1 A MULTICENTER PROSPECTIVE RANDOMIZED CONTROLLED TRIAL OF OPEN REDUCTION INTERNAL FIXATION VERSUS TOTAL ELBOW ARTHROPLASTY FOR DISPLACED INTRA-ARTICULAR DISTAL HUMERAL FRACTURES IN ELDERLY PATIENTS

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Purpose: We conducted a prospective randomized controlled trial to compare functional outcomes, complications and reoperation rates in elderly patients with displaced intra-articular distal humerus fractures treated with open reduction internal fixation (ORIF) or primary semi-constrained total elbow arthroplasty (TEA).

Methods: Forty-two patients were randomized by sealed envelope. Inclusion criteria were age >65 years, displaced intra-articular fractures of the distal humerus (OTA Type 13C), and closed or Gustilo grade I open fractures treated within 12 hours of injury. Both ORIF and TEA were performed following a standardized protocol. Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder and Hand (DASH) scores were collected at 6 weeks, 3 months, 6 months, 12 months and 2 years. Complication type, duration, management, and treatment requiring reoperation were recorded. An intention-to-treat and an on treatment analysis were conducted to address patients randomized to ORIF but converted to TEA intraoperatively.

Results: Twenty-one patients were randomized to each treatment group. Two patients died prior to follow-up and were excluded from the study. As allowed by the study protocol, five patients randomized to ORIF were converted to TEA intraoperatively because of extensive comminution and inability to obtain fixation stable enough to allow early ROM. This resulted in 15 patients (3 male, 12 female) with an average age of 77 years in the ORIF group and 25 patients (2 male, 23 female) with an average age of 78 in the TEA group. Baseline demographics for mechanism, classification, comorbidities, fracture type, activity level and ipsilateral injuries were similar between the two groups. MEPS was significantly improved at 3 months (82 vs 65, p=0.01), 6 months (86 vs 66, p=0.003), 12 months (87 vs 72, p=0.03) and 2 years (86 vs 73, p=0.04) in patients with TEA compared with ORIF. DASH scores showed a significant improvement for TEA compared with ORIF between 6 weeks (43 vs 77, p=0.02) and 6 months (31 vs 50, p=0.01) but not at 12 months (32 vs 47, p=0.1) and 2 years (34 vs 38, p=0.6). The mean flexion-extension arc was 107 degrees (range 42-145) for the TEA group and 95 degrees (range 30-140) for the ORIF group (p=0.19). Reoperation rates for TEA (3/25) and ORIF (4/15) were not statistically different (p=0.2). Conclusion: TEA for the treatment of comminuted intra-articular distal humeral fractures provides improved functional outcome compared with ORIF based on both objective elbow performance scores and patient self-rated upper extremity disability and symptoms. TEA may result in decreased reoperation rates considering 25% of OTA Type 13C fractures were not amenable to internal fixation. Elderly patients have an increased baseline DASH score and appear to accommodate to objective limitations in function with time.

2 FAILED OPEN REDUCTION AND INTERNAL FIXATION FOR ELBOW FRACTURES CONVERTED TO TOTAL ELBOW ARTHROPLASTY

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Background: Failed open reduction and internal fixation (ORIF) of elbow fractures with post-traumatic arthritis is a difficult problem to treat. In some patients, where revision ORIF cannot be adequately performed due to articular incongruity and/or inadequate good quality bone, total elbow arthroplasty (TEA) may be used as a salvage procedure. We report on the outcomes of 28 patients that were salvaged to a TEA after failed attempts at internal fixation.

Materials and Methods: Between August 1992 and August 2004, 28 patients underwent TEA after failed internal fixation. There were 26 females and 2 males who underwent a total of 36 attempts at internal fixation prior to their index elbow arthroplasty. Average age at injury was 66 years (range 28-79 years). Conversion to arthroplasty was performed at an average of 12 months after the last attempt at internal fixation. Average follow-up from date of index TEA was 36 months (range 7-96 months). Patient outcomes after arthroplasty were evaluated clinically and radiographically. American Shoulder and Elbow Surgeons (ASES) scores for pain and function were obtained after the last attempt at internal fixation and after elbow arthroplasty.

Results: Total ASES scores improved from 35.9 after the last attempt at internal fixation to 65 after elbow arthroplasty. Mean ASES pain scores improved from 22 to 35.7. Mean ASES function scores improved from 13.7 to 29.3. All improvements in ASES scores were statistically significant (p<0.05). Postoperatively, an improvement in motion was seen in the majority of patients with a mean arc of motion of 111 degrees (range 30 – 150 degrees). Complications included 1 deep infection and 5 cases of aseptic loosening of the components. The 5 patients with loosening were successfully revised, while the patient with deep infection was ultimately converted to an arthrodesis after a failed revision attempt.

Conclusion: TEA is a salvage procedure for failed internal fixation, leading to significant improvements in pain and function. The high rate of component loosening, which is of concern, may be related to the increased pathology and technical difficulty of elbow joint arthroplasty in the setting of prior failed internal fixation.
3 LONG TERM OUTCOME OF MASON 2 RADIAL HEAD FRACTURES TREATED WITH OPEN REDUCTION AND INTERNAL FIXATION

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Background: Good very long-term results have been reported for nonoperative treatment of stable isolated slightly displaced partial articular (Mason 2) fractures of the radial head. The role of operative treatment is uncertain. This investigation reports the long-term outcome of operatively treated fractures.

Methods: Sixteen patients with displaced but stable, isolated (meaning no associated fracture or ligament injury) partial articular (Mason 2) fractures of the radial head treated operatively between 1975 and 1992 were evaluated an average of 22 years (range, 14 to 30) after injury. Eleven fractures were secured with screws only; five with a small T-plate. Complications included two deep infections, two patients with implants restricting motion, and one posterior interosseous nerve palsy. Hardware was removed routinely (fourteen of sixteen patients).

Results: Between one year after surgery and the latest follow up there was an insignificant improvement in the average flexion arc from 122 degrees (range, 63 to 140) to 128 degrees (range, 110 to 140; p = 0.36). The average flexion arc for all patients at final follow-up was 129 degrees (range, 110 to 145). According to the Mayo Elbow Performance Index elbow function was excellent in 9, good in 4, fair in 2 and poor in one patient. The average score on the Disabilities of Arm Shoulder and Hand questionnaire was 12 points (range, 0 to 52).

Conclusion: The long-term results of the operative treatment of displaced but stable isolated partial articular fractures of the radial head demonstrate no appreciable advantage over nonoperative treatment. The appeal of operative treatment is diminished by the potential complications.

4 NONUNION OF THE CLAVICLE TREATED BY PLATE FIXATION: A REVIEW OF 47 CONSECUTIVE CASES

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Introduction: Previous authors have described a variety of methods to successfully treat clavicular nonunions, with little consensus as to which is the optimal method of fixation. In nearly all reported series, autogenous bone graft is recommended as a necessary adjunct to the healing process. We reviewed our experience with 47 clavicle nonunions performed by three experienced fracture surgeons between 1995 and 2005. This retrospective analysis was performed to assess the efficacy of plate fixation and the need for iliac crest bone grafting.

Methods: 47 consecutive patients underwent superior plating for a clavicular nonunion. Nonunions were repaired at an average of 11 months post fracture. Three patients had undergone a total of five surgical procedures prior to referral to our office. 42 patients were treated with pelvic reconstruction plates and 5 were treated with straight dynamic compression plates. 30 patients were treated with local bone graft only, 14 patients with demineralized bone matrix, and 3 patients with distant autogenous bone graft. Two patients had iliac crest bone grafting and one had graft taken from a resected rib. Union was achieved in 34 patients (72%). The average DASH score was 14.2 (range 0 to 53); however three patients significantly elevated the score with poor outcomes (44, 44, 53). Litigation and workman’s compensation corresponded to worse patient outcomes. On examination two of these patients demonstrated full active range of motion. Removing these three scores gave an average DASH of 8.5 (normal 10.1).

Plate prominence or sensitivity resulted in removal in 20% of cases. These three scores gave an average DASH of 8.5 (normal 10.1). We believe that superiorly applied plate fixation is effective for the treatment of clavicular nonunion. We recommend the use of a curved pelvic reconstruction plate. Iliac crest bone graft is not necessary in most cases to obtain union, but might be considered if significant clavicular shortening cannot be corrected without intercalary grafting.

5 STRUCTURAL AND BIOCHEMICAL EVALUATION OF THE ELBOW CAPSULE FOLLOWING TRAUMA

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Introduction: Post-traumatic stiffness of the elbow is common. While this may be multifactorial, the capsule clearly plays a role. Release or excision of the elbow capsule is necessary when treating arthrodiasis surgically and diminished compliance of the capsular tissue itself has been documented following trauma. This study evaluates the physiologic profile and morphological characteristics in the capsule of contracted elbows.

Materials and Methods: Thirty seven anterior elbow capsules were collected at the time of joint release for post-traumatic contracture. Preoperatively, elbow extension averaged 35° (range 40-80°) and flexion averaged 94° (range 80 to 115°). Capsules from seven cadaveric elbows with no history of trauma or pathology were harvested as controls. The sections were evaluated with polarizing microscopy for birefringence and for comparison of collagen fiber orientation. Immunohistochemistry was performed on paraffin sections using immuno-peroxidase to measure specimens for specific cytokines involved in connective tissue turnover. Sections were graded by a blinded examiner.

Results: The mean thickness of the control capsules was 0.6 mm ± 0.2 mm, and for the contracture specimens, 4.0 mm ± 2.1 (p < 0.05). All control capsules revealed a well organized, parallel arrangement of collagen fibers with intervening fibroblasts. All contracture capsules revealed thickening of the tissue with extensive disorganization of the collagen fiber bundle arrangement. More fibroblasts, particularly in large groups, were found in these specimens and five displayed moderate to severe lymphocyte infiltration. No correlation was identified between these cases and those without lymphocytes in any clinical parameter. Cytokine MMP-1, MMP-2, and MMP-3 staining were significantly increased in the contracture tissue as compared to the controls (p<0.05).

However, collagen type III content was markedly decreased in the contracture capsules compared to the controls. Discussion: Contracted elbow capsules were characterized by a marked thickening, on the average of approximately seven times (and up to 13 times) that of the normal capsule accompanied by collagen disorganization and fibroblast infiltration. In addition, we found the cytokines, MMP-1, MMP-2, MMP-3 and TIMP to be present in greater levels in contracture capsules compared to control specimens. These abnormal cytokines may be involved in the remodeling or repair process following trauma. However, the mechanism of contracture tissue formation differs from that observed in wound healing due to the decreased collagen type III levels observed. This is the first study to characterize the histological profile in post-traumatic contracture of the elbow capsule and associate this to the presence of MMPs, their inhibitors and collagen type.
6 INFLUENCE OF FOREARM ORIENTATION AND AXIAL COMPRESSION ON ELBOW INJURIES IN THE EXTENDED ELBOW

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Introduction: The elbow is the second most commonly dislocated joint in the body. Forty-nine percent of these are complex dislocations (ie, associated with a fracture). There are classic patterns for elbow injuries. Previous experiments have attempted to recreate these injury patterns using external forces. There is a common belief that elbow dislocations are caused by an axial force accompanied by flexion and an additional varus, valgus, or rotation force that leads to posterior dislocation with injury to either the medial or lateral structures. The elbow must flex to at least 20 degrees to unlock the olecranon before a dislocation can occur. The hypothesis of this study was that elbow injury patterns are influenced both by forearm orientation and the compressive interjoint action of joint surfaces in the fully extended elbow. Therefore, the objective of this study was to investigate the joint kinematics and injury pattern of the elbow that resulted from an axial load to failure with the forearm in either pronation or supination. Methods: Fourteen upper extremities were resected through the distal 1/3 humerus. Soft tissues were removed, leaving only the joint capsule, ligaments, interosseous membrane, and muscular insertions of the brachialis, supinator, and triceps. The valgus angle of the specimen was determined using markers and digital photos in supination, pronation, and neutral. A custom apparatus was used that allowed free rotation of the ulna, radius, and humerus about a fixed wrist. A compressive load was applied with a material tester (Instron 4411, Canton, MA) at a rate of two millimeters per second until failure occurred. Force and displacement data were collected.

An optoelectronic, three-dimensional camera system (Optotrak 3020; Northern Digital Inc, Canada) was used to measure kinematic data for the distal humerus, proximal radius, and proximal ulna. Following failure, the elbow was carefully inspected and photographed to document all fractures and disrupted tissues. Results: Of the fourteen specimens, seven elbows failed in pronation and seven elbows failed in supination. In pronation, 6/7 elbows had a terrible triad type elbow injury with fracture of the radial head and coronoid with posterior dislocation. In supination, 6/7 elbows dissociated without coronoid or radial head fractures. Four out of fourteen elbows had damage to the lateral structures and ten out of fourteen had injury to the medial structures. In each case, damage to either the medial or lateral structures correlated with internal or external rotation of the ulna as compared to the humerus. Load to failure of the extended elbow in pronation most commonly led to a terrible triad (fracture of radial head and coronoid with posterior dislocation). In supination, independent rotation of the ulna and humerus enabled the elbow to dislocate without a fracture of the radial head or coronoid. No additional forces were necessary to allow the ulna to rotate out of the olecranon fossa. Post failure dissection revealed the compressive interjoint action to either the medial or lateral structures. The documented structural injuries correlated with the calculated rotations of the humerus and ulna relative to each other. When the ulna rotated externally relative to the humerus, the lateral structures were damaged. When the ulna rotated internally relative to the humerus, there was damage to the medial structures. The post failure dissection demonstrated rotation laxity at the elbow after reduction. Conclusions: During axial compression of the extended elbow, the ulna hinges either medially or laterally and allows the elbow to dislocate. The ligaments on the contralateral side are either torn or attenuated. In our study, the medial structures were more commonly disrupted. The terrible triad injury pattern can be produced with the elbow pronated in full extension.

7 MEDIAL COLLATERAL LIGAMENT RECONSTRUCTION OF THE ELBOW IN THROWING ATHLETES USING THE DOCKING TECHNIQUE

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Introduction: Medial collateral ligament insufficiency of the elbow can be a devastating injury in the throwing athlete. Reconstruction of the MCL was initially described by Jobe and associates; good clinical results have been described following this procedure. Our experience with this technique raised several concerns, and thus the "docking" procedure was developed as an alternative method for elbow MCL reconstruction. The early results of the docking technique were good. We wish to investigate the intermediate term clinical results of this method. Methods: Over a five year period, one-hundred consecutive overhead athletes were treated with surgical reconstruction using the docking technique. The inclusion criterion were as follows: (1) a history of medial elbow pain that prevented throwing, (2) a preoperative MRI demonstrating an MCL injury, (3) clinically significant MCL insufficiency, (4) overhead throwing athlete. At the time of surgery, all patients underwent routine arthroscopic assessment. The ulnar nerve was transposed in twenty-two cases. The average follow-up was thirty-six months (range, twenty-four to sixty months). Results: Ninety of one-hundred (90%) patients were able to compete at the same or a higher level than before the injury for more than twelve months as noted at the follow-up interval. This outcome meets the Conway classification criteria of an excellent result in 90% of study patients. Seven patients (7%) were able to compete at a lower level for more than twelve months (Conway - good result). One patient (1%) was able to throw only recreationally (Conway - fair result). There were only two poor results. Forty-five patients (45%) had associated intraarticular pathology that was treated arthroscopically before ligament reconstruction. There were three complications: two patients had ulnar nerve symptoms postoperatively that required ulnar nerve transposition. Both patients made full recoveries and had excellent results at the time of follow-up. The third patient developed elbow stiffness that required arthroscopic debridement and had a good result at the time of follow-up. Conclusion: The docking technique is a safe and effective procedure that reliably returns throwing athletes to sport. This method allows for excellent graft fixation, the treatment of intraarticular pathology, and minimal ulnar nerve-related complications.

8 DYNAMIC STABILITY OF THE ELBOW: A BIOMECHANICAL STUDY OF MUSCLE CONTRIBUTION TO VALGUS STABILITY

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Background: Limited information is available with regard to the dynamic stability of the elbow joint, ie, the role of muscle function. Biomechanical analysis of common activities, such as overhead throwing, suggests that muscles must play a role in the elbow to aid in counteracting valgus load. We hypothesize that the dynamic action of the flexor pronator mass will decrease the strain on the medial collateral ligament and provide a protective varus correction at the elbow. Method and Materials: Eight fresh frozen cadaveric elbows were tested utilizing a custom made testing device. Muscles of the flexor pronator mass [the flexor carpi ulnaris, flexor carpi radialis, flexor digitorum superficialis, and the pronator teres], the extensor supinator mass and the triceps, biceps, and brachialis were isolated and wrapped in a mesh and wire construct. The insertion of each muscle was left undisturbed while eyelets were placed at the origins of each muscle. The wire and mesh construct was passed through each eyelet and to a pulley system attached to the testing apparatus. The elbow was locked in neutral pro/supination, neutral wrist flexion, and 30 degrees of extension.
flexion at the metacarpophalangeal joint. The humerus was potted into the testing device, while the forearm was allowed 6 degrees of freedom. The arm was placed in a position of throwing and tested at 45 and 90 degrees of flexion. A differential variable reluctance transducer (DVRT) microstrain gauge was placed on the posterior aspect of the anterior band of the anterior bundle of the medial collateral ligament. The arm was repeatedly cycled to remove any crimp from the ligament and insure that the strain gauge was interference from any overlying tissue. In no instance was more than 5% of the muscle mass removed. Fasttrack transmitters were attached to the radius and the humerus to record kinematic data. Each individual muscle was loaded to 2% of maximum muscle force, while the tested muscle was loaded at sequentially greater loads – 20 N, 40 N, and 60 N. Strain and kinematic data was recorded simultaneously and plotted as a function of force. A least square linear analysis was used to fit the data and interpreted as strain/rotation over 10 N of load. Results: The flexor pronator mass created a varus moment and decreased the strain on the ligament. At both 45 and 90 degrees the flexor carpi ulnaris provided the greatest decrease in strain, 3 and 4 times greater than the flexor carpi radialis. However, the flexor carpi radialis provided significant varus correction at 90 degrees (p < .05) while the flexor carpi ulnaris was the only external rotator of the construct (p < .05) and the pronator teres the only internal rotator (p < .05) at both 45 and 90 degrees. Conclusions: In vitro, dynamic activation of the flexor pronator mass provides a significant varus moment at the elbow joint and a significant decrease in strain of the medial collateral ligament. Dynamic stabilizers may help explain why an incompetent medial collateral ligament is often functionally well tolerated by many patients. Proper muscle training may be protective of the medial collateral ligament, and preservation of the muscle mass may protect the reconstructed ligament and aid rehabilitation.

9 COMPLICATIONS AND REVISION OF THE REVERSE PROSTHESIS: A MULTICENTER STUDY OF 457 CASES

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Introduction: Rates of complications and revision in reverse shoulder arthroplasty (RSA) have yet to be well defined. The purpose of this study was to describe complications and revisions occurring in a large, multicenter series. Materials and Methods: From January 1992 to December 2002, 457 RSAs were placed in five surgical centers. 297 reverse arthroplasties were performed in patients with no prior surgery. 94 prostheses were done for revision of a failed hemi- or total shoulder arthroplasty. 70 prostheses were implanted after a failed shoulder procedure other than arthroplasty. Two patients were evaluated using pre- and postoperative range of motion, Constant scores and standardized radiographs. Results: 25.6% of all cases experienced at least one intra- or postoperative complication. There were 39 intraoperative complications, including 28 humerus fractures and 11 glenoid fractures. The rate of intraoperative complications was higher in revision arthroplasty (30.9%) than in primary arthroplasty (2.7%) (p<0.001). There were 80 postoperative complications. Postoperative complication was more frequent in the revision group (33.6%) than the primary group (12.6%) (p<0.001). Instability was most common followed by infection, humeral fracture, glenoid loosening, humeral loosening, humeral disassembly, glenoid disassembly, hematoma, neuropraxia, scapular spine fracture, postoperative stiffness, and venous thrombosis. Rates of dislocation, infection and humeral complications were significantly higher in the revision arthroplasty group (p<0.05). The deltopectoral approach had a higher rate of instability (5.8%) than the suprapteral approach (1.0%) (p<0.05). Conclusions: Most intraoperative complications were related to revision of well-fixed humeral components. Revision RSA has a postoperative complication rate three times that of primary RSA. Dislocation was associated with the deltopectoral approach and revision surgery.

10 EARLY COMPLICATIONS WITH THE DELTA REVERSE SHOULDER ARTHROPLASTY: INFLUENCE OF THE LEARNING CURVE

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Introduction: Shoulder arthroplasty has been greatly advanced by the recent introduction into the United States of various reverse prosthetic systems. These implants are designed to compensate for deficiency in the rotator cuff, but have been seen as subject to frequent complications. Increasing surgeon experience with this new type of arthroplasty however may well lead to fewer complications. This paper reviews the experience of a single surgeon with the Delta reverse shoulder prosthesis with respect to the occurrence of early post-operative complications.

Materials and Methods: An unselected consecutive series of 53 patients were reviewed representing the author’s initial experience with reverse shoulder arthroplasty. All patients received the Delta prosthesis, and all patients were reviewed at three months postoperatively for the occurrence of early complications. The study population included 22 females and 31 males at an average age of 73 years (36-91). The most common preoperative diagnosis was cuff tear arthropathy, present in 32 patients. Remaining diagnosis included failed arthroplasty in five patients, primary sepsis in five, infected arthroplasty in an additional four patients, rheumatoid arthritis in three, post-traumatic problems in three, and a benign tumor in a single patient. Surgery prior to the reverse arthroplasty was common, with fifteen patients having had at least one failed rotator cuff repair, nine with a standard shoulder arthroplasty, and nine with various debridements including temporary antibiotic impregnated methylmethacrylate spacers for infection. A single patient each had proximal humeral resection for fracture treatment and open reduction internal fixation. Results: Overall complications included anterior dislocation in four patients, deep infection in two, and single occurrences of brachial plexopathy, acromial fracture, superficial infection, and post-operative carpal tunnel syndrome. Five patients required revision surgery of the shoulder prosthesis which included component revision in all four patients with instability, and two-stage exchange arthroplasty for the two cases of deep infection. The patient with carpal tunnel syndrome underwent endoscopic release as well. All revision surgeries were performed in the first 23 patients; none of the subsequent 30 patients required additional surgery. All complications occurred in the initial 23 patients with the exceptions of the instances of carpal tunnel syndrome and superficial infection. Discussion: While complications can and do occur with all surgical procedures, it is important to recognize methods of decreasing their frequency. Adjustments to surgical technique and patient management have helped reduce their frequency in the author’s practice. These adjustments include more frequent use of the 42 mm glenosphere in large male patients, improved inferior metaglenoid placement, post-operative immobilization in revision surgery, routine use of antibiotic cement, and increased surgeon familiarity with optimal soft tissue tension. With attention to such details, the complication rate with this type of reverse prosthesis can be reduced. Conclusion: While remaining a technically demanding operation, there does appear to be a substantial reduction in serious complications after reverse shoulder arthroplasty with increased surgeon experience. Surgeons considering the use of this procedure should evaluate whether they will gain the necessary experience to minimize complications.

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ASES Abstracts e55
11 EARLY RESULTS OF REVERSE TOTAL SHOULDER ARTHROPLASTY WITH A DELTA III-TYPE PROSTHESIS
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Purpose: Reverse total shoulder arthroplasty (TSA) was developed in France in the 1980s for the treatment of painful pseudo-paralysis of the shoulder due to arthritis and irreparable rotator cuff tear (RCT). Indications have been expanded to include treatment of failed previous shoulder arthroplasty. The reverse ball-and-socket design alters the biomechanics of the shoulder by medializing and lowering the center of rotation, which improves the lever arm of the deltoid and restores active elevation. The device was FDA approved for use in the US in 2004. This paper will present the early results of an initial consecutive series of reverse TSA by a single US surgeon. Methods: Since 2004, 51 consecutive reverse TSA with a Delta III-Type prosthesis have been performed in 49 patients with an average age 71 years. Diagnoses include 28 shoulders with cuff tear arthropathy, 13 with a failed previous shoulder arthroplasty, and 10 with an irreparable RCT. All patients had painful pseudoparalysis. All surgeries were through a deltopectoral approach. Of the patients with a minimum 4 month follow-up, 2 patients expired and 1 was lost to follow-up, leaving 38 shoulders in 37 patients available for clinical and radiographic follow-up at a mean 8.5 months (range 4.5-15 months). Results: The mean pre-op shoulder subjective value increased from 18% to 73% post-operatively, the pain scale decreased from 8.4 to 1.5, the American Shoulder and Elbow Surgeons Score increased from 18 to 73, and active elevation increased from 37° to 116°, all of which were significant (p<0.0001). Active external rotation improved from 4° to 11° (p<0.05). All but 2 patients were satisfied with the results of the surgery. Radiographically, thirteen shoulders (43%) had no scapular notching, 8 (27%) had Grade 1 notching, 8 (27%) had Grade 2 notching, and 1 (3%) had Grade 3 notching. Seven complications occurred in 6 patients (3 nerve palsies, 1 acromial base fracture, 1 dislocation, and 1 hematoma) for a complication rate of 20%. No infections occurred. Two reoperations (1 closed reduction and 1 open reduction, evacuation of hematoma, and polyethylene exchange) were performed in 1 patient, for a reoperation rate of 3%. Discussion: Historically, painful pseudoparalysis of the shoulder due to arthritis and a massive irreparable RCT has been difficult to treat. Hemiarthroplasty can offer acceptable pain relief but often little gain in function. Reverse TSA provides a solution to a previously unsolvable orthopaedic problem, with short-term results indicating outstanding pain relief and restoration of function. However, long-term studies are lacking and the relationship between scapular notching and loosening of the glenoid base plate is unknown. This paper reports significant pain relief, improvement of range of motion, restoration of function, and patient satisfaction following reverse TSA in the initial series of patients treated at the beginning of a single US surgeon’s learning curve. The complication rate and reoperation rate are consistent with previous studies, and the rate of scapular notching warrants concern. Conclusion: Early results of reverse TSA with a Delta III-Type prosthesis for the treatment of painful pseudoparalysis of the shoulder are promising, with significant pain relief and gains in function realized. The longevity of the device is unknown at this time and concerns exist about long-term fixation of the glenoid component. Its use should be reserved for elderly patients in pain with a severely deficient rotator cuff who are unable to lift the arm away from the side against gravity and who have failed conservative management.

12 CLINICAL AND RADIOGRAPHIC OUTCOMES OF REVERSE TOTAL SHOULDER ARTHROPLASTY: A PROSPECTIVE EVALUATION OF A CONSECUTIVE SERIES
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Objective: To assess the short-term clinical and radiographic outcomes of the reverse total shoulder arthroplasty. Methods: After FDA approval of the reverse total shoulder arthroplasty (TSA) in 2004, a consecutive series of the first sixty-two patients treated with this prosthesis by a single surgeon was prospectively initiated through an IRB-approved protocol. All patients presented with signs and symptoms of painful glenohumeral arthritis combined with severe rotator cuff deficiency, anterosuperior shoulder instability, and/or a painful, dysfunctional failed shoulder arthroplasty. Clinical examination, pre- and post-operative ASES Shoulder Assessment Forms, and serial radiographs (pre-operative, immediate post-operative, 10 days, 6 weeks, 3 months and 1 year) were obtained on all patients. Mean patient follow-up was 15 months (range, 12 to 20). Outcome measures include infections, wound healing problems, clinical failures, nerve injury, acromial stress fractures, revisions, resections, instability, component loosening or radiolucency, glenosphere position relative to the inferior aspect of the bony glenoid, glenosphere tilt (angle of glenosphere relative to the bony glenoid face in the coronal plane), and radiographic glenoid notching. Results: The mean patient age was 70 years (range, 45 to 88). Mean active forward elevation improved with surgery from 53° to 128° (p<0.0001). Median ASES Shoulder Assessment Scores improved with surgery from 34 (range, 0 to 60) to 82 (range, 65 to 95) (p<0.05). Patients with failed previous hemiarthroplasty (n=10) or total shoulder arthroplasty (n=5) had lower postoperative ASES scores and range of motion that did not reach statistical significance. Two patients had transient deltoid pain and spasm attributed to increased deltoid tension, and two other patients had transient postoperative brachial plexus paresthesias; all symptoms resolved spontaneously within 6 weeks of surgery. One elderly patient fell from a height, landed directly on her shoulder, and sustained fractures of the glenoid neck and acromial spine that was managed nonoperatively. Another patient fell down a flight of stairs and sustained a periprosthetic humerus fracture that was treated with open reduction and internal fixation; this represents the only reoperation in this series. There were no dislocations, infections, hematomas or other wound healing problems, periprosthetic stress fractures, clinical failures or revisions with any patients at latest follow-up. Sixty percent (60%) of the glenospheres were positioned neutral (ie, inferior portion of glensphere flush relative to inferior aspect of bony glenoid), and 40% were placed slightly inferiorly (mean distance = 1 mm); no glenospheres were placed superior to the inferior aspect of the bony glenoid. Seventy percent (70%) of the glenospheres were oriented with a slight inferior tilt relative to bony glenoid face in the coronal plane, and 30% were oriented in neutral alignment; no glenospheres were tilted superiorly. Glenoid notching along the inferior bony glenoid was seen in 5 patients (8%), and all were classified as Grade 1.1 Notching was more common when the glensphere was in neutral position relative to the inferior bony glenoid, but this trend was not significant; there was no association between the coronal glenosphere tilt and the presence of glenoid notching. Conclusions: This prospective study represents the short-term results of a consecutive series of the first sixty-two patients treated by one surgeon with the reverse total shoulder arthroplasty since its FDA approval in 2004. Statistically significant improvements in patients’ pain, function, and abilities to perform daily activities were achieved. Four patients had transient postoperative complications related to deltoid tensioning and brachial plexopathy that spontaneously resolved within the first six weeks without sequelae. There were three traumatic periprosthetic fractures in two patients, one of which required reoperation. Other considerable early postoperative complications such as hematomas, infections, dislocations, early catastrophic glenoid failure, and need for component revision surgery were avoided. Further follow-up of this cohort of patients will establish the long-term clinical efficacy of this procedure as well as the potential clinical relevance of glenoid notching.
13 PREOPERATIVE PLANNING FOR REVERSE SHOULDER ARTHROPLASTY: GLENOID COMPONENT POSITIONING
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Background: Preoperative planning techniques for proper glenoid component positioning in reverse shoulder arthroplasty have not been described in the literature. Aligning the lower border of the glenoid baseplate (metaglene) with the inferior border of the reamed glenoid has been recommended as a means of minimizing scapular notching and polyethylene wear, while maximizing shoulder range of motion. We devised a method of preoperative planning utilizing a CT scan of the scapula, and hypothesized that the technique would facilitate successful placement of the glenoid component. Methods: CT scans were made of ten human cadaveric scapulae. The 2D and 3D images were used to calculate the optimal starting point on the glenoid face for drilling a hole to accommodate the central post of the glenoid baseplate component. The optimal drilling point was marked on the cadaveric scapulae, holes were drilled, the articular surfaces reamed, and the components were placed. Recorded data for each scapula included: (1) the distance of the inferior edge of the baseplate to the inferior border of the reamed glenoid face, and (2) whether the baseplate post was contained within the neck of the scapula, or if penetration of the anterior or posterior cortex of the glenoid neck by the post occurred. Results: The slope of the inferior glenoid neck as it approaches the lateral pillar of the scapula significantly influenced the position of the optimal drilling point for the pilot hole on the glenoid face. The position of the optimal point can change as the glenoid face is flattened by the reamer to accept the baseplate. This preoperative planning technique resulted in excellent positioning of the baseplate relative to the inferior edge of the glenoid in all 10 specimens. On average, the baseplate edge was 0.5 mm distal to the inferior border of the reamed glenoid face (range = 1 mm to 2.5 mm). The glenoid baseplate post was contained within the vault of the glenoid in 8 of 10 specimens. The post protruded from the glenoid neck in 2 specimens (it protruded by less than 1 mm in each specimen). The cortex of the glenoid neck was penetrated by the drill in 3 out of 10 specimens (anterior in 2 specimens, and posterior in 1 specimen). The average size of the cortical breach was small (4.5 mm; range = 3 to 5 mm), and the effect of the breach on the structural integrity of the glenoid neck was likely minimal. Conclusions: The final position of the glenoid component in reverse total shoulder arthroplasty is dependent upon the slope of the inferior glenoid neck as it approaches the lateral pillar of the scapula. The morphology of this region of the glenoid is highly variable, and this area is rarely visualized by the orthopaedist at the time of surgery. The position of the optimal drilling point for the pilot hole can change as the glenoid face is flattened by the reamer to accept the baseplate. This can be successfully anticipated with the preoperative CT imaging. As a consequence, we recommend a method of preoperative planning for reverse total shoulder arthroplasty to facilitate proper placement of the glenoid component. A classification system for different inferior glenoid neck morphologies is also proposed.

14 OUTCOMES OF REVERSE SHOULDER PROSTHESSES USING A LATERAL CENTER OF ROTATION AND INFERIORLY TILTED GLENOID COMPONENT: A MINIMUM 2-YEAR FOLLOW-UP STUDY
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Introduction: Glenoid sided failures of the Reverse Shoulder Prosthesis (RSP) have historically been a concern. Previous biomechanical studies have shown that implanting the baseplate of the reverse shoulder prostheses with a slight inferior tilt improves the mechanical environment in the shoulder by reducing shear forces at the baseplate-bone interface. Subsequently, a radiographic study demonstrated that patients with a baseplate implanted with an angle of 72 degrees or less relative to the spine of the scapula (inferior tilt) had a higher rate of survivorship than those implanted with a greater angle (superior tilt). The purpose of this study was to review the outcomes of patients with an inferiorly tilted gleno-sphere. Methods: We studied 101 patients (44 males, 57 females) that had a Reverse Shoulder Prosthesis with the center of rotation lateral to the glenoid (average 8.7 mm, range 6-10 mm) and with the glenoid baseplate component implanted with inferior tilt (average age 66°; range 52-72°). Average follow-up was 36 months (24-84 months). All patients were treated for rotator cuff deficiency in the setting of glenohumeral arthritis or for a failed shoulder replacement with instability. Clinical and radiographic evaluation was performed, including ASES scores and range of motion measurements. Glenoid sided failure was defined as breakage of the screws and shift of the device. Results: Two patients out of 101 suffered glenoid-sided failures and were both subsequently revised to another RSP. The 84 month Kaplan-Meier survivorship of the series was 98% (95% CI: 95-100%). Total ASES score improved from 32 to 63 (p < .0001), flexion improved from 47° to 96° (p < .0001), abduction improved from 41° to 93° (p < .0001) and external rotation improved from 19° to 28° (p = .026). Seventy-two patients rated their outcome as excellent or good, 18 were satisfied, and 11 out of 101 rated their outcome as unsatisfied. Scapular notching was not found in any of the patients. Conclusion: The results of this study demonstrate that a Reverse Shoulder Prosthesis with a center of rotation lateral to the glenoid provides for acceptable survivorship, improved range of motion (including external rotation), and no scapular notching.

15 TOTAL SHOULDER ARTHROPLASTY VS HEMIARTHROPLASTY FOR RHEUMATOID ARTHRITIS: RESULTS OF 303 CONSECUTIVE CASES
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Introduction: The purpose of this study was to review our experience with total shoulder arthroplasty and hemiarthroplasty in patients with RA to determine the results, the risk factors for an unsatisfactory outcome, and the rates of revision. Methods: Between 1976 and 1991, 195 TSA and 108 HHR were performed by the senior author in patients with rheumatoid arthritis. One hundred eighty-seven TSA and 95 HHR with complete preoperative evaluation, operative records, and minimum 2-year follow-up (mean 11.6 years) or follow-up until revision were included in the clinical analysis. Twenty patients died and one was lost to follow-up. All 303 shoulders were included in the survival analysis. Results: There was significant long term pain relief, improvement in active abduction, and external rotation with both HHR and TSA (p < .0001). There was not a significant difference in improvement in pain and motion comparing HHR and TSA for patients with a thin or torn rotator cuff. However, among patients with an intact rotator cuff, improvement in pain and abduction were significantly greater with TSA. Additionally, among patients with an intact rotator cuff, the risk for revision was significantly lower for TSA (p = .004). The
overall rate of revision for glenoid component related problems was 11/195 (5.6%) compared to 8/108 (7.4%) for painful glenoid arthritis. **Conclusion:** The data from this study indicate there is marked long term pain relief and improvement in motion with shoulder arthroplasty for rheumatoid arthritis. Among patients with an intact rotator cuff, total shoulder arthroplasty appears to be the preferred procedure for pain relief, improvement in abduction, and lower risk of revision surgery.

16 COMPARISON OF CONFORMING AND NON-CONFORMING RETRIEVED GLENOID COMPONENTS
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**Introduction:** Glenoid component loosening remains the primary long-term failure mode for TSA. Little is known about in vivo wear patterns manifested on retrieved polyethylene glenoid components, the design and clinical factors that affect wear performance, and the relation to loosening. The purpose of the study was (1) to report the findings from the retrieved prosthetic glenoid components after TSA, (2) to compare the conforming and non-conforming glenoid designs with clinical, radiographic, and biomechanical wear analysis. **Methods:** From 1979 to 2005, 65 glenoid components were retrieved during revision TSA at a single hospital. The clinical information was obtained from medical records including patient demographics, medical comorbidities, shoulder history, clinical assessment (pain, range of motion), intraoperative findings, implant information, and post-operative complications. The most recent plain shoulder radiographs (AP and axillary) prior to removal of the glenoid were carefully examined and scored. The extent and amount of radiolucency was measured with digital calipers. The glenoid loosening classification was determined for each glenoid (Torchia et al, JSES 1997). The polyethylene bearing surfaces of the components were examined microscopically for evidence of burnishing, abrasion, scratching, pitting, delamination, focal wear, surface deformation, embedded third body debris, and fracture. The surface was divided into anterior, posterior, superior, and inferior quadrants and given a subjective damage score of 0-3 for each damage mode in each quadrant. **Results:** Sixty-five glenoids were retrieved from 59 patients with an average age of 61.4 years (SD 11.46). The mean length of glenoid implantation was 4.01 years (range, 0.1 to 19.2 years). The average forward elevation was 65.31 degrees (range, 0 to 160 degrees) and external rotation was 15.84 degrees (range, –40 to 60 degrees). The primary diagnosis for the initial surgery was 49% osteoarthritis, 20% post-traumatic osteoarthritis, 17% inflammatory arthritis, and 14% osteonecrosis. The revision diagnosis was 81.5% aseptic glenoid loosening and 14.8% septic loosening. Additional pathology determined at the time of revision surgery include 51.9% glenoid osseous defect, 42.5% humeral head subluxation or dislocation, 44% rotator cuff tendinopathy, and 26% deltoid atrophy. There were five identifiable manufacturers (37 Biomet, 14 Neer II, 5 Custom HSS, 4 DePuy, and 1 Howmedica) and 4 unknown glenoid implants. Sixty-one glenoid were cemented and four required screw fixation. The articulation of the glenoid implants was non-conforming in 51 (47.7%) and conforming in 34 (52.3%). In 75% of the cases, the glenoid was removed, and the TSA was converted to a hemiarthroplasty. Scratching was the most common damage mode with an average score of 9.6 out of 12; pitting was second most with an average score of 5.8. Both modes were most common on the inferior aspect of the glenoid component. Edge deformation was evident in 31 of the 65 glenoids (47.7%). Abrasion on the edge of the glenoid consistent with impingement between the edge of the glenoid component and the humerus was evident in 17 of 65 glenoids (26.1%). The abraded area was found on the anterior side in 82.3% (14 of 17). The 4 glenoids with metal backing fixed with screws all had embedded metallic particulate debris. A focal wear damage pattern was evident in 7 glenoids, all with nonconforming designs. The mean damage grade was 27.59 (SD 11.74) for the conforming glenoids and 28.69 (SD 8.21) For the non-conforming glenoids (P<0.05). Edge deformation was evident in 52.9% of conforming glenoids and only 25.8% of non-conforming glenoids. The plain radiographs revealed that the conforming glenoids had stability score of 2.44 (SD 0.77) and lucency scores of 4.58 (SD 0.77) compared to non-conforming glenoids stability score of 1.55 (SD 1.18) and lucency score of 3.50 (SD 1.87) (P<0.05). Radiolucence lines of the conforming glenoids were greater in zones 1, 2, and 4 compared to the non-conforming glenoids, but the difference was only statistically significant in zone 2 (P<0.05). **Discussion:** The present study is the largest series of retrieved glenoid implants after TSA. The cause of glenoid loosening appears to be multifactorial, and there are a number of patient-related factors and prosthetic-related factors that contribute to glenoid failure. Conforming glenoids more likely to show edge deformation compared to non-conforming glenoids. The radiographic analysis demonstrates that conforming glenoids have a greater degree of radiolucency and glenoid loosening compared to non-conforming glenoids.

17 TOTAL SHOULDER ARTHROPLASTY WITH METAL-BACKED, BONE IN-GROWTH GLENOID COMPONENTS
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**Background:** Loosening of a cemented glenoid component is an important cause of failure in total shoulder arthroplasty. A metal-backed, bone in-growth glenoid component has been designed as an alternative. The purpose of this study is to examine the results of this type of total shoulder arthroplasty. **Methods:** One hundred and twenty-four total shoulder arthroplasties with metal-backed, bone in-growth glenoid components were performed between 1989 and 1994. All patients had a minimum radiographic and clinical follow-up of two years or until the time of revision surgery. Mean clinical follow up was 9.4 years; mean radiographic follow-up was 6.9 years. Degenerative joint disease was present in 71% of patients, rheumatoid arthritis in 14.5%, and other diagnoses in the remaining. The glenoid component was bone-grafted in 14 shoulders; rotator cuff tears were present in 24 shoulders. **Results:** Clinical data included pain ratings that decreased from an average of 4.5 preoperatively, to 2.0 postoperatively. Range of motion in active elevation increased from 102 degrees preoperatively, to 133 degrees postoperatively. Range of motion in external rotation increased from 30 degrees preoperatively, to 56 degrees postoperatively. All clinical data was significant (p<0.0001). Three major issues arose. Subluxation occurred in 38, radiographic change was present in 62 shoulders (glenoid loosening in 47 [35%], humeral loosening in 20 [15%], polyethylene wear with metal wear of the glenoid component in 28 [21%]). Revision procedures were required in 40 shoulders [27%]. There were no identifiable patient, disease, or surgical characteristics associated with failure, either clinically or radiographically. Kaplan-Meier survival estimates were performed for the endpoint of revision and/or radiographic failure. The one year survival estimate was 93.3% (standard error 0.022). The five year survival estimate was 79.8% (standard error 0.037). The ten-year survival estimate was 48.2% (standard error 0.052). **Conclusions:** A higher rate of failure of total shoulder arthroplasties performed with a metal-backed, bone in-growth glenoid component raises concern for its use in shoulder arthroplasty, other than for special situations.
18 A PROSPECTIVE MULTICENTER EVALUATION OF TO- 
TAL SHOULDER REPLACEMENT FOR PRIMARY GLENOU- 
mERAL ARTHRITIS: MINIMUM TWO-YEAR FOLLOW-UP IN 
102 PATIENTS
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Purpose: Total shoulder replacement (TSR) is successful in pa-
tients with glenohumeral osteoarthritis (GHOA). However, there are few well-controlled prospective studies on the results of TSR. This prospective multicenter study evaluates the results of TSR for primary GHOA using validated outcome scores in 102 patients with minimum two-year follow-up.

Materials and Methods: Between September 2001 and October 2004, 210 patients of an average age of 69 years (range 50-89) had total shoulder replacement for glenohumeral osteoarthritis. Patients with prior surgery, rotator cuff tears, inflammatory arthritis, avascular necrosis, or prior fracture were excluded. The Bigliani-Flato prosthesis (Zimmer Corp) was used in all patients, while an offset humeral head (83%) and a cemented all-polyethylene pegged (83%) glenoid component were the most common variations used. Pre- and post-operative evalua-
tion included the simple shoulder test (SST), American Shoulder and Elbow Surgeon (ASES) score, visual analog scale (VAS) pain score, and physical examination. Baseline and minimum two-year follow-up scores were assessed in the first 102 patients. Statistical analysis was performed using the Student’s t-Test. Results: SST scores improved significantly from 3.66 pre-operatively to 9.71 post-operatively (p<0.0001). Active lateral elevation improved significantly from 105° to 154° (a gain of 49°) (p<0.0001), as did strength of elevation (3.26 kg to 5.76 kg, p<0.0001). Active internal rotation (S1 to L1, p<0.0001). Of these 102 patients, two required revision surgery for subscapularis tear, and one had a subdural hematoma. No patient had revision surgery for prosthetic loosen-
ing, malposition, or fracture. Discussion and Conclusion: While the success of TSR for the treatment of GHOA is well recognized through several retrospective studies, there are few well designed prospective studies with sufficient patient numbers and follow-up to justify the use of current prosthetic designs. This prospective multi-
center clinical trial represents a large series of patients (210 total, 102 minimum two-year follow-up) who had TSR for primary GHOA using the Bigliani-Flato modular prosthesis. In these patients, using validated outcome scores (ASES, SST, VAS), significant improvements in pain, range of motion, and function were ob-
erved at minimum two-year follow-up. Subscapularis rupture was the only early (two-year) post-operative complication (2 out of 210). No revisions or failures due to prosthetic malposition, loo-
sering, or fracture were observed. This prospective multicenter study demonstrates that TSR is successful for the treatment of primary GHOA, with reliable pain relief and improvement in shoulder function.

19 SUBSCAPULARIS REPAIR AFTER SHOULDER ARTHRO-
PLASTY: BIOMECHANICAL AND CLINICAL VALIDATION OF 
A NOVEL TECHNIQUE
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Introduction: Unacceptable subscapularis function has been reported after total shoulder arthroplasty (TSA). Some have pro-
posed releasing the subscapularis with lesser tuberosity bone for added strength. We report biomechanical and clinical results of a novel technique for subscapularis handling during TSA.

Methods: BIOMECHANICAL: In 15 cadaveric humeri, all musculature was removed except the subscapularis. Standard humeral head osteot-
omy was performed for TSA. Subscapularis was released with a “fleck” of lesser tuberosity bone in 10 specimens and tenotomy was performed in five. Osteotomies were repaired with single-row heavy nonabsorbable sutures and five were secured with an addi-
tional row of double-row. Repairs were subjected to cycles of loading at 180 N for 400 cycles—increasing by 180 N to failure. CLINICAL: One hundred consecutive patients underwent dual-row repair of the subscapularis “fleck” osteotomy following TSA. Minimum follow-
up was 24 months (range 24-48 months).

Results: BIOMECHANICAL: Both single (430 N) and double-row (466 N) fixation of the fleck osteotomy were significantly stronger than tenotomy suture repair (252 N) (p=0.04). There was no significant differ-
ence between single and double-row ultimate strength. Qualita-
tively, double-row fixation more securely fixed the fleck osteotomy to donor site with respect to gross rotational motion.

CLINICAL: At final review lift-off test was rated normal in 79/100 (79%). Bell-
ley was rated normal in 86/100 (86%). Eighty-two (82%) were able to tuck in their shirts.

Discussion: Subscapularis release with “fleck” osteotomy provides superior biomechanical ultimate strength compared to standard tenotomy. Dual-row fixation qualita-
tively appears to improve potential for healing and a functional subscapularis muscle unit. Clinical results of this dual-row technique document improved restoration of subscapularis integrity for activi-
ties of daily living.

20 THE COST OF ANATOMIC Versus SEMI-CON-
STRAINED (REVERSE) SHOULDER ARTHROPLASTY
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Introduction: Surgeons must remain not only cognizant of ad-
vances in implant technology but of the costs generated by the use of 
such implants. Two and one-half years ago, semi-constrained 
shoulder arthroplasty (reverse) was given FDA approval for use in 
the United States. The purpose of the present study was to deter-
mine the economic impact of the use of anatomic and reverse 
shoulder arthroplasty and to examine the opportunities, if any, for 
cost savings. Materials and Methods: At one US not-for-profit center 
doing a reasonably high volume of shoulder arthroplasty, in 2004, 
28 reverse shoulder arthroplasty procedures were performed by one surgeon. During the same 12 months, 28 anatomic shoulder arthroplasty procedures (humeral press fit and glenoid press fit) done at the same institution were randomly selected. The charges, costs and reimbursement were compared. Between July 1, 2004, and April 30, 2005, all of the author’s shoulder arthroplasty procedures were again reviewed for comparison data between reverse shoulder arthroplasty and anatomic shoulder arthroplasty (total shoulder arthroplasty and hemiarthroplasty) for financial data that included charges by department, operating room charges, length of stay and payor distribution. The final component of the study reviewed all reverse shoulder arthroplasty cases between 
April 22, 2004, and March 1, 2006, to compare the charges, costs and reimbursement for primary versus revision cases. Results: Operating room charges (the department responsible for implant purchase) for reverse exceeded anatomic shoulder arthroplasty by $226,667.00. Average length of stay: reverse 2.0 days, anatomic 2.0 days. Cost per patient was reverse $14,837 vs anatomic $9327.00, a difference of $5,510.00. The implant cost was reverse $8,204.70 vs anatomic $3990.00, a difference of $4214.70. Actual reimbursement for reverse was $7479.00 versus anatomic, $7861. Net income for reverse was −$358.00 vs −$1,600.00 for anatomic. Between July 1, 2004, and April 30, 2005, 42 reverse, 31 hemiarthroplasty and 55 total shoulder arthroplasty procedures were performed. The total charges and cost were highest for the reverse and lowest for the hemiarthro-
plasty. Reimbursement was highest for anatomic total shoulder.
arthroplasty. Average length of stay: reverse 2.5 days, hemiarthroplasty 2.0 days and anatomic total shoulder 2.2 days. State or federal government agencies were the payors for 77% of the cases. Net income for reverse, hemiarthroplasty and anatomic total shoulder arthroplasty was $9,667.00, $458.00, and $965.00 respectively. Charges were always higher for revision reverse cases owing to greater OR time, longer anesthesia, greater dependence upon anesthesia, and more costly implants. Conclusions: Anterior, posterior, and bipolar shoulder arthroplasty, while less expensive than reverse shoulder arthroplasty, remains a costly procedure. The reverse, semi-constrained shoulder arthroplasty system appears to provide an excellent solution for the surgical management of the rotator cuff deficient arthritic shoulder and other special conditions. However, it is a very expensive operation with, at this time, no conceivable profit margin. Given this fact, the technical difficulty, the frequency of its use in revision arthroplasty cases and the potential complications which can further add to the cost of care, the widespread use of this implant should be carefully considered.

21 EFFECT OF TOTAL SHOULDER REPLACEMENTS ON AIRPORT SECURITY SCREENING IN THE POST 9/11 ERA
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Introduction: There are few reports in the literature on the effect of orthopaedic implants on airport security devices and none on shoulder arthroplasty implants on airport security devices post-9/11/2001. Since 9/11/2001 airport security screening devices have become more sensitive in response to the increasing threat of terrorism. Oftentimes, patients with joint implants activate the metal detectors and are subsequently subjected to more intensive screening. In this study, we assess the effects of shoulder joint implants on different airport security devices and what effect the results had on passenger travel. Materials and Methods: 154 patients who had previously undergone shoulder replacement responded to a questionnaire regarding their travel experiences post-9/11. 85 patients had flown during that time period (Male: 47, Female: 38; mean age: 67.8 years). 79 had traveled domestically (mean: 7 flights) and 22 patients had taken international flights (mean: 6.1 flights). The questionnaire addressed each patient’s height/weight; number of flight segments flown (domestic and international), number of times patient activated the doorway alarm/wand alarm, and effect of the patient activation on travel (when applicable). Results: On average, patients with shoulder replacements traveling domestically activated the security gate 52% of the time. The average for international travel was 42%. Of the patients that flew both domestically and internationally, there was a high correlation of activation (R = 0.54). Twenty-six patients had multiple joint implants (average 2.8). Multiple joint implants caused increased alarm activation (p < 0.001). All patients reported that their travel was delayed during the instances of security activation. There was no statistically significant effect of Body Mass Index, height, weight, age or sex on security device activation. 71% of the patients were told by their doctor that the shoulder replacement may activate security devices. 46% of these patients were given a card by their doctor indicating the presence of a total joint. These patients found the card to be helpful in only 30% of their security encounters. Conclusion: This is the largest study on the effects of joint implants, shoulder implants in particular, on airport security devices and the only one that has analyzed the data of post-9/11/2001 travel. Patients traveling s/p TSR are often delayed and subjected to more rigorous screening when traveling, especially in the post-9/11 environment. Doctors often warn their patients of potential problems and may try to avert this by giving letters documenting the presence of a joint implant. The acceptance of these cards is sporadic. This study raises the importance of notifying patients of potential security delays, especially patients with multiple joint implants, as it may directly affect travel plans. In addition, these patients may benefit from the establishment of an international joint registry.

22 TEN TO THIRTY-ONE YEAR SURVIVAL ANALYSIS OF TOTAL ELBOW ARTHROPLASTY WITH THE COONRAD AND COONRAD-MORREY PROSTHESIS
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Total elbow arthroplasty (TEA) is an accepted option in treating end-stage elbow destruction. However, there are few reports of long-term survival beyond 15 years. We reviewed the functional survival of forty-one total elbow arthroplasties by a single surgeon, using the semi-constrained Coonrad or Mayo modified, Coonrad-Morrey prosthesis. Methods: We retrospectively reviewed 65 consecutive patients (64 elbows) who underwent TEA between 1974 and 2005, selecting 40 patients (41 elbows) followed ten years or more for this study (range, 10-31 years). Excluded were 21 patients with less than 10 years follow up and three patients with unavailable records. Presenting etiology included: posttraumatic arthritis (n = 24), inflammatory arthritis (n = 12), osteoarthritis (n = 4), and tumor resection (n = 1). Patient selection criteria excluded those with any history of prior infection, or refusal to adopt a sedentary limited level of postoperative use of the elbow. Follow up data were obtained from patient records, clinical photographs, radiographs, the Mayo elbow performance score (MEPS), referring physician reports for patients unable to return for examination and in nine deceased patients, function as described by the referring physician or close family members until death. Permanent implant removal was considered the failure end point for functional survival analysis. Results: Of 41 arthroplasties, twenty elbows were found functional at ten to fourteen years, ten elbows from fifteen to nineteen years, eight from twenty to twenty-nine years and two at thirty-one years. Thirteen elbows were revised. Complications (34%) included: five transient ulnar paresthesias, one heterotopic ossification, aseptic loosening in six, and implant fracture in two. There were no acute operative infections or peri-prosthetic fractures. The average preoperative MEPS score was 36 (range: 0 to 65) with improvement at last follow-up to 90 (range: 60 to 100). The elbows rated excellent in 33, good in 7 and fair in 1. All patients expressed satisfaction. The average functional prosthetic survival time was 18 years (range 10-31 years). Conclusion: Total elbow arthroplasty is a durable and effective option in alleviating pain and restoring motion in the salvage elbow. Pre-operative agreement to sedentary elbow use for a lifetime, as a condition for surgery, is considered to be an important but unproven factor in the longevity of the implant.

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Introduction: As our understanding of the natural history of rotator cuff disease continues to improve, epidemiologic data demonstrates the large prevalence of shoulder pain and rotator cuff pathology encountered in the general population.1,6 Chronic rotator cuff tendinopathy and tearing has been associated with subacromial impingement and intrinsic degenerative changes amongst other factors. Imaging and cadaveric studies have demonstrated an increasing prevalence of rotator cuff tears with increasing age and a region of hypovascularity at the articular surface of the distal aspect of the supraspinatus tendon.7,10 The
etiology of rotator cuff disease and the natural history of the blood supply to the rotator cuff have not been definitively established. To date, there has not been a live, dynamic assessment of the baseline vascularity of the asymptomatic rotator cuff. The clinical relevance of the vascular supply in understanding the pathogenesis of rotator cuff disease requires further study. This study was designed to test the hypothesis that regional variations in supraspinatus tendon vascularity exist with an age-dependent decrease in asymptomatic individuals with intact rotator cuffs. Methods: After obtaining Institutional Review Board approval, 30 patients (mean age: 41.5; range: 22-65) underwent lipid microsphere contrast-enhanced ultrasound (Perflutren; Bristol-Myers Squibb, N. Billerica, MA) examinations of a randomly selected shoulder with images obtained at baseline, after contrast administration at rest, and after contrast administration following exercise to optimally visualize the intra-tendinous blood flow to the supraspinatus tendon. Contrast harmonic imaging is a form of non-linear imaging that takes advantage of stimulated echoes produced by microbubble oscillations which result from resonance of the transmitted acoustic frequency.11 Exclusion criteria included a history of shoulder pathology, tobacco use, or cardiovascular disease as well as any patient with a rotator cuff tear >20%. Exercise consisted of two sets of 20 repetitions of forward elevation in the plane of the scapula with a 5 lb weight. Qualitative and quantitative analysis was then performed by determining four regions of interest (bursal medial, articular medial, bursal lateral, and articular lateral) with ultrasound imaging quantification and analysis software (QLAB; Philips, Andover, MA). This software permitted analysis of each region of interest and normalization of data for interpretation of the mean intensity per pixel to analyze the contrast-enhanced imaging of blood flow. Post-injection images were then normalized per patient relative to their baseline values. No patient had an adverse reaction to the contrast agent. Results: Using a Mann-Whitney non-parametric test, a statistically significant decrease in blood flow to the supraspinatus tendon with age was observed in a comparative analysis of patients under 40 and over 40 (P<0.05 for all four zones before exercise and for the bursal medial, articular medial, and bursal lateral zones after exercise; P<0.06 for the articular lateral zone after exercise). A statistically significant increase in blood flow with exercise was observed in an analysis of all patients (P<0.001). Discussion: This study is the first to demonstrate in vivo an age-dependent decrease in blood supply to the supraspinatus tendon in asymptomatic individuals with an intact rotator cuff. The addition of exercise to the protocol demonstrated a statistically significant increase in the level of blood flow from that at rest and provides a more accurate and dynamic assessment of peri-tendinous blood flow. The age-related decrease in the vascular supply of the tendon observed in this study is consistent with reports in the literature demonstrating an increasing prevalence of rotator cuff pathology with age, and may predispose to the development of rotator cuff tendinopathy and ultimately attritional tears.

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24 THE OUTCOME AND STRUCTURAL INTEGRITY OF ARTHROSCOPIC ROTATOR CUFF REPAIR USING THE DOUBLE-ROW SUTURE ANCHOR TECHNIQUE

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Background: The reported rate of failure after arthroscopic rotator cuff repair has varied widely. The influence of repair technique on the failure rates and functional outcomes after open or arthroscopic rotator cuff repair remain controversial. The purpose of this study was to evaluate the functional and anatomical results after arthroscopic rotator cuff repair using the double-row suture anchor technique with the use of CT or MRI arthrogram in order to determine the postoperative integrity of the repair. Methods: A prospective series of 105 consecutive patients undergoing arthroscopic double-row rotator cuff repair of the supraspinatus or combined supraspinatus and infraspinatus were evaluated at a minimum of two years after surgery (range 24-58 months). The evaluation included routine history and physical, preoperative and postoperative strength, pain, range of motion and Constant scores. Tears were classified as small, large and massive according to the number of tendons torn and the degree of coronal plan retraction based on the classification of Patte. In addition, all patients in this series had a preoperative and postoperative CT arthrogram or MRI arthrogram in order to define the extent of the rotator cuff tear and evaluate the structural integrity of the repair postoperatively. Results: The rate of structural failure after double-row suture anchor fixation in this study was 11.4%. The mean preoperative and postoperative Constant scores were 43.2 points (range 8-83, SD ± 15.1 points) and 80.1 points (range 46-100, SD ± 11.1 points), respectively. There were 36 small rotator cuff tears, 64 large tears of isolated supraspinatus or combined supraspinatus and infraspinatus tendons and 22 massive rotator cuff tears. Seventeen patients had freezing of the subscapularis that did not require repair. Intact rotator cuff repairs were associated with significantly increased strength and active range of motion. Pain relief and all parameters of shoulder function significantly improved after rotator cuff reconstruction. There were no surgical complications. Conclusion: Arthroscopic repair of rotator cuff tears using the double-row suture anchor technique results in a much lower rate of failure than previously reported for either open or arthroscopic repair methods. There was no significant relationship identified between clinical outcomes and age, size of tear, mechanism of injury, duration of symptoms or workman’s compensation. The excellent clinical re-
results in terms of function and pain relief appear to correlate with the integrity of the repair.

25 THE EFFECT OF REHABILITATION ON CUFF INTEGRITY AND RANGE OF MOTION FOLLOWING ARTHROSCOPIC ROTATOR CUFF REPAIR: A PROSPECTIVE, RANDOMIZED STUDY OF A STANDARD AND DECELERATED REHABILITATION PROTOCOL

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Introduction: Arthroscopic rotator cuff repair has come under greater scrutiny due to recent reports of rates of structural failure higher than that reported following open repair. Rehabilitation is a critical factor that can influence postoperative structural integrity, yet its effects on repair integrity have been poorly studied. Currently, there is no consensus regarding the type of therapy used following arthroscopic rotator cuff repair. A prospective, randomized study was carried out in order to determine the effect of two different rehabilitation protocols on structural integrity and range of motion following arthroscopic rotator cuff repair. Materials and Methods: During this prospective study, 70 patients undergoing primary arthroscopic rotator cuff repair were preoperatively randomized to either a Standard (37 patients) or Decelerated (33 patients) rehabilitation protocol. In the Standard group, there were 16 small (<1.6 cm), 10 medium (full width supraspinatus), and 11 large to massive tears (>2 or 3 tendons). In the Decelerated group, there were 14 small, 7 medium, and 12 large to massive tears. Preoperative and postoperative evaluations included physical examination, ASES score, and visual analog pain and satisfaction scores. All arthroscopic repairs were performed by the senior author and consisted of a single row of metal anchors placed at the lateral tuberosity with simple sutures. All but 2 patients in each group underwent arthroscopic acromioplasty. The average age of the Standard group was 57 years (range: 33 to 77 years) and for the Decelerated group 56 years (range: 29 to 78 years). Following repair, all patients were immobilized in an ultraling for 6 weeks. For both groups, pendulums exercised were initiated on post-op day #1, supine passive external rotation stretches were started on post-op day #7, and passive internal rotation stretches started at 4 weeks. The only difference between groups was that supine passive forward elevation exercises were started on post-op day #7 in the Standard group and at 4 weeks in the Decelerated group. The same aching phase of rehabilitation was identical for both groups. All patients underwent postoperative diagnostic ultrasonography of the shoulder with an Aloka SSD-3500 ultrasound unit (Aloka, Inc, Wallingford, CT) and a 7.5–MHz linear transducer by the senior author. Dynamic images of the subscapularis, supraspinatus, and infraspinatus tendons were recorded at 4 time intervals: 4 weeks, 7 weeks, 3 months, and 6 months postoperatively. Recorded video images were reviewed by the senior author and 2 independent musculoskeletal radiologists blinded to the rehabilitation protocol. A tear was diagnosed when there was a gap in the tendon substance with retraction from the bone and/or a hypoechogenic focal defect. Interobserver reliability was calculated by determining the Kappa value. Chi-square test was utilized to determine whether a significant difference could be found between groups with respect to the numbers of recurrent tears. Postoperative range of motion was measured using a goniometer. The Student t test was utilized to compare postoperative range of motion for each group at each time interval. Results: For postoperative range of motion, no significant differences were found between groups at any of the time intervals. Mean postoperative forward elevation improved from 147° to 172°, mean external rotation improved from 45° to 68°, and mean internal rotation improved from L1 to T8 for both groups. At the conclusion of the study period, postoperative ASES, pain, and satisfaction scores significantly improved both groups. There was no significant difference between groups. Interobserver reliability for the ultrasound readings was good to excellent with a Kappa value of 0.834. Postoperative ultrasound examination demonstrated 3 re-tears in the Standard group and 2 re-tears in the Decelerated group during the early post-op period (4-7 weeks) (p = 0.05). By 3 months, there were 2 more re-tears in the Standard group and by 6 months, there were 2 more re-tears in the Standard group and 1 more in the Decelerated group (p = 0.05). At the conclusion of the study period, 81% (30 of 37) of cuffs were intact for the Standard group vs 91% (30 of 33) of cuffs were intact for the Decelerated group (p = 0.05). For both groups, 35% (8 of 23) of large to massive re-tears were re-torn vs 4% (2 of 47) of small to medium re-tears were re-torn (p < 0.05). There was a trend for re-tears to occur in older patients. The average age of the patients with a recurrent tear was 62 years vs 56 years for those with an intact cuff (p = 0.11). Conclusion: Rehabilitation can impact postoperative rotator cuff integrity. While a statistically significant difference was not found between the re-tear rates in the Standard and Decelerated groups (19% vs 9%), this difference may be clinically relevant. This study supports the use of a decelerated rehabilitation protocol following arthroscopic rotator cuff repair because it resulted in fewer recurrent tears and did not result in an increased incidence of postoperative stiffness. The wide variations in rehabilitation protocols currently in use may account for some of the variations in postoperative repair integrity reported in the literature.

26 HEALING RATE OF PARTIAL-THICKNESS ROTATOR CUFF TEARS AFTER ARTHROSCOPIC TAKEDOWN AND REPAIR

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Introduction: Although healing after rotator cuff repair has been the focus of recent research, very little information exists regarding partial tears. Healing after full thickness rotator cuff (FTRCT) repairs range from 5-71%. To date, no study has reported on healing after takedown and repair of partial thickness rotator cuff tears (PTRCT). The primary purpose of this study was to evaluate cuff integrity after repair of PTRCTs. Methods: 43 consecutive patients who underwent debridement of PTRCT tear followed by repair were evaluated by ultrasound for evidence of cuff healing at a minimum of 6 months postoperatively. All patients were reexamined by an independent observer. Outcome assessment data was obtained. Results: 43 of 49 patients returned follow-up. The average age was 53 (range 34-73). 38 patients (88%) had an intact cuff repair on ultrasound. Five patients had a recurrent tear. Two tears were smaller than original size, two were the same size, and one was larger. ASES scores improved from 46.1 ± 17.8 preoperatively to 79.6 ± 18.7 at follow-up. 91% patients returned to work at their previous occupation. Overall patient satisfaction was 93%. Conclusions: 88% of partial thickness tears heal after takedown and repair. These results exceed those published for healing of FTRCTs. As a large percentage of degenerative FTRCTs deteriorate towards FTRCTs, these results support a strategy of takedown and repair in comparison to debridement alone when surgery is indicated.

27 A COMPARISON OF PROSPECTIVE AND RETROSPECTIVE FUNCTIONAL OUTCOME ASSESSMENT AFTER ROTATOR CUFF REPAIR (RCR)

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Introduction: Prospective outcome studies are generally considered to be better than retrospective studies for evaluating orthopaedic treatments. The purpose of this study was to assess correlations between prospective and retrospective outcome after RCR to determine which better reflects patient satisfaction. Methods: 114 pa-
tients (120 shoulders) with chronic rotator cuff tears were evaluated pre-operatively and at a mean of 54 months (34-85) after RCR. Outcome was evaluated with visual analog scales (VAS) (pain, function, quality of life, and satisfaction), the Disability of Arm Shoulder and Hand (DASH), and Simple Shoulder Test (SST). At the study evaluation the patients provided a retrospective assessment of the improvement that resulted from the RCR. Results: Retrospective assessment of the subjective and objective improvement of the patient's current status was significantly correlated with the prospectively determined improvement (p<0.001). However, the correlations were only fair (r=0.23 to 0.25). Post-operative patient satisfaction was more highly correlated with all retrospective evaluations (r=0.41 to 0.58; p<0.001) than with the prospective improvement in all functional outcome measures (r=0.19 to 0.26; p<0.05). Discussion: Retrospective and prospective evaluations of the outcome of RCR are different and have only fair correlations. Patient satisfaction has a greater correlation with retrospective outcomes than with prospective improvement. This suggests that a patient's current status is more important than the improvement from their pre-operative status. Consequently, retrospective evaluation may aid in supplementing prospective evaluations as it may reflect a patient's perception of the success of RCR even though it does not correlate as well with the prospectively determined improvement in outcome.

28 INTEROBSERVER AND INTRAOBSERVER VARIABILITY IN THE DIAGNOSIS AND TREATMENT OF SLAP LESIONS AMONGST EXPERIENCED SHOULDER ARTHROSCOPISTS: A STUDY OF 73 SURGEONS ACROSS TWO CONTINENTS
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Aims of Study: Superior Labrum Anterior to Posterior (SLAP) lesions are a relatively rare entity and classification as a basis for selection of treatment has remained a point of controversy. No studies have evaluated the judgment of surgeons with arthroscopy as a basis for classification and treatment decisions. We hypothesize that expert surgeons would demonstrate a significant variation in their classification and treatment recommendations for these lesions when asked to consider arthroscopic video of a variety of cases. Materials and Methods: Two-hundred seventy eight CD-ROMs containing 23 video vignettes of approximately 15 seconds duration were sent to the membership of the American Ortho-Arthroscopy Association of North America (AANA), the American Orthopaedic Society for Sports Medicine, and the American Shoulder and Elbow Society. Each surgeon was asked to review the vignettes and classify the SLAP lesion type (according to Snyder's classification) and provide a treatment recommendation for each vignette. Seventy-three expert surgeons responded to the solicitation with a completed analysis. The same CD-ROM was re-sent to each of these 73 surgeons at a minimum of 12 months after the first viewing in order to obtain data on intra-observer reliability. Sixteen of the 73 surgeons returned this second CD-ROM with a complete analysis. Six surgeons from Europe and 67 surgeons from the United States were amongst the participants. Demographic data obtained from each surgeon included the number of shoulder arthroscopies performed per year, years in practice, residency arthroscopy training, and number of years and other factors analyzed. The range of intraobserver agreement varied considerably for both diagnosis and treatment of SLAP lesions. When the correct decision rate was 95.8% (95% CI 93.5-97.4%). However, the data was considerably more variable when treatment was analyzed in conjunction with diagnosis. Of those surgeons making the diagnosis of a type I lesion, 17.8% of them repaired the labrum, repaired the labrum and tenodesed the biceps, or did nothing. The analysis for type II lesions resulted in 14.3% of surgeons making the decision not to repair the labral lesion and, rather, to either tenodese the biceps (10%, 95% CI 8-13%) or debride the labrum only (3%, 95% CI 1.5-4.5%). The analysis of type III lesions resulted in only 50.8% of respondents making the decision to debride the bucket-handle lesion (95% CI 42-60%) while 43.5% of respondents opted to repair the labrum and 5.6% decided for biceps tenodesis. Of those surgeons making the diagnosis of a type IV lesion, 29.8% decided for labrum repair with biceps tenodesis and 54.4% opted for labrum repair only while 15.8% of respondents indicated that they would only debride the labrum (95% CI 11-21%). Our analysis identified a correlation between lower arthroscopic volumes per year and the decision to treat type II SLAP lesions with debride-ment alone (p=0.02, χ²-test). A statistically significant relationship between the number of years in practice and an increased tendency to treat type III lesions with debridement alone was also identified (p=0.02, χ²-test). Multiple logistic regression analysis showed no relationship between correct treatment decisions based on diagnosis and any of the demographic factors analyzed. The type of SLAP lesion is significantly correlated with the likelihood of a correct treatment decision (p<0.001) where SLAP types I, II and IV are significantly more likely to be treated correctly than type III lesions. In regards to our analysis of intraobserver variability, the range of intraobserver agreement varied considerably for both diagnosis (range 24-94%) and treatment (range 35-94%) across all SLAP types. Conclusion: This study is the first analysis of the interobserver and intraobserver variability for the diagnosis and treatment of SLAP lesions. The data demonstrated that, while experienced arthroscopists are skilled at making the correct diagnosis, the treatment of these lesions varies considerably amongst surgeons. Type I, II and IV lesions have a significantly greater likelihood to result in the correct treatment than type III SLAP tears. Surgeon experience significantly influences the correct decision for treatment of type II lesions and those arthroscopists with fewer years in practice were more likely to correctly treat type III lesions. No significant correlation between years in practice, subspecialty and residency arthroscopy training, or case volume and the likelihood of correct treatment were identified. Interestingly, intraobserver variability amongst surgeons varies widely for both the diagnosis and treatment of SLAP lesions.

29 TRAUMATIC POSTERIOR SUBLUXATION OF THE SHOULDER IN ATHLETES TREATED WITH ARTHROSCOPIC REPAIR
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Introduction: The impact of posterior instability on the athletic shoulder can be functionally significant and disabling. Open posterior reconstruction has been considered the standard of treatment for this problem. The purpose of this report was to assess the functional outcomes in athletes treated by arthroscopic repair for traumatic posterior instability. Methods: This is a retrospective review of 16 athletes (average age 21.6 years) who opted for arthroscopic repair of traumatic posterior instability of the shoulder between 2001 and 2004. All of these patients sustained an acute injury either by contact or during a fall on the outstretched hand. Twelve of the sixteen patients reported recurrent instability episodes. Preoperative MRI-arthrogram confirmed a posterior capsulo-labral complex injury in all patients. Treatment included diagnostic arthroscopy and arthroscopic repair. All patients (16/16) were found to have an injury to the posterior-inferior capsulo-labral complex (Bankart lesion). Additional findings included chondral or osteochondral loose bodies (6/16), intra-substance capsular irregularity (4/16), and superior labral injury (2/16). Arthroscopic repair included repair of the posterior Bankart lesion with suture anchors or arthroscopic tacks (16/16), loose body removal (4/16), capsular plication (2/16), and electrothermal treatment.
RESULTS: The follow-up ranged from 14.6 to 60 months. All patients were evaluated utilizing the modified ASES scale. The average total modified ASES score was 90 for this group of patients. All patients returned to sports. Two of sixteen patients reported persistent mild pain and one of these two patients reported a single episode of recurrent instability. Both of these patients had returned to contact football. CONCLUSIONS: In this group of athletes with traumatic posterior instability, a posterior-inferior capsulolabral lesion was uniformly present. This finding is distinctly different than the posterior-superior lesion commonly found in the overhand throwing athlete. Arthroscopic repair in this group was effective in a high percentage of cases. This technique compares favorably to reported results for open posterior repair.

30 POSTERIOR-INFERIOR INSTABILITY IN THE COMPETITIVE SWIMMER
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Introduction: Shoulder pain occurs commonly in the competitive swimmer. Treatment options can be frustrating due to the demanding anaerobic nature of the sport. Traditionally anterior instability was thought to play a significant role in chronic anterior-superior shoulder pain that may limit or stop a swimmer’s ability to workout or compete. Recent changes in stroke techniques and underwater techniques have led to a change in symptomatology and direction of instability. This investigation reports the results of non-operative and arthroscopic treatment of posterior-inferior instability in the competitive swimmer.

Methods: This is a prospective evaluation of 148 consecutive swimmers that were evaluated for the complaints of shoulder pain and had a diagnosis of posterior-inferior instability between January 1998 and January 2004. 125 swimmers with 135 shoulders comprising Group A were placed on a rehabilitative program focusing on scapular stabilization, posterior cuff strengthening, core strengthening and a direct discussion with the 113 of the swimmer’s coaches to alter hand position. Group B consisted of the swimmers that underwent arthroscopic surgical reconstruction (posterior-inferior capsular plication and posterior labral repair when necessary). All patients had ASES scoring of pain, function, and satisfaction at the time of initial evaluation and at the time of final follow-up. Results: Group A patients had an average age of 15.2 years, 10 swimmers had bilateral shoulder symptoms. The follow-up ranged from 12-42 months. 11 patients (9.6%) failed conservative rehabilitation, 7 requiring arthroscopic repair and 4 that retired from swimming. 114 swimmers were able to return to full competition. The initial ASES modified score of pain, function, and satisfaction was 23.8, 8.1, and 51.6: the final ASES scores were 29.1, 9.6, and 58.2. Group B consisted of 30 shoulders in 29 swimmers, 12 swimmers that had failed multiple attempts of rehabilitation, 10 swimmers that had undergone previous anterior instability repairs, and 7 patients with 8 shoulders from Group A. Average age was 16.8 years. Follow-up ranged from 24 months to 42 months. 23 swimmers returned to full competition, 6 swimmers were able to return to competition with altered technique, 2 swimmers returned to competition then retired. The initial ASES modified score of pain, function, and satisfaction was 20.8, 7.2, and 48.9: the final ASES scores were 27.2, 9.6, and 58.2. Conclusion: Posterior-inferior instability occurs frequently in the competitive swimmer as a result of repetitive internal rotation positioning. Non-operative management provides excellent result, and return to competition with shoulder girdle strengthening, improving scapulohumeral coordination, and stroke technique changes. Arthroscopic repair of posterior inferior instability restores glenohumeral stability, decreases pain and can return the swimmer to competition with low morbidity.

31 A COMPARISON OF FOREARM SUPINATION AND ELBOW FLEXION STRENGTH IN PATIENTS WITH EITHER LONG HEAD OF THE BICEPS TENOTOMY OR TENODESIS
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Background: Multiple studies support both tenotomy and tenodesis of the long head of the biceps tendon (LHBT) as a surgical treatment option for painful proximal LHBT pathology. Some favor tenodesis over tenotomy as tenotomy has been theorized to lead to increased postoperative weakness. However, there is no current strength analysis study comparing LHBT tenotomy to tenodesis. The purpose of the present study was to compare the forearm supination and elbow flexion strength of the upper extremity in patients who have had an arthroscopic LHBT release with patients that have had an LHBT tenodesis. Hypothesis: The experimental hypothesis is that forearm supination and elbow flexion strength will be less in the biceps tenotomy group compared to the biceps tenodesis group.

Study Design: Case Control Study; level III. Methods: Cybex isokinetic strength testing was performed on 17 patients who underwent arthroscopic LHBT tenotomy, 19 patients who underwent arthroscopic LHBT tenodesis and 31 age, gender and BMI matched control subjects. Subjects were considered fully recovered from shoulder surgery, were released for unrestricted activities, and were at least 6 months post-operation prior to testing. Subjects were tested for forearm supination and elbow flexion strength of both arms using a Cybex II NORM isokinetic dynamometer at 60 and 120 degrees per second. Testing was performed on injured and uninjured arms as well as dominant and non-dominant arms in controls. Both forearm supination and elbow flexion strength values were recorded. Results: Comparison between involved and uninvolved upper extremities within each group utilizing a paired t test showed a 7% increase in elbow flexion strength when comparing dominant and non-dominant arms at 60 deg/sec. Comparison between groups utilizing 2x3 ANOVA (speed x group) showed no statistical difference in either forearm supination or elbow flexion strength comparing the tenotomy, tenodesis, and control groups. Conclusion: Both LHBT tenotomy and tenodesis are valuable surgical options in the treatment of the symptomatic LHBT. Following either procedure, no statistically significant forearm supination or elbow flexion strength differences existed in the involved extremity between the two study groups.

32 ARTHROSCOPIC ANTERIOR SHOULDER STABILIZATION IN CONTACT ATHLETES
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Introduction: Open techniques have traditionally been used for the treatment anterior shoulder stabilization in contact athletes. There remains some question as to whether currently applied arthroscopic stabilization techniques are effective in returning contact athletes to sport. Purpose: The purpose of this study was to evaluate the results of arthroscopic anterior stabilization in a group of contact athletes with traumatic anterior instability of the shoulder. The primary study objective was to determine the effectiveness of arthroscopic stabilization procedure in facilitating a return to contact sport. Methods: Twenty-four patients (28 shoulders) who participated in contact sports and underwent anterior shoulder stabilization between January 1, 1994, and December 31, 2003, were identified. Patients were included if they participated in contact sports, were diagnosed with recurrent anterior instability, under-
went arthroscopic repair, and had two year minimum follow-up. Patients were excluded if they had extensive intra-articular bone loss (Hill Sachs >40%, large bony Bankart, or “inverted pear-shaped” glenoid) or had prior surgery on the shoulder. All patients participated in a telephone interview and 13 patients (15 shoulders) filled out American Shoulder and Elbow Society Shoulder Assessment, L’Insalata Shoulder Questionnaire, and Western Ontario Shoulder Instability Index; underwent physical examination, and radiographic evaluation. Results: Twenty-one of the 28 shoulders (75%) were able to return to the same level of contact sport after arthroscopic repair. Of the seven that did not return to contact sport, only one patient reported that his return was prohibited by his shoulder function. There were no significant differences in patient demographics between those who returned to contact sport and those who did not. Two of the 28 shoulders (7%) developed recurrent instability, but only one required an additional stabilization procedure. The mean age at surgery was 23 and the mean time to follow-up was 4.2 years (Table I). Conclusions: This study demonstrated a 92.9% success rate with arthroscopic anterior shoulder stabilization in contact athletes. Seventy-five percent of the athletes returned to contact sport at the same level. Since the ability to return to sport is multifactorial, and there were no differences between our two groups, our overall rate of return to sport likely underestimates athletes’ potential to return to contact sport. We have shown that contact athletes without significant bony injury can expect excellent functional results after arthroscopic anterior shoulder stabilization and that a successful return to competitive contact athletics is a realistic expectation.

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<th>Returned</th>
<th>Did not return</th>
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<tr>
<td>Percentage</td>
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<tr>
<td>Age at surgery</td>
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<tr>
<td>Time of follow up</td>
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<td>ASES score</td>
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<td>Internal rotation</td>
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33 ENDOSCOPIC RELEASE OF THE SPINOGLENOID LIGAMENT
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Purpose: Spinoigolenoid ligament entrapment of the suprascapular nerve presents with acute onset of deep, diffuse, posterolesional shoulder pain. Patients demonstrate consistent findings of pain with palpation over the suprascapiular notch, spinati muscle atrophy, or isolated infraspinatus muscle atrophy often secondary to a ganglion at the spinoigolenoid notch. The current trend is toward early surgical decompression through an open posterior approach. The purpose of this study was to determine the outcome following endoscopic release of the spinogolenoid ligament, in treatment of suprascapiular nerve entrapment syndromes (SNES). Methods: Between 1/1998 and 3/2006, 16 patients presented with posterior shoulder pain, presumed to have SNES. Diagnosis was determined by physical exam, and confirmed by MRI and EMG/NCV studies. The average patient age was 39 (range 23 to 69). There were 6 males and 10 females. All patients had limited use of their shoulder prior to surgery. All patients underwent endoscopic spinogolenoid ligament release performed by one surgeon, in the beach chair position using standard posterior, lateral, and accessory portals as needed. Pre-operative and post-operative ASES score, shoulder pain, strength, and ROM were documented. A paired sample t-test was applied to preoperative and postoperative measurements within each group. Results: Four patients were excluded from the study secondary to concomitant open supraspinatus medial wedge resection. At 4 years average follow-up (range 1 to 8 years), 11 of the 12 (94%) remaining patients had relief of their shoulder pain. All had full range of motion, and improvement in ASES score (p<0.05). All patients returned to full activities of daily living. The average time of return to full function was 6 months. No nerve or vascular complications were noted. Seven of the patients did not have full return of function of the infraspinatus; however these patients had significantly longer time from injury to surgery. No patient required open decompression of the spinogolenoid notch. Conclusions: Entrapment of the suprascapular nerve by the spinogolenoid ligament can be a common cause of posterior shoulder pain. This simple minimally invasive technique of endoscopic release of the spinogolenoid ligament can provide for patients symptomatic relief and allow them to return to function faster and with less complications than traditional open posterior release. Early treatment is recommended to improve return of function of the infraspinatus.

34 ARTHROSCOPIC SUBDELTOID TRANSFER OF THE LONG HEAD OF THE BICEPS TENDON TO THE CONJOINT TENDON: A NEW TECHNIQUE WITH CLINICAL RESULTS AT A MINIMUM 2 YEAR FOLLOW-UP
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Introduction: The treatment of biceps tendon pathology remains controversial. The etiology of biceps tendinitis may involve biceps tendon instability or pathology within the tendon. Transfer of the long head of the biceps (LHBT) to the conjoint anterolateral tendon on the coracoid process may yield relief of symptoms and preserve function and muscle contour. We sought to evaluate clinical and functional outcome in a cohort of patients who underwent transfer of the LHBT. Methods: 54 patients diagnosed with biceps pathology or instability underwent an arthroscopic assisted or arthroscopic transfer LHBT as either an isolated procedure or part of another shoulder procedure by the senior author. The procedure was performed using a new arthroscopic subdeltoid technique. 39 shoulders in 40 patients were examined at a minimum of 2 years. Patients underwent complete shoulder evaluation and clinical outcomes were scored based on ASES, UCLA, and L’Insalata questionnaires. Ipsilateral and contralateral metrics were also evaluated. Results: 40 shoulders (13 female, 26 male; average age 38.5) were evaluated with L’Insalata, UCLA, and ASES scoring 75.57, 27.32, and 78.72 respectively. In the 25 patients who had an isolated LHBT transfer the L’Insalata, UCLA, and ASES scores were 85.2, 29.5 and 84.8. This difference was statistically significant. 3 patients had early traumatic failure due to non-compliance with post-surgical rehab protocols. This included the 2 patients who had a Popeye sign at follow-up during active elbow flexion. There was not a statistically significant side to side strength difference using a 10 lb. weight. 80% were self-rated as good to excellent and 20% of patients were self-graded as fair or poor, which includes the 3 failures mentioned above. 100% of the patients reported no arm pain at rest with regard to the biceps. 95% of patients reported no biceps tenderness upon palpation of the bicipital groove. 5 patients complained of fatigue discomfort (soreness) isolated to the biceps muscle following resisted elbow flexion. Conclusion: Arthroscopic subdeltoid transfer of the LHBT is
an appropriate and reliable intervention for patients with chronic, refractory biceps pathology. There was no loss of strength for biceps curls. 100% of patients reported no pain isolated to biceps muscle at rest. 95% of patients had resolution of their preoperative biceps symptoms. This procedure is an acceptable surgical alternative when compared to tenotomy, which has a significantly higher rate of Popeye’s sign and fatigue discomfort, as well as tenodesis, with tenodesis site tenderness reported between 6-40%.

35 ARTHROSCOPIC REVISION OF FAILED OPEN ANTERIOR STABILIZATION OF THE SHOULDER

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Background: The results of surgical treatment of anterior instability of the shoulder are well reported. The recurrence of instability represents the most common complication of this surgery and its evaluation poses both a diagnostic and therapeutic problem. A failed open stabilization has often been thought to necessitate an open revision. The purpose of this study is to report the results of arthroscopic Bankart repair following failed open treatment of anterior instability. Materials and Methods: We performed a retrospective review of 22 patients with recurrent anterior shoulder instability (ie, subluxations or dislocations, with or without pain) after open surgical stabilization. There were 17 men and five women with an average age of 31 years (range, 15-65). The most recent interventions consisted of 16 osseous transfers (12 Latarjet and four Eden-Hybinette), three open Bankart repairs and three capsular shifts. The causes of failure were additional trauma in 12 patients and complications related to the bone-block in 13 (poor position, fracture, pseudarthrosis or lysis). All patients were noted to have distension of the anterior-inferior capsular structures. Labral re-attachment and capsuloligamentous re-tensioning with suture anchors was performed in all cases with an additional rotator interval closure in four patients and an inferior capsular plication in 12 patients; the bone block screws were removed in eight patients.

Results: At an average of 43 months (range, 24-72 months), 19 patients were evaluated by two independent observers. One patient had recurrent subluxation, and two patients had persistent apprehension. Anterior elevation was unchanged, and loss of external rotation (RE1) was 6°. Nine patients returned to sport at the same level; all patients returned to their previous occupations, including the six cases of work-related injury. Eighty-nine percent were satisfied or very satisfied; the subjective shoulder value (SSV) was 83% ± 23%; the Walch-Duplay, Rowe and UCLA scores were 85 ± 21, 81 ± 23 and 30 ± 7 points respectively. The number of previous interventions did not influence the results. Eight patients (42%) were still painful (six with light pain and two with moderate pain). Conclusions: Arthroscopic revision of open anterior shoulder stabilization gives satisfactory results. The shoulders are both stable and functional. While the stability obtained with this approach is encouraging, our enthusiasm is tempered by some cases of persistent pain.