

SPECIALTY UPDATE

WHAT'S NEW IN SHOULDER AND ELBOW SURGERY

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Sources

The sources for this annual update on shoulder and elbow surgery were presentations and symposia at meetings of the American Orthopaedic Society for Sports Medicine (Specialty Day, New Orleans, Louisiana, February 8, 2003), the Arthroscopy Association of North America (Specialty Day, New Orleans, Louisiana, February 8, 2003; Twenty-second Annual Meeting, Phoenix, Arizona, April 24-27, 2003; and Twenty-first Fall Course, Palm Desert, California, November 17-19, 2002), the American Academy of Orthopaedic Surgeons (Seventieth Annual Meeting, New Orleans, Louisiana, February 5-9, 2003), the American Shoulder and Elbow Surgeons (Specialty Day, Nineteenth Open Meeting, New Orleans, Louisiana, February 8, 2003; and Nineteenth Annual Meeting, Pebble Beach, California, October 30-November 3, 2002), and The American Orthopaedic Association (116th Annual Meeting, Charleston, South Carolina, June 11-14, 2003).

Shoulder

Rotator Cuff

Basic Science

Kelly compared the muscle-firing patterns in both symptomatic and asymptomatic patients who had two-tendon rotator cuff tears. Asymptomatic patients demonstrated increased firing of the intact subscapularis, whereas symptomatic patients continued to rely on torn rotator cuff tendons and scapular muscle substitution, resulting in compromised function. Kalandiak compared the in vivo kinematics of painless shoulders that had massive rotator cuff tears with those of normal shoulders with use of cinefluoroscopy. Only one patient demonstrated normal "ball and socket" kinematics; most demonstrated increased scapulothoracic motion during initial forward elevation. The mean active forward elevation was 129° when performed against no resistance but only 86° when performed against resistance.

Rubino studied the progression of fatty infiltration by harvesting the supraspinatus muscle bilaterally at various time-

intervals following unilateral surgical detachment of that tendon in a rabbit model. A consistent decrease in muscle weight was noted when detached specimens were compared with intact specimens. Fatty infiltration was evident as early as six weeks after detachment and increased over time as a percentage of muscle volume ($p = 0.002$).

Schlegel compared the modified Mason-Allen stitch with a horizontal mattress stitch in a sheep model to determine the effect on tendon-healing to bone. Subsequent biomechanical and histological testing demonstrated similar stiffness and loads to failure and normal-appearing tendon-to-bone insertions. St. Pierre compared three different suture-repair techniques in a human cadaver model. The modified Mason-Allen and double-mattress techniques had higher ultimate loads to failure than did the single-horizontal-mattress technique when used with suture anchors.

Boswell compared bioabsorbable screw-and-washer fixation with various suture-anchor repairs for rotator cuff fixation in a bovine model. The study demonstrated that 5-mm gap formation occurred later in association with the bioabsorbable screw-and-washer method than it did in association with any suture-anchor repair method, including a technique involving the use of single-loaded anchors with modified Mason-Allen sutures. Tasto used a bovine model to demonstrate that the depth of insertion of suture anchors influences their ultimate load strength and mode of failure. Countersunk anchors had greater ultimate load strength to failure than did anchors that were placed proud or level with the cortical surface. In addition, no sutures in the countersunk-suture-anchor group failed during cyclical loading.

Hawkins compared the accuracy of physical examination alone with that of physical examination coupled with magnetic resonance imaging for the diagnosis of rotator cuff tears. Prospective data were collected on 299 patients who underwent rotator cuff surgery, 148 of whom had ancillary magnetic resonance imaging data. The positive predictive values for the diagnosis of a full-thickness tear on physical exami-

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nation with and without magnetic resonance imaging were comparable. However, the negative predictive value for this diagnosis was significantly lower for physical examination coupled with magnetic resonance imaging than for physical examination without magnetic resonance imaging ($p < 0.05$); this finding supported the adjunctive use of magnetic resonance imaging to rule out a full-thickness rotator cuff tear. In contrast, magnetic resonance imaging did not impart any significant advantage over physical examination alone for the diagnosis of partial-thickness tears.

Impingement

Burkhart reviewed the results of arthroscopic treatment of combined subcoracoid and subacromial impingement associated with supraspinatus and subscapularis tears. All patients underwent arthroscopic subcoracoid and subacromial decompression and rotator cuff repair. At the time of the final follow-up, seven of eight patients reported good to excellent results and all patients reported decreased pain. Four patients regained active overhead function and improved subscapularis function.

Full-Thickness Tears

Yamaguchi compared symptomatic and asymptomatic rotator cuff tears with use of ultrasonography in 588 patients who presented with unilateral shoulder pain. The prevalence of rotator cuff disease increased with age: patients with no rotator cuff tears had an average age of forty-nine years, patients with a unilateral rotator cuff tear had an average age of fifty-nine years, and patients with a bilateral tear had an average age of sixty-eight years. Logistic regression showed a 50% likelihood of a bilateral tear after the age of sixty-six years. Overall, a patient with a symptomatic full-thickness rotator cuff tear had a 35% chance of a contralateral asymptomatic rotator cuff tear. The high incidence of asymptomatic tears and the increased incidence with advancing age suggest that at least some rotator cuff disease is intrinsic.

Metcalf performed a meta-analysis to compare arthroscopic and open rotator cuff repair techniques. Various demographic and outcome measures were recorded. The analysis encompassed 1845 patients who had undergone open repair of a full-thickness tear and 373 patients who had undergone arthroscopic repair; the average age, duration of follow-up, and proportion of tears measuring >3 cm were comparable between the groups. Overall, 83% of patients in the open repair group and 87% in the arthroscopic repair group had a good or excellent result. Kim compared the results of forty-two arthroscopic rotator cuff repairs with those of thirty-four mini-open repairs that had been performed to salvage technically unsuccessful arthroscopic repairs. After a mean duration of follow-up of thirty-nine months, the pain and activity levels and the University of California at Los Angeles (UCLA) and American Shoulder and Elbow Surgeons (ASES) scores were similar in both groups. Tetreault evaluated range of

motion and patient satisfaction following arthroscopic rotator cuff repair and compared these results with those in a matched group of patients who had undergone mini-open rotator cuff repair. No significant differences between the two groups were identified with regard to active flexion, external rotation, or the Simple Shoulder Test score, but strength was significantly improved in the arthroscopic repair group ($p < 0.01$).

Fealy reported on the recurrence of rotator cuff tears following open, mini-open, and arthroscopic repairs. Patients underwent serial Doppler ultrasonography at six weeks, three months, and six months following repair. A rotator cuff defect was identified with ultrasonography at some point postoperatively in 48% of the shoulders, but this finding did not correlate with functional outcome according to the ASES and UCLA scores. The study also demonstrated a decline in rotator cuff perfusion over time, irrespective of repair technique, but it failed to demonstrate a difference in perfusion between intact repairs and repairs that had failed. Popowitz reported on the outcome of rotator cuff repair in wheelchair-bound patients who had sustained a spinal cord injury. After a mean duration of follow-up of 3.5 years, six of eight shoulders had improved strength and range of motion. The mean ASES score had improved from 34 to 84 points, and all but one of the patients were satisfied with the result. The authors stressed that compliance with a demanding postoperative rehabilitation program is essential in this challenging population.

Farrell reported on the results of subacromial smoothing, consisting of bursectomy and débridement of both rotator cuff insertion and tuberosity excrescences, without acromioplasty in the treatment of irreparable rotator cuff tears. The results of the Simple Shoulder Test revealed that 80% to 85% of the patients had a comfortable shoulder at both short and long-term follow-up, compared with 90% to 95% of age and gender-matched control patients who had undergone rotator cuff repair. However, the ability to throw overhead was compromised in the group managed with smoothing.

Kocher identified determinants of patient satisfaction following rotator cuff surgery in a prospective study of 311 patients with multiple diagnoses, including impingement, partial-thickness tears, and full-thickness tears. Significantly decreased satisfaction was noted for patients managed with débridement for massive, irreparable rotator cuff tears; patients with subscapularis tears; and patients with large, two-tendon tears. Decreased satisfaction also was noted for patients with limited or weak active forward elevation, positive impingement signs, acromioclavicular joint pain on cross-body adduction, and acromioclavicular joint tenderness. Klepps assessed the effect of rotator cuff integrity, measured with magnetic resonance imaging, on outcome in a group of forty-seven consecutive patients undergoing open rotator cuff repair. The thirty-two patients who were available for clinical and magnetic resonance imaging evaluations had significant improvement in function according to both the ASES score

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and the Constant score ($p < 0.05$). The overall rate of repeat tears was $<40\%$. Guerra also reported on the use of magnetic resonance imaging for the evaluation of arthroscopic rotator cuff repairs. Twelve patients from a cohort of patients who had undergone 100 consecutive arthroscopic repairs were randomly selected for magnetic resonance imaging after a mean duration of follow-up of twenty-nine months. The mean UCLA score for these patients improved from 16 to 33 after the repair ($p < 0.01$). All twelve patients had confirmation of tendon-to-bone healing on magnetic resonance imaging, but two patients had residual full-thickness or partial-thickness tears. Although the method of selecting random patients is unusual, the findings of that study counter those of previous studies demonstrating a high rate of repeat tears following arthroscopic rotator cuff repair, even among asymptomatic patients.

Subscapularis Tears

Esch reported on a technique for arthroscopic repair of partial subscapularis tendon tears in which one or two suture anchors are inserted into the lesser tuberosity through the anterior portal while the site is viewed from an anterosuperior portal. A tendon-penetrating device is used to pass the sutures through the tendon, and the knots are tied arthroscopically from the anterior portal. The author cautioned that these tears are often missed and typically appear in association with partial or full-thickness supraspinatus tears. Fox reported on the arthroscopic repair of subscapularis tendon tears, including partial-thickness tears, full-thickness tears involving the superior portion of the tendon, and complete subscapularis disruptions. Eighteen patients with a mean age of fifty-four years underwent repair with use of suture anchors and nonabsorbable sutures as well as adjunctive subcoracoid decompression. After a mean duration of follow-up of twenty-seven months, the mean ASES score had increased from 41 to 81 points, the visual analog pain score had decreased from 6.1 to 1.8, and 79% of patients rated their function as good or excellent.

Calcific Tendinitis

Wung reported on the use of shock-wave therapy for the treatment of calcific tendinitis in a placebo-controlled, prospective study. After two years of follow-up, 91% of the patients in the study group had a good or excellent result, compared with none of the patients in the sham-treatment group. The clinical recurrence rate was 6%. The calcium deposits were completely dissolved in 58% of the patients and partially dissolved in 15%. Moreover, they did not recur during the study period. Gerdesmeyer, in a randomized, prospective, placebo-controlled, multicenter study, also demonstrated significantly better outcome in the shock-wave therapy group on the basis of the Constant score. These studies appear to demonstrate the effectiveness and safety of this new modality. Porcellini described the arthroscopic treatment of calcific tendinitis, consisting of removal of all visible deposits and arthroscopic repair of larger

partial and all complete tears. Clinical examination and ultrasonography, performed at a minimum of two years of follow-up, demonstrated that the mean Constant score had improved from 55 to 86 but that some calcifications persisted in the majority of patients.

Acromioclavicular Joint

Levine found comparable results following the use of direct and bursal approaches for arthroscopic distal clavicular resection (as indicted by ASES scores of 90 and 94, respectively, at the time of the final follow-up) and reported that only four of sixty-six patients had an unsatisfactory result. However, all four of these patients had had the resection through the direct approach and two required acromioclavicular joint stabilization for anteroposterior instability. The author cautioned that the direct approach might damage the superior capsular ligaments, potentially leading to anteroposterior distal clavicular instability.

Glenohumeral Instability

Basic Science

Lee investigated the effects of failure modes in a cadaver model of anteroinferior shoulder dislocations. He found that when the dislocation resulted in a Bankart lesion, changes were noted after three subsequent dislocations. When the dislocation resulted in capsular failure, only a single dislocation was required to cause damage. Grossman, with use of a cadaver model, found that posterior capsular contracture forces the humeral head posterosuperiorly during external rotation, which may explain the etiology of superior labrum (SLAP) lesions in athletes who participate in overhead sports. Warren reported that ultraviolet radiation resulted in shortening of the shoulder capsule of as much as 10% and was associated with a corresponding 15% increase in stiffness.

Miller tested the hypothesis that shoulders with acute anterior dislocations should be immobilized in external rotation. A Bankart lesion was created arthroscopically in ten human cadaver shoulders, and a force sensor was placed between the detached labrum and the glenoid rim. The contact force between the labrum and the glenoid reached a maximum when the arm was placed in 45° of external rotation, suggesting that immobilization in that position may reduce the rate of recurrence.

Clinical

Itoi tested Miller's hypothesis in a randomized, prospective, clinical study. Patients with an initial anterior shoulder dislocation were randomized to treatment with immobilization in either internal or external rotation for three weeks. Six of the twenty shoulders that were immobilized in internal rotation had a recurrent dislocation within a sixteen-month follow-up period, compared with none of the twenty shoulders that were immobilized in external rotation with use of a custom orthosis. The author suggested that externally rotating the shoulder

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allows the anterior aspect of the labrum to oppose the glenoid rim during healing so that normal anatomy is restored. In contrast, traditional immobilization in internal rotation medializes the anteroinferior aspect of the labrum, causing loss of normal concavity-compression.

Edwards presented the radiographic findings for 160 shoulders with recurrent anterior instability, 132 of which had sustained recurrent dislocations. A humeral impaction fracture was identified on the anteroposterior radiographs of 100 of 132 shoulders in the dislocation group, twelve of eighteen shoulders in the subluxation group, and five of ten shoulders in the group with instability diagnosed at the time of arthroscopy. A glenoid lesion was identified in 107 of 132 shoulders in the dislocation group and fifteen of eighteen shoulders in the subluxation group. These findings support the routine use of radiographs in the evaluation of suspected anterior glenohumeral instability.

Kim presented the results of arthroscopic anterior shoulder stabilization after two to six years of follow-up. Recurrent instability, defined as dislocation, subluxation, or a positive apprehension test, occurred in seven (4%) of 167 patients. According to the Rowe scale, 78% of the patients had an excellent result and 17% had a good result. Glenoid bone loss correlated strongly with recurrent instability ($p < 0.0001$).

Hale reviewed the results of open anterior capsulolabral reconstruction for the treatment of recurrent traumatic anterior shoulder dislocation in a group of sixty-nine patients, seven of whom had undergone previous shoulder stabilization. The capsulolabral complex had detached from the glenoid in all cases. Instability was eliminated in sixty-four (93%) of the patients; three of the remaining five patients sustained recurrent traumatic dislocations, and two had recurrent subluxations. Araghi reported on the recurrence of anterior shoulder instability in patients forty years of age or older. Of the twelve patients who were identified on the basis of a retrospective review, ten underwent anterior shoulder reconstruction. All ten patients had an essential Bankart lesion and, at a minimum of thirty-two months following the reconstruction, nine of the ten involved shoulders remained stable. Araghi also reported on the results of revision reconstruction performed for the treatment of recurrent anterior shoulder instability in twenty-nine patients. The findings at the time of surgery included capsulolabral detachment in 70% of the patients, capsular redundancy in 83%, and rotator interval defects in 48%. At a minimum of two years following surgical treatment of all identified lesions, no dislocations were reported for twenty-one of twenty-three patients.

Hovellius presented the results of 118 Bristow-Latarjet repairs that had been performed for the treatment of recurrent anterior shoulder dislocations. At the time of the two-year follow-up, one shoulder had dislocated and five others had subluxated; the overall satisfaction rate was 98%. At the time of the fifteen-year follow-up, four patients had had recurrent dislocations and one of these patients had undergone

revision surgery. Twelve additional patients had had subluxations. The overall satisfaction rate remained 98%, and the mean Rowe score was 84.

Metcalf conducted a meta-analysis to compare the outcomes of arthroscopic and open reconstructions that had been performed for the treatment of anterior shoulder instability. Open procedures, restricted to Bankart-type reconstructions, were associated with an average redislocation rate of 8%, an average external rotation loss of 11%, and a 91% rate of good to excellent results. Arthroscopic procedures involving the use of suture anchors were associated with an average redislocation rate of 9%, an average external rotation loss of 2%, and a 92% rate of good to excellent results, thereby providing a success rate equivalent to that of open reconstructions without the associated external rotation loss.

Posterior Instability

Kim reported on the arthroscopic posterior capsular shift for the treatment of recurrent posterior shoulder instability in twenty-seven patients, all of whom had evidence of postero-inferior capsulolabral stripping or stretching. At a mean duration of follow-up of thirty-nine months, all but one of the patients had a stable shoulder, had a good or excellent result according to the UCLA score, and had returned to their previous sport with little or no limitation. Arciero reviewed the outcome following arthroscopic or open reconstruction for the treatment of traumatic posterior shoulder instability in twenty-four shoulders. All patients had posterior apprehension and increased posterior translation, and twenty-one of the twenty-four shoulders had radiographic evidence of posterior instability. After a mean of twenty-nine months of follow-up, nineteen of the twenty-four shoulders were rated as good or excellent and had been returned to unrestricted use, including for sports or military activity.

Complications

Krishnan found that the prevalence of recurrent instability after open capsulorrhaphy was higher than previously reported. At a minimum duration of follow-up of two years, anterior instability had recurred in five of forty-five shoulders, posterior instability had recurred in five of twenty-two shoulders, and multidirectional instability had recurred in fifteen of forty-five shoulders. The higher rates of failure noted for shoulders with posterior and multidirectional instability were consistent with those reported in previous studies, but the author also suggested that open instability surgery may not be as successful as once thought and may provide results that are inferior to those of arthroscopic repair.

Edwards reported on the development of glenohumeral arthrosis before and after surgery for anterior instability in a multicentric study of 625 patients. The prevalence of arthritis before anterior reconstruction was 9.2%. Risk factors for arthritis included the age of the patient at the time of the initial dislocation, the interval between the initial dislocation and

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surgery, and the presence of glenoid bone defects ($p < 0.0001$). The postoperative prevalence of arthritis in patients without preoperative evidence of arthritis was 20% and was correlated with the age of the patient at the time of the initial dislocation and at the time of surgery ($p < 0.05$), the number of dislocations, and the duration of follow-up ($p < 0.01$). No correlation between the development of arthritis and the type of surgical reconstruction (Bankart, Bristow-Latarjet, or arthroscopic) was identified. The author concluded that similar factors contribute to preoperative and postoperative arthritis in patients with anterior shoulder instability. While these findings suggest that surgery may not prevent the development of arthritis, properly designed prospective studies on the effectiveness of timely anatomic repairs in preventing arthritis are lacking.

Biceps Lesions

Koenig compared the symptoms and functional limitations following biceps tenodesis with those following biceps tenotomy or spontaneous rupture. The mean ages of the patients in the tenodesis and tenotomy groups were forty-eight and sixty years, respectively. After a minimum duration of follow-up of twelve months, the mean ASES scores in the tenodesis and tenotomy groups were 90 and 84 points, respectively. Six of twenty-four patients who had had a tenotomy or rupture complained of cramping with forceful supination and elbow flexion activities, but no patient with a "Popeye" deformity complained of it. Wolf reported on the results of arthroscopic biceps tenotomy for the treatment of biceps tendon degeneration in sixteen patients with a mean age of fifty-nine years. Thirteen patients reported a good or excellent result, twelve patients reported normal strength, and ten patients reported normal function. Inferior results were observed in patients less than fifty years old. Cameron performed isolated biceps tenotomy for the treatment of biceps tendonitis and found no significant difference in elbow flexion and forearm supination strength between operatively treated and control extremities. A "Popeye" muscle deformity developed in only 21% of the patients. Gramstad determined safe arm positions for postoperative motion of the shoulder and elbow following biceps repair by recording tension on the tendon of the long head of the biceps as the arm was placed in various positions. The study suggested that shoulder motion should be performed with the elbow flexed and that elbow motion should be performed with the shoulder flexed forward and rotated internally. Weber reported on the results of subpectoral "mini-open" biceps tenodesis after a mean duration of follow-up of 6.7 years. Following arthroscopic tenotomy, a 2-cm mid-axillary incision is made and the tendon is repaired to the bicipital groove inferior to the pectoralis major tendon with use of a unicortical screw.

Warner reported on the arthroscopic repair of isolated SLAP tears in nonathletic patients with use of suture anchors. Sixteen of twenty-four patients returned to work at their previous level, and seven returned at a reduced level. Of the seven

patients with work-related injuries, only two returned to work at their previous level. After a mean duration of follow-up of twenty-one months, the mean ASES score was 75 points overall but only 57 points among patients with work-related injuries.

Glenohumeral Arthritis**Basic Science**

Norris found that, following total shoulder arthroplasty, retrieved glenoid implants demonstrated a combination of abrasive wear and fatigue failure. Increased implant shelf-life correlated with shorter survival, and Hylamer implants demonstrated shorter in vivo survival and increased wear rates compared with non-Hylamer implants. These findings were independent of the method of sterilization. Consequently, Hylamer is no longer used in total joint arthroplasty.

Kleppe studied the natural history of hemophilic shoulder arthropathy by reviewing the experience at one center over a period of thirty-four years. Radiographic changes were noted to evolve from mild subchondral irregularities and greater tuberosity cysts to joint-space narrowing, osteophyte formation, and deformity. The severity of symptoms was correlated with radiographic scores.

Non-Prosthetic Treatment

Nowinski reported on the treatment of advanced glenohumeral arthritis with use of arthroscopic capsular release, biceps tenotomy or tenodesis, acromioplasty, and distal clavicular excision. Thirty-three patients with a mean age of sixty-two years were followed for a minimum of thirty-six months. Overall, active forward elevation increased by 42° and external rotation increased by 32° . In addition, 77% of the patients achieved a good or excellent result, and 80% indicated that they would have the surgery again. Three patients, all of whom had a biconcave glenoid preoperatively, required conversion to prosthetic arthroplasty at a mean of twenty-eight months after arthroscopy. Feldman reported on arthroscopic débridement for glenohumeral osteoarthritis, performed without capsular release and without routine decompression or biceps tenotomy. After a mean duration of follow-up of 3.8 years, nineteen of twenty-five patients were available for evaluation. Overall, 68% of the patients were satisfied with pain relief, but active motion decreased in all planes and function (as indicated by the UCLA score) did not change. Three patients subsequently underwent prosthetic hemiarthroplasty.

Williams reported on the biological resurfacing of the glenohumeral joint in six young patients (average age, thirty-eight years) with osteoarthritis. The anterior capsule was used to provide soft-tissue interposition, and the procedure (unlike those described in previous reports) did not employ prosthetic hemiarthroplasty. After a mean duration of follow-up of twenty-seven months, all patients reported pain relief and a good functional result. This technique may be a viable alternative to prosthetic shoulder arthroplasty in young, active patients.

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Gunther reported on nine patients who underwent arthroscopic débridement and core decompression for the treatment of glenohumeral osteonecrosis. At the time of arthroscopy, all shoulders had synovitis, eight shoulders had humeral head softening or chondral delamination, and five shoulders had loose bodies. Six patients demonstrated improved function and decreased symptoms at the time of the one-year follow-up, and one patient had undergone prosthetic shoulder arthroplasty.

Conventional Prosthetic Arthroplasty

Wirth described the use of impaction bone-grafting, a technique borrowed from revision hip arthroplasty, in place of cement for patients in whom conventional press-fit implantation failed to provide adequate humeral component fixation during shoulder arthroplasty. After an average duration of follow-up of fifty-six months, all sixty-eight patients who had been managed with this technique reported significant improvement in terms of pain and function according to a visual analog scale and the Simple Shoulder Test, respectively ($p < 0.05$). Bone graft resorption, as evidenced by humeral component subsidence, was noted in only one asymptomatic patient.

Edwards found that the prevalence of radiolucent lines behind the faceplate was significantly greater in patients with flat-back glenoid components than in those with convex-back glenoid components after two years of follow-up. No significant differences in the prevalence of radiolucent lines around the keel or in progression of the radiolucent lines were observed between the two groups. The results of that study correlate with those of previous biomechanical studies demonstrating superior pullout strength in association with convex components. Rosenberg reported on the improved survival of an uncemented total shoulder prosthesis following modification of the glenoid component to a design that incorporated a hydroxyapatite coating on the baseplate. The four-year survival of thirty-four shoulder replacements employing the newer design was 93%, compared with 83% for those employing the earlier design.

Trojani evaluated the results of primary shoulder arthroplasty for two groups in which the same humeral component was inserted with or without cement. After a mean duration of follow-up of thirty-nine months, the press-fit stems were associated with significantly higher rates of loosening and revision surgery than the cemented stems were ($p < 0.05$). Moreover, the cemented stems were associated with significantly better results in terms of pain, activity level, and the Constant score ($p < 0.05$). Because the humeral component used in that study originally was intended for insertion with cement, the author suggested that specifically designed stems should be used for cementless fixation.

Outcomes of Arthroplasty

Hammond evaluated the effect of surgeon experience on the

clinical and economic outcomes of shoulder arthroplasty. The study demonstrated that the risk of at least one complication in the group of patients managed by high-volume surgeons was nearly one-half of that in the group managed by low-volume surgeons. Patients managed by high-volume surgeons were three times more likely to have a hospital stay of less than six days than patients managed by low-volume surgeons were, but the average cost of hospitalization was not significantly different between the two groups.

Sperling expanded upon previously published work in a presentation on the minimum fifteen-year results of hemiarthroplasty and total shoulder arthroplasty in patients fifty years old or less. No significant difference was noted between the two procedures in terms of long-term pain relief or improvement in active motion. After a minimum of ten years of radiographic follow-up, radiolucent lines around the glenoid component were present in 74% of the shoulders that had been treated with total shoulder arthroplasty and glenoid erosions were identified in 64% of the shoulders that had been treated with hemiarthroplasty. The estimated twenty-year survival was 74% after hemiarthroplasty and 84% after total shoulder arthroplasty. However, thirty-seven (60%) of sixty-two shoulders that had been treated with hemiarthroplasty and fourteen (48%) of twenty-nine shoulders that had been treated with total shoulder arthroplasty were rated as unsatisfactory, in large part because of residual soft-tissue contractures.

Tapscott reported on the results of sixty-two hemiarthroplasties that had been performed for the treatment of glenohumeral osteoarthritis in fifty-six patients with a mean age of sixty-four years. After a minimum duration of follow-up of five years (mean, seven years), active forward elevation had improved by a mean of 28°, active external rotation had improved by a mean of 22°, and the mean Simple Shoulder Test score had improved from 5 to 9.1. Only two of the sixty-two shoulders required conversion to total shoulder arthroplasty; the low rate of revision was attributed to proper humeral component version, anatomic component sizing, and the selection of shoulders with concentric glenoids.

Nowinski reported on the results of twenty-six press-fit hemiarthroplasties that had been performed in conjunction with biologic glenoid resurfacing with use of anterior capsule, autogenous fascia lata, or tendoachilles allograft. According to Neer's criteria, the result was excellent in twelve shoulders and good in nine. Three of five shoulders with a poor result were revised to total shoulder arthroplasty. Glenoid erosion averaged 7.2 mm but stabilized after five years.

Cemented all-polyethylene glenoid components remain the most popular, but some surgeons continue to implant glenoid components without cement. Martin presented data on total shoulder arthroplasties that had been performed with use of a plasma-sprayed, screw-fixed, metal-backed glenoid component. After a mean duration of follow-up of 7.8 years, 122 of 134 patients had no or minimal pain and the mean ASES score was 75. Radiolucent lines were noted around 39% of the glen-

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oid components, and thirteen clinical failures (prevalence, 10%) were identified. Predictors of clinical failure included pain, male gender, and radiolucent lines under the flat portion of the glenoid tray. The author admitted that although the prevalence of radiolucent lines was lower than that associated with cemented glenoid components, the rate of failure was not.

Sperling demonstrated that shoulder arthroplasty for the treatment of capsulorrhaphy arthropathy or arthritis following instability surgery provided significant pain relief ($p < 0.001$) and improved function. However, the procedure was associated with a high rate of revision and unsatisfactory results because of recurrent instability or glenoid arthrosis as well as a rather young patient population. Implant survival was estimated to be 61% at ten years. Edwards also found that shoulder arthroplasty for the treatment of capsulorrhaphy arthropathy yielded improved function. The mean Constant score improved from 35 to 71 points, the mean active forward elevation improved from 84° to 135°, and the mean external rotation improved from 8° to 42°. In addition, posterior glenoid erosion, thought to be associated with the earlier repair of anterior instability, was not observed at the time of the arthroplasty. Edwards also reported on the results of shoulder arthroplasty for the treatment of fixed anterior glenohumeral dislocations. Although the average Constant score improved only modestly to 46 and active forward elevation improved to only 98°, nine of twelve patients reported that the result was good after a minimum duration of follow-up of two years. Recurrent instability and glenoid loosening were common complications.

Mansat found that both hemiarthroplasty and total shoulder arthroplasty were successful for the treatment of osteonecrosis of the humeral head. According to Neer's criteria, sixteen of nineteen shoulders had a good to excellent result and more than 80% of the shoulders were painless. However, motion deficits often persisted, especially when the osteonecrosis occurred following radiation.

Orfaly demonstrated improvements in both comfort and function following hemiarthroplasty for the treatment of arthritis associated with massive rotator cuff tears. Only two patients were believed to have cuff tear arthropathy; the remainder had osteoarthritis and either a massive rotator cuff tear or a tear for which a previous repair had failed. The mean Simple Shoulder Test score improved from 3 to 8, and the mean ASES score improved from 21 to 83 ($p < 0.001$). The mean active elevation improved from 94° to 114°, and the mean external rotation improved from 17° to 40°.

Basamania reported on a new prosthesis that enables greater articulation with the acromion for patients with cuff tear arthropathy. After a minimum duration of follow-up of twelve months, forty-four of sixty-eight patients rated the result as excellent and all patients were satisfied. The severity of pain (assessed with use of a visual analog scale) decreased from 9.5 to 1.4, the average forward flexion improved from 65° to 128°, and the average external rotation improved from 15° to 35°.

Constrained Prosthetic Arthroplasty

Frankle demonstrated that a primary reverse ball-and-socket prosthesis for cuff tear arthropathy or rotator cuff deficiency and anterosuperior escape provided predictable improvements in comfort and function with minimal complications, with 71% of patients rating the result as good to excellent. In contrast, use of the prosthesis to salvage a failed shoulder reconstruction provided more modest improvements and was associated with a higher prevalence of complications, including component dissociation, glenoid loosening, recurrent instability, and infection.

Complications and Revisions

In a review of 2885 consecutive patients who had undergone primary shoulder arthroplasty, Sperling identified five patients who had sustained a pulmonary embolism. None of these patients had had a fatal pulmonary embolism, and three had presented with symptoms that initially were attributed to other causes. Although pulmonary embolism is an infrequent complication of shoulder arthroplasty, it should be suspected in patients in whom respiratory difficulty develops postoperatively.

Miller discussed subscapularis tendon rupture following shoulder arthroplasty in a report on seven patients who presented with weakness in internal rotation, increased external rotation, and anterior instability. Factors associated with subscapularis rupture included lengthening procedures performed for the treatment of an internal rotation contracture and a history of previous surgery involving the subscapularis tendon. All patients underwent tendon repair, and four patients required an additional pectoralis major tendon transfer. After a mean duration of follow-up of 2.3 years, the ASES scores were lower than those for patients who had undergone uncomplicated shoulder arthroplasty, and two patients had had additional surgery for instability. Boileau reported on fifty-one patients who had anterior instability following shoulder arthroplasty. Anterior glenohumeral instability developed within six weeks in nearly half of the cases. Thirty-five of thirty-eight patients who sustained a dislocation underwent revision surgery. At the time of revision surgery, subscapularis rupture or incompetence was noted in 87% of the patients and component malposition was noted in 47%.

The management of patients who have had a failed shoulder arthroplasty and the outcome of revision shoulder arthroplasty have received considerable attention. Dines evaluated the effectiveness of revision shoulder arthroplasty performed for various modes of failure. The best outcomes were observed following revision or removal of the glenoid component, whereas the worst outcomes were observed following infection and subsequent resection arthroplasty. Rather poor outcomes were noted following revision of a modular humeral head component and revision rotator cuff repair. Martin reviewed the results of revision shoulder arthroplasty, performed for various indications but mainly for persistent pain after hemiarthroplasty or aseptic glenoid loosening, in sixty-

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eight patients after a mean duration of follow-up of 6.5 years. Shoulders requiring glenoid revision were treated with bone-grafting of the glenoid vault with or without implantation of an uncemented glenoid component or with implantation of a cemented polyethylene component. Although the mean ASES score improved from 17 to 59, multiple complications were noted, including anterior deltoid avulsion (five shoulders), deep wound infection (two shoulders), and radial and axillary nerve palsy. Radiolucent lines were commonly noted around both the humeral and the glenoid component. Romeo revised four of nineteen five-pegged glenoid components within five years after the index total shoulder arthroplasty, suggesting that multiple-peg designs may have no advantage over designs with a central keel or fewer peripheral pegs. Carroll reported on sixteen consecutive patients who underwent total shoulder arthroplasty after a hemiarthroplasty had failed because of glenoid arthrosis. The average age of the patients was fifty-two years, and the average interval to revision surgery was 3.5 years. After an average duration of follow-up of 5.5 years, the average ASES score was 73.6 and active forward elevation and external rotation had improved by 50° and 31°, respectively. Although eleven of fifteen patients were satisfied with the result, seven had an unsatisfactory result according to Neer's criteria. Thus, the overall results of revision total shoulder arthroplasty for glenoid arthrosis appear to be inferior to those of primary total shoulder arthroplasty. Carroll also reported on twelve consecutive patients who underwent revision hemiarthroplasty after a total shoulder arthroplasty had failed because of glenoid loosening. The average interval to revision surgery was 5.5 years, and all patients had insufficient glenoid bone stock for glenoid reimplantation. After a mean duration of follow-up of 6.5 years, the average ASES score was 78 and active forward elevation and external rotation had improved by 26° and 15°, respectively. Three of eleven patients had an excellent result and five of eleven had a satisfactory result according to Neer's criteria.

Kalandiak specifically reviewed failed hemiarthroplasties that originally had been performed for the treatment of osteoarthritis. In contrast with the findings of other studies in which glenoid arthrosis was the primary mode of failure, Kalandiak reported that humeral component malpositioning (seen in seventeen of the twenty shoulders) was the most common mode of failure. Untreated or progressive glenoid erosion (ten shoulders), posterior instability (six shoulders), and shoulder stiffness (five shoulders) were also commonly seen. Revision surgery resulted in marked improvements in active forward elevation and external rotation, pain scores, and the number of functions performed on the Simple Shoulder Test.

Coste reviewed the prevalence of infections following shoulder arthroplasty in a large series of 2396 shoulder arthroplasties after a minimum duration of follow-up of two years. Forty-two infections were identified, for an overall prevalence of 1.8% after primary arthroplasty and 4% after revision ar-

throplasty. Higher rates were noted for patients with cuff tear arthropathy, sequelae of fractures, and postradiation osteonecrosis. Treatment consisted of early surgical débridement and excision of all infected tissue, appropriate antibiotics coverage, and either immediate or staged exchange of all prosthetic components. Despite these measures, the infections persisted in 29% of patients.

Iannotti retrospectively reviewed the results of glenohumeral arthrodeses that had been performed with use of a vascularized fibular or large structural allograft following the aseptic failure of prosthetic arthroplasties that were associated with severe bone, rotator cuff, and deltoid deficiency. Although several complications were reported, including infection and nonunions requiring bone-grafting and additional internal fixation, all patients ultimately had a successful fusion and improvement in function.

Proximal Humeral Fractures**Basic Science**

Hertel identified predictors of humeral head ischemia following proximal humeral fracture. With use of laser Doppler flowmetry and by observing backflow after humeral head drilling, the author determined that the presence of an anatomic neck fracture, a short calcar segment, and a disrupted medial hinge were strong predictors of ischemia.

Treatment

Lervick reported on the results of hemiarthroplasty for the treatment of acute proximal humeral fractures in patients less than sixty years old. After an average duration of follow-up of 6.8 years, the result was excellent for five of twenty-two shoulders and satisfactory for eleven, the average ASES score was 68.6, and the average Simple Shoulder Test score was 7.9. Active forward elevation averaged 134°, and active external rotation averaged 40°. Overall, nineteen patients had little or no pain with activities of daily living. Orfaly compared the functional outcomes of shoulder arthroplasty for acute and chronic fractures and found nearly identical results and similar complication rates in the two groups. The results contradicted the widely held belief that the results of late arthroplasty for fractures are inferior to those of early arthroplasty.

Leger presented the results of shoulder arthroplasty for the treatment of nonunion of the surgical neck of the humerus. The initial fracture was a two-part fracture in six of twenty-two patients, a three-part fracture in thirteen, and a four-part fracture in three. A tuberosity osteotomy and osteosynthesis were required in all cases. After a minimum duration of follow-up of two years, the mean Constant score had increased from 23 to 39, the mean anterior elevation had increased from 53° to 65°, and the mean external rotation had increased from 13° to 28°. Neither the initial fracture pattern nor a delay to prosthetic replacement affected the outcome. The procedure aims to provide only "limited goals," with substantial pain relief but only modest gains in active motion.

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Clavicular Fractures

McKee used patient-based outcome measures and objective muscle-strength testing to identify patient dissatisfaction and residual strength deficits following conservative treatment of displaced, midshaft clavicular fractures. After a mean duration of follow-up of fifty-four months, the mean Constant score was 69 points and the endurance strength on the involved side in various planes of motion was only 66% to 84% of that on the contralateral side.

Humeral Shaft Fractures

Ring discussed the treatment options for radial nerve palsy associated with humeral shaft fractures. In a series of twenty-four patients with high-energy diaphyseal humeral fractures and complete radial nerve palsy, fourteen patients, including all eleven patients with open fractures, underwent radial nerve exploration. None of the six transected nerves that were identified recovered after primary repair, whereas all eight intact nerves and nine of ten unexplored nerves recovered. The time to nerve recovery averaged seven weeks but ranged from one to twenty-five weeks, suggesting that patience is warranted before tendon transfers are considered.

Neurologic Injuries

Suprascapular nerve entrapment is often unrecognized until chronic weakness, atrophy, and shoulder pain have set in. Koch described the results of open surgical decompression, performed through an incision based off of the posterior aspect of the distal part of the clavicle, for entrapment at the suprascapular notch. After a mean duration of follow-up of four years, eleven of nineteen patients rated the result as good or excellent and six rated it as fair. All patients returned to regular work or activity, and no patient stated that the surgical procedure had made the shoulder worse; however, only thirteen stated that they would have the procedure again. The author stressed the importance of communicating realistic expectations to patients undergoing this procedure.

Miscellaneous

Pearl demonstrated that arthroscopic release of internal rotation contractures of the shoulder secondary to birth palsy in infants and toddlers was effective for achieving passive external rotation while concurrently preserving adequate external rotation strength to center the glenohumeral joint and normalize glenoid development.

Tae compared the natural course of idiopathic adhesive capsulitis in a group of patients who did not receive active treatment with the course in a group of patients who were managed with intra-articular cortisone injection followed by a passive stretching program. After a mean duration of follow-up of fourteen months, nineteen of twenty-eight patients in the treatment group had mild residual symptoms and twenty-five had shoulder motion on the involved side that was at least 80% of that on the normal, contralateral side. After a mean

duration of follow-up of forty months, three of nineteen patients in the control group reported mild pain and all but two had normal motion. The authors concluded that idiopathic adhesive capsulitis resolves in most cases, even without active treatment; however, active treatment appears to accelerate recovery substantially.

Karas found that prolonged overhead throwing produced changes in scapular kinematics (as measured with use of a motion-analysis system) and in periscapular muscle strength (as measured with use of a dynamometer). Significant decreases in scapular protraction and acromial cephalad rotation ($p < 0.05$) were noted following a simulated baseball game involving seventy-five pitches. Karas concluded that the observed kinematic changes might contribute to rotator cuff impingement among overhead throwers.

Rosen reported on the results of a survey of a random group of more than 700 primary-care physicians regarding the decision-making processes employed in the treatment of common shoulder conditions. Only 49% of patients were treated according to an algorithm recommended by the American Academy of Orthopaedic Surgeons, including 29% of patients with chronic rotator cuff symptoms, 44% of patients with a frozen shoulder, and 46% of patients with an acute rotator cuff tear. The study suggested the need for improved musculoskeletal education for primary-care physicians.

Cole collected normative strength and motion data and found that men without shoulder pathology had significantly higher mean Constant scores than women, irrespective of age. The Constant scores of female patients less than fifty years old were significantly higher than those of older female patients. The study illustrated that Constant scores should be adjusted on the basis of age and gender-matched normalized scores.

Elbow**Instability****Basic Science**

Spagnuola employed a cadaver model to compare the Jobe and docking reconstructive techniques for ulnar collateral ligament insufficiency. Both techniques failed at lower valgus moments than did the native elbow. However, at 90° of elbow flexion, flexibility following either reconstruction technique was comparable with that for the unreconstructed elbow.

Armstrong used a cadaver model to compare the two techniques noted above with a single-strand reconstruction performed with use of interference screws and a single-strand reconstruction performed with use of an endobutton for ulnar fixation. The docking technique demonstrated higher peak loads to failure than did either the Jobe or the interference screw reconstruction, and the endobutton reconstruction demonstrated higher peak loads than did the Jobe reconstruction ($p < 0.004$), but there was no difference in peak loads between the docking and endobutton reconstructions. The peak loads of all ulnar collateral ligament reconstructions were considerably inferior to those of the intact ligament.

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Safran used a cadaver model to study the effect of passive muscle length and bulk and forearm rotation on valgus laxity of the elbow. Irrespective of the elbow flexion angle, applied torques produced greater angular displacements with the intact elbow in neutral rotation than in pronation or in supination. In general, these findings persisted following partial and complete ligament section, suggesting that valgus laxity of the elbow should be examined with the elbow in neutral rotation.

Clinical

Shibayama used valgus stress radiography to predict the outcome following conservative treatment of partial tears of the ulnar collateral ligament. The ulnohumeral distance as measured on a plain radiograph was subtracted from that measured on a stress radiograph, which was made with the shoulder abducted to 65° and maximally rotated externally, the elbow flexed to 30°, and the forearm pronated. Twelve of thirteen patients with a side-to-side difference of ≤ 0.5 mm responded to conservative treatment, whereas eight of twelve patients with a difference of ≥ 1.0 mm had a failure of conservative treatment and required reconstruction.

Andrews reported the results of ulnar collateral ligament reconstruction in thirty-one high-school baseball players over a six-year period. Twenty of the twenty-seven patients who were available for follow-up were able to return to baseball at the same level or a higher level after reconstruction. Risk factors for ulnar collateral ligament injury in this population included year-round throwing, seasonal or event overuse, inadequate warm-up before throwing, a throwing velocity of >80 miles/hr (>129 km/hr), and throwing breaking pitches before the age of fourteen years. The author concluded that the results after reconstruction were comparable with those in more mature throwers.

Trenhaile reported on the primary surgical repair of ulnar collateral ligament injuries in a group of seventy-five non-professional athletes with symptomatic instability. The repair was performed with one of three methods: plication, repair to bone with use of suture anchors or drill-holes, or flexor pronator fascia augmentation. After a mean duration of follow-up of forty-five months, the patients had significant improvement in the Andrews-Carson elbow score ($p < 0.0001$) and only three failures were reported. The average time to return to sports activity was four months in 95% of the athletes.

Kim reviewed the two to eight-year results of reconstruction of the lateral ulnar collateral ligament with use of an autogenous tendon graft. Stability was obtained in ten of thirteen patients, with elimination of the active apprehension signs and pivot shift. The failures were related to radiocapitellar bone loss. Gurley reviewed the results of both arthroscopic and open radial ulnohumeral ligament reconstructions that were performed for the treatment of posterolateral rotatory instability of the elbow. After a mean duration of follow-up of thirty-six months, the mean Andrews-Carson score had improved from 143 to 185 ($p < 0.0001$). Improvements following

arthroscopic plication were more modest than those following open reconstruction, but the final outcome scores were comparable. The authors noted that 26% of the patients had had a prior lateral epicondylar release and cautioned that surgeons who perform such releases should be familiar with the proximity of the radial ulnohumeral ligament.

Tendon Injuries

Wild presented the outcome of distal biceps tendon ruptures that were repaired with two suture anchors placed through a single incision. Fifty-one of sixty-eight patients, with a mean age of forty-two years, were available for study; six patients had a partial rupture or declined surgery and eleven patients were lost to follow-up. No patient had a rerupture or lost $>5^\circ$ of flexion-extension or forearm rotation. Complications were rare and included one wound infection and three transient nerve palsies. Mazzocca reported on the biomechanical properties of interference-screw fixation for distal biceps tendon ruptures. In a cadaver model, no difference in load to failure was demonstrated between bone-tunnel and interference-screw fixation. Johnson compared one-incision and two-incision techniques for the repair of acute distal biceps tendon ruptures. Twelve patients who underwent a one-incision repair and fourteen patients who underwent a two-incision repair were evaluated after a mean duration of follow-up of twenty-nine months. No postoperative neurological complications or radioulnar synostoses were identified in either group, and the overall satisfaction rate exceeded 95%. No significant objective differences were noted, but there was a trend toward increased isokinetic strength and endurance in the two-incision group. Kruetz evaluated the use of extracorporeal shock-wave therapy for the treatment of tennis elbow and found decreased pain at six months compared with that in control patients who had undergone a conservative treatment program.

Fractures and Dislocations

Hastings performed a cadaver study to determine the optimum site for triceps reattachment after the operative treatment of comminuted olecranon fracture and triceps avulsion. He found that elbow extension torque was best preserved by reattachment to the subcutaneous border of the ulna, with periarticular attachments resulting in significant decreases in the triceps mechanical lever arm and length. King studied the effect of radial head excision and modular metallic radial head arthroplasty on kinematics and stability in elbows with intact and deficient ligaments. Radial head excision caused altered elbow kinematics and increased laxity, even when the ligaments were intact. The kinematics and laxity after modular metallic radial head arthroplasty were similar to those of a stable elbow with a native radial head. Radial head arthroplasty alone was insufficient for the management of complex elbow injuries associated with combined damage to the radial head and collateral ligaments. King advised concomitant repair of the ligaments and muscular origins in order to

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adequately restore elbow stability.

Mader reported on the long-term results of the use of hinged external fixation for the treatment of unstable elbow dislocations. Sixteen patients with an unstable elbow following a dislocation were managed with a unilateral hinged fixator for five to six weeks. Forearm rotation was allowed immediately, and elbow flexion and extension were allowed after a delay of four days. No ligamentous repairs were performed, and no complications were observed during the treatment period. After a mean duration of follow-up of forty-nine months, all patients had a functional arc of motion (mean, 125°) and all elbows were clinically stable. The mean Mayo elbow performance score was 95 of 100 points. Radiographs demonstrated congruent joints with no degenerative changes and showed a small amount of heterotopic bone in two elbows. Pennig described the results of combined internal and hinged external fixation of complex intra-articular fracture-dislocations of the elbow. Twelve radial head fractures, seven olecranon fractures, and eleven distal humeral fractures were included in the series. Following limited internal fixation, a hinged external fixator was applied across the elbow and was maintained for five to six weeks to enable early range of motion. After a mean duration of follow-up of thirty-six months, all patients had a functional arc of motion, all elbows were stable, and the mean Mayo elbow performance score was 95 points.

Ring reported on fifteen patients in whom an unstable distal humeral nonunion was treated with open reduction and internal fixation, joint contracture release, and autogenous bone-grafting. The mean duration between the original fracture and the index treatment was eleven months. Twelve nonunions healed, but five of these required additional surgery. Three nonunions failed to heal and required total elbow arthroplasty. After a mean duration of follow-up of fifty-one months, the total arc of motion averaged 95° and the outcome according to the Mayo elbow performance score was excellent in two patients and good in nine. Ring also reported on nineteen patients in whom operative treatment of a posterior Monteggia fracture had failed. All patients were managed with a dorsal plate that was contoured to wrap around the olecranon process. Adjunctive procedures included radial head replacement, application of a hinged external fixator, and reattachment of the lateral collateral ligament complex. After a mean duration of follow-up of fifty-eight months, the average ASES score was 89 and the result in fourteen patients was rated as good or excellent.

Blaine showed that a recontouring osteotomy for the treatment of extension malunions of the distal part of the humerus improved elbow flexion from a mean of 104° preoperatively to a mean of 127° postoperatively, without the need for osteotomy and internal fixation. Extension also improved, from 44° preoperatively to 19° postoperatively, allowing five of the nine patients in the series to achieve a functional (100°) arc of elbow motion.

Kamineni reviewed the results of total elbow arthroplasty for the treatment of acute distal humeral fractures in forty-three patients with a mean age of sixty-seven years. After a mean duration of follow-up of seven years, the mean flexion-extension arc was from 24° to 132° and the mean Mayo elbow performance score was 93 points. Although complications occurred in 31% of the patients, most of these complications did not require further surgery and only five implants were revised during the study period. Kamineni concluded that total elbow arthroplasty should be considered for physiologically older patients with complex distal humeral fractures in osteopenic bone.

Arthritis

Outcome

Whaley reported on the results of total elbow arthroplasty following previous synovectomy and radial head resection for rheumatoid arthritis. Fifteen elbows undergoing arthroplasty at a mean of nine years following synovectomy and radial head excision were matched with a control group of elbows undergoing arthroplasty without prior synovectomy or radial head excision. After a mean duration of follow-up of six years in the study group and 9.4 years in the control group, there had been no revisions. Thirteen patients in the study group reported an excellent result, and two reported a good result. The author concluded that radial head excision and synovectomy in appropriately selected patients with rheumatoid arthritis does not impact later prosthetic replacement. Mansat abandoned the use of the GUEPAR nonconstrained total elbow implant in patients with rheumatoid arthritis after a complication rate of >50% was noted. The complications included loosening of the implant in five of twenty-one elbows after a mean duration of follow-up of 5.4 years.

Complications and Revisions

Adams reported on polyethylene wear in a study of 843 semiconstrained total elbow arthroplasties that were performed over a twenty-year period. Twelve patients, with a mean age of fifty-two years, underwent articular bushing exchange and débridement at a mean of 7.5 years following implantation. Patients with posttraumatic arthritis who exceeded suggested lifting restrictions were more vulnerable to bushing wear. At a mean of forty-nine months after revision surgery, the mean arc of motion had improved from 89° to 109°. Three patients underwent an additional bushing exchange an average of six years after the first exchange. Figgie, in a study of 170 semiconstrained total elbow arthroplasties that were performed over a thirteen-year period, reported that six elbows required revision for failure of the locking mechanism and catastrophic polyethylene wear between five and thirteen years after implantation. One of the six elbows had a similar failure 3.5 years later, requiring a second revision.

Arthroscopy

Kelly reported on the use of arthroscopic débridement for the treatment of osteoarthritis of the elbow in a study of twenty-

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two patients (twenty-three elbows) with a mean age of fifty-one years. After a mean duration of follow-up of forty months, twenty-one patients reported faring "better" or "much better" and eighteen patients reported minimal or no pain, but twelve patients had occasional problems with daily activities. The result according to the Mayo elbow performance score was excellent for eight patients and good for seven. Mileti reported on osteocapsular arthroplasty, an arthroscopic procedure for the treatment of osteoarthritis that involves removal of loose bodies; resection of osteophytes in and around the olecranon, coronoid, and radial fossae; and release of capsular contractures. Continuous passive motion is employed postoperatively for two to six weeks. After a minimum duration of follow-up of one year, the mean total arc of motion had improved from 76° to 124°, with flexion to 136° and an extension deficit of 12°. A functional arc of motion was achieved in fifteen of seventeen patients. Pain at the end of the range of motion, which had been moderate to severe in all patients preoperatively, was eliminated in thirteen patients. McLaughlin reported on the arthroscopic excision of the radial head in a group of thirty-six patients with various diagnoses, including posttraumatic, degenerative, and inflammatory arthritides. Twenty-eight patients underwent concurrent arthroscopic modification of the Outerbridge-Kashiwagi procedure. After a mean duration of follow-up of fifty-two months, the mean flexion had improved from 108° to 130° and the mean extension had improved from 32° to 5°. Forearm pronation and supination had increased by 30° and 35°, respectively. Two patients required revision surgery, one for contracture release and one for radial head replacement.

Evidence-Based Orthopaedics

In 2002, the editorial staff of *The Journal* reviewed a large number of research studies related to the musculoskeletal system that received a Level of Evidence grade of I. Over forty medical journals were reviewed to identify these articles, all of which have a high-quality study design. Of the articles identified, thirteen were related to the shoulder and elbow. A list of those titles is appended to this review after the standard bibliography. We have provided a brief commentary about each of the articles to help to guide your further reading, in an evidence-based fashion, in this subspecialty area.

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Upcoming Meetings

- Arthroscopic Rotator Cuff Repair. Gartsman GM, course chairman. January 16-18, April 16-18, 2004; July 23-25, 2004; November 5-7, 2004. J.W. King Orthopedic Institute, Houston, TX. Contact: Brenda Cockerham. E-mail address: brenda.cockerham@hcahealthcare.com
- Arthroscopic Glenohumeral Reconstruction. Gartsman GM, course chairman. February 20-22, 2004; May 21-23, 2004; September 10-12, 2004. J.W. King Orthopedic Institute, Houston, TX. Contact: Brenda Cockerham. E-mail address: brenda.cockerham@hcahealthcare.com
- Arthroscopic and Open Techniques in Shoulder Surgery. February 6-8, 2004. Rosemont, IL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org
- The Twentieth Annual Open Meeting of the American Shoulder and Elbow Surgeons. March 13, 2004. San Francisco, CA. Contact: Emily Jones. E-mail address: jones@aaos.org
- Upper Extremity: Fingertip to Shoulder. April 3-6, 2004. Bal Harbour, FL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org
- Ninth International Congress on Surgery of the Shoulder. May 2-5, 2004. Washington, DC. Contact: Emily Jones. E-mail address: jones@aaos.org
- Twenty-first Annual Meeting of the San Diego Shoulder Arthroscopy. July 7-10, 2004. San Diego, CA. Contact: James Esch, MD. E-mail address: jesch@shoulder.com
- The Shoulder: Advanced Management Options from Open to Arthroscopic. July 16-18, 2004. Rosemont, IL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org
- Sports Clinic Orthopaedic Medical Associates. Shoulder Surgery Controversies. October 1-3, 2004. Laguna Hills, CA. Contact: Wesley Nottage, MD. E-mail address: tscwmn@aol.com
- Elbow Reconstruction: Arthroscopy, Instability, and Arthroplasty. October 8 and 9, 2004. Rosemont, IL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org
- Fourth Biennial AAOS/ASES Shoulder and Elbow Course—Current Techniques and Controversies. October 14-17, 2004. Monterey, CA. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org

**Recent Publications of Interest
Shoulder****Rotator Cuff
Impingement**

- Nicholson GP.** Arthroscopic acromioplasty: a comparison between workers' compensation and non-workers' compensation populations. *J Bone Joint Surg Am.* 2003;85:682-9.
- Roberts CS, Davila JN, Hushek SG, Tillett ED, Corrigan TM.** Magnetic resonance imaging analysis of the subacromial space in the impingement sign positions. *J Shoulder Elbow Surg.* 2002;11:595-9.

Gill TJ, McIrvine E, Kocher MS, Homa K, Mair SD, Hawkins RJ. The relative importance of acromial morphology and age with respect to rotator cuff pathology. *J Shoulder Elbow Surg.* 2002;11:327-30.

Tears

Galatz LM, Connor PM, Calfee RP, Hsu JC, Yamaguchi K. Pectoralis major transfer for anterior-superior subluxation in massive rotator cuff insufficiency. *J Shoulder Elbow Surg.* 2003;12:1-5.

Instability**Basic Science**

Debski RE, Moore SM, Mercer JL, Sacks MS, McMahon PJ. The collagen fibers of the anteroinferior capsulolabrum have multiaxial orientation to resist shoulder dislocation. *J Shoulder Elbow Surg.* 2003;12:247-52.

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Cooper ME, Hutchinson MR. The microscopic pathoanatomy of acute anterior shoulder dislocations in a simian model. *Arthroscopy*. 2002;18:618-23.

Anterior Instability

Kim SH, Ha KI, Jung MW, Lim MS, Kim YM, Park JH. Accelerated rehabilitation after arthroscopic Bankart repair for selected cases: a prospective randomized clinical study. *Arthroscopy*. 2003;19:722-31.

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Iannotti JP, Norris TR. Influence of preoperative factors on outcome of shoulder arthroplasty for glenohumeral osteoarthritis. *J Bone Joint Surg Am*. 2003;85:251-8.

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Fractures

Clavicle Fractures

McKee MD, Wild LM, Schemitsch EH. Midshaft malunions of the clavicle. *J Bone Joint Surg Am*. 2003;85:790-7.

Humeral Head Fractures

Robinson CM, Page RS. Severely impacted valgus proximal humeral fractures. Results of operative treatment. *J Bone Joint Surg Am*. 2003;85:1647-55.

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Frankle MA, Ondrovic LE, Markee BA, Harris ML, Lee WE 3rd. Stability of tuberosity reattachment in proximal humeral hemiarthroplasty. *J Shoulder Elbow Surg*. 2002;11:413-20.

Shoulder Stiffness

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Elbow

Instability

Basic Science

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Ahmad CS, Lee TQ, ElAttrache NS. Biomechanical evaluation of a new ulnar collateral ligament reconstruction technique with interference screw fixation. *Am J Sports Med*. 2003;31:332-7.

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Tendon Injuries

Haake M, Konig IR, Decker T, Riedel C, Buch M, Muller HH; Extracorporeal Shock Wave Therapy Clinical Trial Group. Extracorporeal shock wave therapy in the treatment of lateral epicondylitis: a randomized multicenter trial. *J Bone Joint Surg Am*. 2002;84:1982-91.

El-Hawary R, Macdermid JC, Faber KJ, Patterson SD, King GJ. Distal biceps tendo repair: comparison of surgical techniques. *J Hand Surg [Am]*. 2003;28:496-502.

Arthritis

Antuna SA, Morrey BF, Adams RA, O'Driscoll SW. Ulnohumeral arthroplasty for primary degenerative arthritis of the elbow: long-term outcome and complications. *J Bone Joint Surg Am*. 2002;84:2168-73.

Fractures

Clinical

Ring D, Quintero J, Jupiter JB. Open reduction and internal fixation of fractures of the radial head. *J Bone Joint Surg Am*. 2002;84:1811-5.

Karlsson MK, Hasselius R, Besjakov J, Karlsson C, Josefsson PO. Comparison of tension-band and figure-of-eight wiring techniques for treatment of olecranon fractures. *J Shoulder Elbow Surg*. 2002;11:377-82. Erratum in: *J Shoulder Elbow Surg*. 2002;11:647.

Complications and Revisions

Ring D, Jupiter JB. Operative release of complete ankylosis of the elbow due to heterotopic bone in patients without severe injury of the central nervous system. *J Bone Joint Surg Am*. 2003;85:849-57.

Arthroscopy

Ball CM, Meunier M, Galatz LM, Calfee R, Yamaguchi K. Arthroscopic treatment of post-traumatic elbow contracture. *J Shoulder Elbow Surg*. 2002;11:624-9.

Appendix: Evidence-Based Articles

Shoulder

Bottoni CR, Wilckens JH, DeBerardino TM, D'Alleyrand JC, Rooney RC, Harpstrite JK, Arciero RA. A prospective, randomized evaluation of arthroscopic stabilization versus nonoperative treatment in patients with acute, traumatic, first-time shoulder dislocations. *Am J Sports Med*. 2002;30:576-80.

The authors reported the results of a prospective study of a controlled population of military personnel who were treated with sling immobilization or arthroscopic tack fixation. The authors defined failure as a second dislocation, symptomatic subluxation, or instability that prevented a return to active duty or that required an operation. Nine of twelve patients had a failure of nonoperative treatment, and one of nine had a failure of operative treatment. The study demonstrated that operative intervention successfully altered the natural history of an acute, traumatic shoulder dislocation in an active patient population. It would be interesting to repeat this study but to compare operative treatment with nonoperative immobilization with the arm in external rotation.

Gibson JNA, Handoll HHG, Madhok R. Interventions for treating proximal humerus fractures. In: *The Cochrane Library, Issue 2*. Oxford: Update Software; 2002.

The authors reviewed ten randomized studies and divided them into groups of studies comparing methods of conservative treatment, those comparing surgical treatment with conservative treatment, and those comparing methods of operative treatment. The studies that were reviewed had weaknesses such as

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small study-group sizes, possible bias, different outcome measures, and inadequate follow-up. To quote from the article, "Only tentative conclusions can be drawn from the available randomized trials, which do not provide robust evidence for many of the decisions that need to be made in contemporary fracture management. It is unclear whether operative intervention, even for specific fracture types, will produce consistently better long term outcomes."

Osbahr DC, Cawley PW, Speer KP. The effect of continuous cryotherapy on glenohumeral joint and subacromial space temperatures in the postoperative shoulder. *Arthroscopy*. 2002;18:748-54.

Continuous cryotherapy successfully reduced glenohumeral joint and subacromial space temperatures in the immediate postoperative period in spite of a bulky bandage. Glenohumeral joint temperatures were decreased by approximately 1°C while subacromial space temperatures were decreased by 1° to 3°. These findings were significant.

Barber FA, Herbert MA. The effectiveness of an anesthetic continuous-infusion device on postoperative pain control. *Arthroscopy*. 2002;18:76-81.

The authors presented the results of a prospective, randomized, double-blind study that documented a significant decrease in pain in association with the use of a continuous-infusion anesthetic pump. Decreased pain was noted following glenohumeral joint procedures (capsular reefing, SLAP repair) as well as subacromial space procedures (rotator cuff repair, arthroscopic subacromial decompression). Weaknesses of the study include the small size of the study group (fifty patients with four different diagnoses) and the fact that the surgeon was aware of the treatment before the start of the operation.

Scoggin JF 3rd, Mayfield G, Awaya DJ, Pi M, Prentiss J, Takahashi J. Subacromial and intra-articular morphine versus bupivacaine after shoulder arthroscopy. *Arthroscopy*. 2002;18:464-8.

This prospective, randomized, double-blind study demonstrated that intra-articular and subacromial bupivacaine produced significant decreases in pain (as measured with use of a visual analog scale) when compared either morphine or saline solution. Morphine was not different from saline solution in terms of reducing postoperative pain. Despite differences in the level of pain, there were no significant differences in the amount of supplemental analgesics requested among these three groups.

Speed CA, Richards C, Nichols D, Burnet S, Wies JT, Humphreys H, Hazleman BL. Extracorporeal shock-wave therapy for tendonitis of the rotator cuff. A double-blind, randomised, controlled trial. *J Bone Joint Surg Br*. 2002;84:509-12.

In this double-blind, placebo-controlled study, seventy-four patients with chronic, noncalcific tendonitis of the rotator cuff were randomized to receive either active treatment (1500 pulses at 0.12 mJ/mm²) or sham treatment. Both study groups showed significant and sustained improvement from two months onward. There was no significant difference between the groups with respect to change in the Shoulder Pain and Disability Index scores or night pain over the six-month period. The authors concluded that moderate-dose extracorporeal shock-wave therapy has a significant and sustained placebo effect, but there is no evidence that such therapy provides any added benefit compared with sham treatment.

Elbow

Struijs PA, Smidt N, Arola H, van Dijk CN, Buchbinder R, Assendelft WJ. Orthotic devices for tennis elbow: a systematic review. *Br J Gen Pract*. 2001;51:924-9.

The authors reviewed all randomized, controlled trials describing individuals with lateral epicondylitis and assessing the use of an orthotic device as a treatment strategy. No definitive conclusions could be drawn concerning the effectiveness of orthotic devices for lateral epicondylitis. Better-designed randomized clinical trials of sufficient power are needed.

Green S, Buchbinder R, Barnsley L, Hall S, White M, Smidt N, Assendelft W. Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults (Cochrane Review). In: *The Cochrane Library, Issue 4*. Oxford: Update Software; 2003.

Treatment with topical nonsteroidal anti-inflammatory drugs was associated with a significant decrease in pain when compared with placebo. There was no effect on strength, tenderness, range of motion, or the doctor's opinion regarding outcome. One study compared oral diflunisal with naproxen; no difference was found with regard to symptoms or pain relief.

Smidt N, Assendelft WJ, van der Windt DA, Hay EM, Buchbinder R, Bouter LM. Corticosteroid injections for lateral epicondylitis: a systematic review. *Pain*. 2002;96:23-40.

The authors reviewed thirteen studies. Corticosteroid injections demonstrated significant effects in terms of pain, global improvement, and strength over the short term (less than six weeks). The authors could not identify any significant or clinically relevant results in favor of corticosteroid injections over the intermediate term (six weeks to six months) or long term (more than six months).

Green S, Buchbinder R, Barnsley L, Hall S, White M, Smidt N, Assendelft W. Acupuncture for lateral elbow pain (Cochrane Review). In: *The Cochrane Library, Issue 4*. Oxford: Update Software; 2003.

The authors reviewed four small, randomized clinical trials. There was insufficient evidence either to support or to refute the use of laser or needle acupuncture for the treatment of lateral elbow pain. Needle acupuncture demonstrated short-term benefit with respect to pain. No benefit lasting more than twenty-four hours was demonstrated.

Fink M, Wolkenstein E, Karst M, Gehrke A. Acupuncture in chronic epicondylitis: a randomized controlled trial. *Rheumatology (Oxford)*. 2002;41:205-9.

The authors compared twenty-three patients who had received real acupuncture (with needle insertion performed at real acupuncture points) with twenty-two who had received sham acupuncture (with needle insertion performed at nonspecific points). Significant improvement was noted in pain intensity, arm function, and strength by two weeks after treatment with real acupuncture. At two months, arm function was still better in the real acupuncture group but the differences in pain and maximal strength were no longer significant.

Buchbinder R, Green S, White M, Barnsley L, Smidt N, Assendelft WJ. Shock wave therapy for lateral elbow pain (Cochrane Review). In: *The Cochrane Library, Issue 4*. Oxford: Update Software; 2003.

The authors reviewed two randomized clinical trials. One trial demonstrated that extracorporeal shock-wave therapy provided significant benefits compared with placebo, but the second study demonstrated no such benefits. When the authors pooled the data from the two studies, the benefits observed in the first trial were no longer significant. Further studies are needed to clarify the value of shock-wave therapy for lateral elbow pain.

Speed CA, Nichols D, Richards C, Humphreys H, Wies JT, Burnet S, Hazleman BL. Extracorporeal shock wave therapy for lateral epicondylitis—a double blind randomised controlled trial. *J Orthop Res*. 2002;20:895-8.

The authors studied seventy-five patients who were randomized to receive either extracorporeal shock-wave therapy (1500 pulses at 0.12 mJ/mm²) or sham therapy on a monthly basis for three months. Outcome was assessed with use of a visual analog scale for pain during the day and at night. Both groups showed significant benefit at two months, but there was no difference between the groups over the study period. Moderate-dose shock-wave therapy appears to have a significant placebo effect in subjects with lateral epicondylitis, but there is no evidence that such treatment provides any added benefit compared with sham therapy.