION, AND STRENGTH

Positioning (pain free)

Operative Side	**Contralateral Side**
up to waist	up to waist
up to xiphoid	up to xiphoid
up to neck	up to neck
up to top of head	up to top of head
above head	above head

_____ º	_____ º	Forward Elevation (flexion)
_____ º	_____ º	Lateral Elevation (abduction)
_____ º	_____ º	Cross-body Adduction (antecubital fossa to the opposite acromion)

Positioning – Operative Side		**Positioning – Contralateral Side**	
hand behind head with elbow forward	yes (2) no	hand behind head with elbow forward	yes (2) no
hand behind head with elbow back	yes (2) no	hand behind head with elbow back	yes (2) no
hand on top of head with elbow forward	yes (2) no	hand on top of head with elbow forward	yes (2) no
hand on top of head with elbow back	yes (2) no	hand on top of head with elbow back	yes (2) no
full elevation from top of head	yes (2) no	full elevation from top of head	yes (2) no

Operative Side

Internal Rotation

dorsum of hand to lateral thigh	☐ yes (0) ☐ no
dorsum of hand to buttock	☐ yes (2) ☐ no
dorsum of hand to lumbosacral junction	☐ yes (4) ☐ no
dorsum of hand to waist (3rd lumbar vert)	☐ yes (6) ☐ no
dorsum of hand to 12th dorsal vertebra	☐ yes (8) ☐ no
dorsum of hand to interscap. region (DV7)	☐ yes (10) ☐ no

External Rotation

_____ º

External Rotation Lag Sign (Arm at side)

☐ positive ☐ negative

Hornblower's Sign (Arm abducted)

☐ positive ☐ negative

Impingement

Neer

☐ positive ☐ negative

Hawkins

☐ positive ☐ negative

Subscap Strength

Lift Off

☐ positive ☐ negative

Belly-Press Test

☐ positive ☐ negative

Strength of Abduction: active motion, pain free

Measurement	1	2	3	points
at 90º	___kg	___kg	___kg	_____
at ____º	___kg	___kg	___kg	_____

Contralateral Side

Internal Rotation

dorsum of hand to lateral thigh	☐ yes (0) ☐ no
dorsum of hand to buttock	☐ yes (2) ☐ no
dorsum of hand to lumbosacral junction	☐ yes (4) ☐ no
dorsum of hand to waist (3rd lumbar vert)	☐ yes (6) ☐ no
dorsum of hand to 12th dorsal vertebra	☐ yes (8) ☐ no
dorsum of hand to interscap. region (DV7)	☐ yes (10) ☐ no

External Rotation

_____ º

External Rotation Lag Sign (arm at side)

☐ positive ☐ negative

Hornblower's Sign (Arm abducted)

☐ positive ☐ negative

Impingement

Neer

☐ positive ☐ negative

Hawkins

☐ positive ☐ negative

Subscap Strength

Lift-Off

☐ positive ☐ negative

Belly-Press Test

☐ positive ☐ negative

Strength of Abduction: active motion, pain free

Measurement	1	2	3	points
At 90º	___kg	___kg	___kg	_____
at ____º	___kg	___kg	___kg	_____

ASES PHYSICIANS ASSESSMENT SIGNS

Sign	right				left			
Supraspinatus/greater tuberosity tenderness	0	1	2	3	0	1	2	3
Acromioclavicular joint tenderness	0	1	2	3	0	1	2	3
Biceps tendon tenderness (or rupture)	0	1	2	3	0	1	2	3
Other tenderness-list:	0	1	2	3	0	1	2	3
Impingement I (passive forward elevation in slight internal rotation)	yes		no		yes		no	
Impingement II (passive internal rotation with 90 degrees of flexion)	yes		no		yes		no	
Impingement III (90 degrees of active abduction-classic painful arc)	yes		no		yes		no	
Subacromial crepitus	yes		no		yes		no	
Scars-location:	yes		no		yes		no	
Atrophy-location:	yes		no		yes		no	
Deformity-describe:	yes		no		yes		no	

ASES PHYSICIANS ASSESSMENT: STRENGTH (RECORD MRC GRADE)

0 = none contraction; 1 = flicker; 2 = movement with gravity eliminated;
3 = movement against gravity; 4 = movement against some resistance; 5 = normal power

	right						left					
Testing affected by pain?	yes			no			yes			no		
Forward elevation	0	1	2	3	4	5	0	1	2	3	4	5
Abduction	0	1	2	3	4	5	0	1	2	3	4	5
External rotation (arm comfortably at side)	0	1	2	3	4	5	0	1	2	3	4	5
Internal rotation (arm comfortably at side)	0	1	2	3	4	5	0	1	2	3	4	5

ASES PHYSICIANS ASSESSMENT: INSTABILITY

0= none; 1 =mild (0-1 cm translation);
2 = moderate (1-2 cm translation or translates to glenoid rim); 3 = severe (>2 cm translation or over rim of glenoid)

	right				left			
Anterior translation	0	1	2	3	0	1	2	3
Posterior translation	0	1	2	3	0	1	2	3
Interior translation (sulcus sign)	0	1	2	3	0	1	2	3
Anterior apprehension	0	1	2	3	0	1	2	3
Reproduces symptoms?	yes		no		yes		no	
Voluntary instability?	yes		no		yes		no	
Relocation test positive?	yes		no		yes		no	

Generalized ligamentous laxity? yes no

Other physical findings:

Comments/Notes

_____

_____

_____

DATE: _____ **SIGNATURE:** _____

COMPLICATIONS SINCE DISCHARGE:

 Yes **No**

If yes, please specify below:

 humeral fracture
 septic loosening
 aseptic loosening of humeral component
 aseptic loosening of glenoid component
 position change of humeral component:
 tilt: _____ subsidence: _____
 position change of glenoid component:
 please specify: _____
 luxation/dislocation 1)
 ectrophic ossification
 superficial would infection 2)
 deep joint infection 2)
 device fracture
 clinical deep vein thrombosis
 other: _____

1) LUXATION/DISLOCATION

 anterior subluxation
 anterior luxation
 posterior subluxation
 posterior luxation
 inferior luxation
 inferior subluxation
 other: _____

2) SIGNS OF INFECTION

 chronic: _____
 acute: _____
 other: _____

Treatment of Complications

_____

_____

Revision indicated?

 Yes
 No

if yes, please specify:

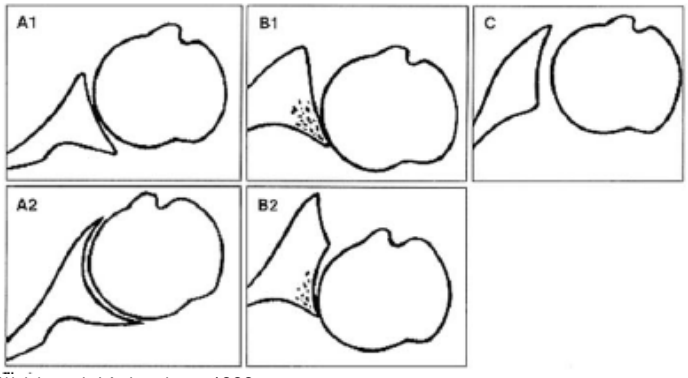
 revision humeral component
 revision glenoid component
 other: _____

Date of planned revision: _____

Glenoid

Assessed? □ Yes □ No

Glenoid Imaging Method: □ x-ray □ CT □ MRI



Walch et al. J Arthroplasty. 1999

Axial Glenoid Morphology:

Operated Side
- □ A1 – Well balanced stress distribution
- □ A2 – Well balanced stress distribution with concentric wear
- □ B1 – Asymmetric stress distribution with subluxation
- □ B2 – Asymmetric stress distribution with biconcavity
- □ C

Contralateral Side
- □ A1 – Well balanced stress distribution
- □ A2 – Well balanced stress distribution with concentric wear
- □ B1 – Asymmetric stress distribution with subluxation
- □ B2 – Asymmetric stress distribution with biconcavity
- □ C

Rotator Cuff

Assessed? □ Yes □ No

Rotator Cuff Imaging Method: □ x-ray □ CT □ MRI

Operated Side

Subscapularis	Long head biceps	Supraspinatus	Infraspinatus	Teres Minor
□ N/A	□ N/A	□ N/A	□ N/A	□ N/A
□ Intact	□ Normal	□ Intact	□ Intact	□ Torn
□ Partial tear	□ Inflamed but located	□ Deep partial tear	□ Partial tear	□ Can't say
□ Complete tear	□ Subluxed	□ Bursal partial tear	□ Complete tear	
	□ Dislocated	□ Complete tear		
	□ Partially torn / frayed			
	□ Pre-rupture			
	□ Complete rupture			

Contralateral Side

Subscapularis	Long head biceps	Supraspinatus	Infraspinatus	Teres Minor
□ N/A	□ N/A	□ N/A	□ N/A	□ N/A
□ Intact	□ Normal	□ Intact	□ Intact	□ Torn
□ Partial tear	□ Inflamed but located	□ Deep partial tear	□ Partial tear	□ Can't say
□ Complete tear	□ Subluxed	□ Bursal partial tear	□ Complete tear	
	□ Dislocated	□ Complete tear		
	□ Partially torn / frayed			
	□ Pre-rupture			
	□ Complete rupture			

POST-OP IMAGING

GLENOID

☐ **X-ray not clear**

☐ grade 0 ☐ grade 1 ☐ grade 2 ☐ grade 3 ☐ grade 4 ☐ grade 5

no radiolucency | complete radiolucency around 1 or 2 pegs | complete radiolucency (≤2mm) around 1 peg | complete radiolucency (≤2mm) around 2 or more pegs | complete radiolucency (>2mm) around 2 or more pegs | gross loosening

Osteolysis
- ☐ no osteolysis
- ☐ around 1 peg
- ☐ around more than one peg
- ☐ other: _____

Glenoid migration
- ☐ none
- ☐ caudal
- ☐ medial
- ☐ incomplete contact on AP and axial radiograph

Glenoid component seating
- ☐ complete
- ☐ incomplete contact on AP radiograph
- ☐ incomplete contact on axial radiograph

GLENOID

Operative Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

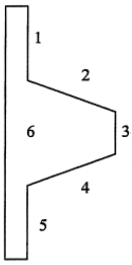
Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm

Migration? ☐ Yes ☐ No
Osteolysis? ☐ Yes ☐ No

Contralateral Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm



Migration? ☐ Yes ☐ No
Osteolysis? ☐ Yes ☐ No

HUMERAL

Operative Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

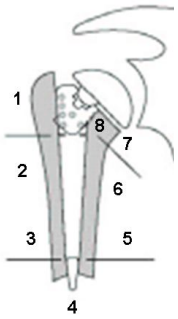
Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm
Zone 7	< 1mm	1 – 2 mm	> 2 mm
Zone 8	< 1mm	1 – 2 mm	> 2 mm

Migration? ☐ Yes ☐ No
Osteolysis? ☐ Yes ☐ No

Contralateral Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm
Zone 7	< 1mm	1 – 2 mm	> 2 mm
Zone 8	< 1mm	1 – 2 mm	> 2 mm



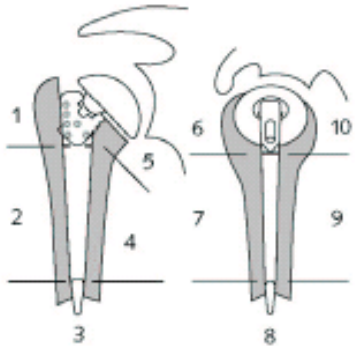
Migration? ☐ Yes ☐ No
Osteolysis? ☐ Yes ☐ No

HUMERAL HEAD AND STEM

Head position with Respect to glenoid

- ☐ centered
- ☐ posterior ___ mm
- ☐ anterior ___ mm
- ☐ inferior ___ mm
- ☐ superior ___ mm

	Radiolucency			Osteolysis	
	0 mm	1-2 mm	>2mm	yes	no
zone 1	☐	☐	☐	☐	☐
zone 2	☐	☐	☐	☐	☐
zone 3	☐	☐	☐	☐	☐
zone 4	☐	☐	☐	☐	☐
zone 5	☐	☐	☐	☐	☐
zone 6	☐	☐	☐	☐	☐
zone 7	☐	☐	☐	☐	☐
zone 8	☐	☐	☐	☐	☐
zone 9	☐	☐	☐	☐	☐
zone 10	☐	☐	☐	☐	☐



Interface: _____

Stem position

☐ unchanged ☐ varus tilt ___° ☐ valgus tilt ___° ☐ axial subsidence ☐ retroversion ___° ☐ other: _____

Reverse TSA

Glenoid Notching AP XR:

Operative Side

- ☐ No notch
- ☐ Small notch – no screws involved
- ☐ Notch extending to lower screw
- ☐ Severe notching – extends beyond lower screw

Contralateral Side

- ☐ No notch
- ☐ Small notch – no screws involved
- ☐ Notch extending to lower screw
- ☐ Severe notching – extends beyond lower screw

Glenoid Lucencies

Operative Side:

- ☐ No lucencies
- ☐ Involving central peg
- ☐ Involving screws
- ☐ Involving baseplate (sup or inf)
- ☐ Migration / Tilt of component

Contralateral Side:

- ☐ No lucencies
- ☐ Involving central peg
- ☐ Involving screws
- ☐ Involving baseplate (sup or inf)
- ☐ Migration / Tilt of component

Humeral Lucencies:

(zones are same as those in figure for Humeral Radiolucent Lines, previous page)

Operative Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm
Zone 7	< 1mm	1 – 2 mm	> 2 mm

Contralateral Side:

Radiolucent Lines? ☐ No ☐ Yes: (circle)

Zone 1	< 1mm	1 – 2 mm	> 2 mm
Zone 2	< 1mm	1 – 2 mm	> 2 mm
Zone 3	< 1mm	1 – 2 mm	> 2 mm
Zone 4	< 1mm	1 – 2 mm	> 2 mm
Zone 5	< 1mm	1 – 2 mm	> 2 mm
Zone 6	< 1mm	1 – 2 mm	> 2 mm
Zone 7	< 1mm	1 – 2 mm	> 2 mm

Ossifications

Operative Side

- I. Isolated small items of bone in S.T.
- II. > 1cm between bone surfaces
- III. < 1cm between bone surfaces
- IV. Ankylosis

Contralateral Side

- I. Isolated small items of bone in S.T.
- II. > 1cm between bone surfaces
- III. < 1cm between bone surfaces
- IV. Ankylosis

Measurements Postop

Operative Side

CR to A (mm) _____
A to LA (mm) _____
L (mm) _____

Contralateral Side

CR to A (mm) _____
A to LA (mm) _____
L (mm) _____