

## 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, Dallas, Texas, February 16, 2002), the Arthroscopy Association of North America (Specialty Day, Dallas, Texas, February 16, 2002; Twenty-first Annual Meeting, Seattle, Washington, April 19-22, 2002; and Twentieth Fall Course, San Antonio, Texas, November 29-December 2, 2002), the American Academy of Orthopaedic Surgeons (Sixty-ninth Annual Meeting, Dallas, Texas, February 13-17, 2002), and the American Shoulder and Elbow Surgeons (Specialty Day, Dallas, Texas, February 16, 2002, and Eighteenth Annual Meeting, Napa, California, September 2001).

**Shoulder***Rotator Cuff*

## Basic Science

Several studies have employed sophisticated animal models to investigate rotator cuff repair and healing. Coleman reported on a chronic rotator cuff injury and repair model involving sheep. Infraspinatus contractile forces and histological findings were evaluated at various times following either immediate or delayed tendon repair. Longer delays to repair led to greater decreases in force and more modest recovery following repair. Muscle biopsies confirmed progressive fatty infiltration that was partially reversed after tendon repair in the group with a six-week delay before repair but not in the group with an eighteen-week delay before repair. This model has important implications regarding the recovery of strength following the repair of chronic rotator cuff tears.

Rodeo presented a study on growth factor-enhanced rotator cuff tendon-bone healing in a sheep model. Histological analysis demonstrated greater new-bone and fibrovascular tissue formation in the treated animals. A substantial increase in attachment strength was noted in the treated animals at twelve

weeks. The study demonstrates the ability of a growth factor to influence changes at the tendon-bone interface.

MacGillivray evaluated the augmentation of rotator cuff repairs with a bioabsorbable scaffold in a goat model. Biomechanical testing showed no significant improvement in load to failure when a tendon defect was covered with a polylactic acid patch. The inability of the patch to enhance repair strength was thought to result from shielding of the patch from direct load by the repair.

Halder used a cadaveric model to identify the characteristics of rotator cuff tears that were responsible for loss of strength. Detachment of one-third and two-thirds of the supraspinatus tendon affected force transmission by the rotator cuff only slightly, while detachment of the whole tendon resulted in greater reductions in force transmission. Simulated muscle retraction also led to reductions in force transmission. Side-to-side repair of defects involving one third and two thirds of the tendon restored near-normal force transmission. These results echoed the clinical observation that patients with small rotator cuff tears may present without a loss of strength. Furthermore, side-to-side repair of otherwise irreparable defects may help to restore the integrity of the rotator cable.

Chronic rotator cuff tears are often accompanied by muscle atrophy, fatty infiltration, and retraction, which may decrease overall muscle volume. Apreleva determined the reliability and validity of magnetic resonance imaging in the assessment of rotator cuff muscle volume in a study of cadaveric shoulders. Magnetic resonance imaging scans were made and the supraspinatus, infraspinatus-teres minor, and subscapularis muscle volumes were then computed with use of three-dimensional image-analysis software. Muscle volumes were confirmed with use of water displacement after dissection. The muscle volumes measured with use of the two methods were found to correlate highly, suggesting that magnetic resonance imaging may hold promise for the preoperative as-

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assessment of rotator cuff muscles and the prediction of functional outcome following repair.

Bonutti presented research on the use of an allograft bone button for rotator cuff repairs. The buttons are fashioned from cortical bone, drilled for suture passage, and inserted directly to a depth of 20 mm, where they lock into cancellous bone. The results of mechanical testing were comparable with those associated with other suture anchors. Use of the button during fifty consecutive repairs demonstrated the ability to insert the button without predrilling and the ability to space buttons as little as 3 mm apart. Radiographs suggested that the allograft bone consistently consolidated in the humeral head.

### Impingement

Habermeyer reported on anterosuperior shoulder impingement resulting from biceps pulley lesions. A lesion of the pulley complex was confirmed with arthroscopy in fifty-three patients. Forty-six patients had involvement of the long head of the biceps, with two complete tears, thirteen partial tears with subluxation, nine tendon subluxations, and twenty-two cases of synovitis. Pulley lesions were frequently combined with articular side partial-thickness tears of the supraspinatus, the subscapularis, or both. Anterosuperior labral lesions were also commonly seen. The authors hypothesized that pulley lesions destabilize the long head of the biceps and alter glenohumeral kinematics, leading to anterosuperior internal impingement.

Edwards described the results of arthroscopic treatment of posterosuperior glenoid impingement in tennis players. Twenty-eight athletes underwent arthroscopic débridement of articular side supraspinatus tears and posterosuperior labral tears that define the condition. Twenty-three patients were satisfied with the result and twenty-two returned to tennis, but only twelve returned to their preinjury level. Moreover, twenty patients reported at least some pain during tennis, so the operation's effect on long-term participation remains unknown.

### Full-Thickness Tears

Ziegler discussed the role of in-office shoulder ultrasonography in the evaluation of rotator cuff disorders. Findings documented at the time of surgery were compared with those documented with use of ultrasound. For both partial and full-thickness tears, ultrasound demonstrated a sensitivity, specificity, positive predictive value, and negative predictive value of  $\geq 94\%$ . In addition to its accuracy, ultrasound obviates the need for further tests and follow-up visits, thereby increasing efficiency and reducing cost.

Galatz investigated the correlation between functional outcome and repair integrity after the arthroscopic repair of large and massive rotator cuff tears. Postoperatively, 100% of patients were satisfied and stated that they would undergo the procedure again; the average American Shoulder and Elbow

Surgeons (ASES) score improved to 85 points, with 84% of the patients reporting little or no pain. Patients regained overhead motion, with forward flexion averaging  $152^\circ$  and external rotation strength comparable with that of the contralateral shoulder. However, ultrasound revealed that seventeen of eighteen repairs had disrupted, with the majority of the defects returning to their original size, suggesting that outcome is independent of rotator cuff healing. The authors could not determine which portion of the repair technique accounted for the favorable outcome.

### Subscapularis Tears

The belly-press test is often used to evaluate subscapularis function when the lift-off test cannot be performed because of pain or stiffness. Tokish evaluated whether the belly-press and lift-off tests are equivalent measures of subscapularis function. Electromyographic measurement determined that the belly-press and lift-off tests activated the proximal and distal portions of the subscapularis muscles greater than they activated the other muscles that were tested, indicating that the tests are valid and specific for subscapularis muscle function. The belly-press test was found to activate the proximal part of the subscapularis muscle more than the lift-off test, while the lift-off test activated the distal part of the subscapularis.

### Acromioclavicular Joint

Shubin-Stein compared the magnetic resonance images for twenty-five symptomatic and fifty asymptomatic patients in order to identify features specific to the symptomatic acromioclavicular joint. Twenty of twenty-five symptomatic shoulders were found to have reactive bone edema in either the distal part of the clavicle or the acromion, or both, whereas none of the asymptomatic shoulders demonstrated this finding.

Weber described the results of a mini-open coracoclavicular reconstruction in which the coracoacromial ligament is harvested and tagged arthroscopically to maximize graft length and minimize deltoid injury. The reconstruction is then carried out through a small incision over the acromioclavicular joint. Sloan reported on the use of the lateral half of the conjoined tendon for coracoclavicular reconstruction. Biomechanical testing demonstrated that the lateral 12 mm of the conjoined tendon and the coracoacromial ligament had comparable ultimate tensile strengths, but both were substantially less than the strength of the intact coracoclavicular ligament. The authors advocated the use of the lateral half of the conjoined tendon for coracoclavicular ligament reconstruction so that the coracoacromial ligament, typically harvested for Weaver-Dunn reconstructions, is retained as an important static shoulder stabilizer.

### Biceps

Kelly examined the functional and cosmetic outcome following arthroscopic tenotomy of the long head of the biceps. The

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Popeye sign that often accompanies detachment of the long head of the biceps tendon was specifically evaluated: 26% of the patients had no sign at rest or during active elbow flexion, 17% had a positive sign both at rest and during active elbow flexion, and 57% had no sign at rest but a positive sign during active elbow flexion. Side-to-side strength differences were modest, and 96% of the patients had mild or no biceps tenderness during palpation of the bicipital groove. The authors concluded that arthroscopic tenotomy is an appropriate and reliable intervention in this group of patients. The loss of biceps strength appeared minimal, but cosmetic deformity and fatigue-related discomfort were common complaints.

Kim reported on the clinical assessment of SLAP lesions (lesions of the superior portion of the labrum, anterior and posterior) on the basis of symptoms and physical examination findings. Symptoms were not helpful in distinguishing patients with SLAP lesions from other patients, and the various clinical tests had poor positive predictive value.

Weber presented the results of arthroscopic repair of ninety-five type-II SLAP lesions. All repairs were carried out with the patient in the lateral decubitus position with use of suture anchors and nonabsorbable sutures that were placed and tied through an anterosuperior portal. Postoperatively, patients wore a sling for three weeks and were started on immediate passive range of motion. Neither clinical tests (sensitivity, 55%) nor magnetic resonance imaging (sensitivity, 35%) provided accurate diagnosis of the SLAP tear. Nearly all patients had other associated abnormalities that required intervention. There were no instances of hardware loosening or failed repair, but two patients underwent subsequent arthroscopy that documented healing. After a mean duration of follow-up of four years, the mean UCLA score improved from 19 to 33 points, but patients who had filed a Workers' Compensation claim fared worse than those who had not.

### *Glenohumeral Instability*

#### Basic Science

McCarty studied the relationship of the axillary nerve to the shoulder capsule with varying degrees of arm abduction in a cadaver model. Arm abduction increased the distance from the glenoid to the axillary nerve from 10 mm at 0° of abduction to 35 mm at 90° of abduction. However, the teres minor branch was near the glenoid at all abduction angles, with a distance of 7 mm measured at 0° of abduction.

#### Clinical

The late Alexandra Kirkley, in a prospective randomized clinical trial of forty patients who were less than thirty years old, compared the effectiveness of immediate arthroscopic stabilization with that of immobilization and rehabilitation for the treatment of traumatic anterior shoulder dislocation. At an average of seventy-nine months after the initial intervention, the patients who had undergone surgical stabilization fared better than those who had not (as indicated by a

Western Ontario Shoulder Instability Index of 86% for the former group compared with 75% for the latter group). Although the difference was not significant with the numbers available, she concluded that the difference was clinically important and justified early surgical treatment for this group of patients.

Freehill described the high rate of synovitis following arthroscopic stabilization of the shoulder with use of a polylactic acid tack. Ten (19%) of fifty-two patients had pain and progressive stiffness at a mean of eight months postoperatively. Second-look arthroscopy revealed that nine patients had gross implant debris and that all patients had synovitis. Three patients had substantial full-thickness chondral damage of the humeral head. Following arthroscopic débridement, loose body removal, and synovectomy, seven patients recovered full motion with little or no pain.

Kim presented the results of a prospective randomized clinical study comparing accelerated and conventional rehabilitation following arthroscopic Bankart repair. Sixty-two nonathletic patients with a classic Bankart lesion undergoing arthroscopic repair with use of suture anchors were randomized either to three weeks of immobilization with an abduction sling followed by conventional rehabilitation or to accelerated rehabilitation consisting of staged range-of-motion and strengthening exercises beginning immediately postoperatively. Patients who underwent accelerated rehabilitation recovered a functional range of motion and returned to functional activity more quickly than did those who had conventional rehabilitation. At the time of the final follow-up, there was no difference between the groups with regard to return to activity, pain, range of motion, and functional outcome as assessed with the ASES, UCLA, and Rowe scores.

Cohen examined the results of arthroscopic shoulder stabilization in professional athletes involved in high-intensity contact sports. A successful outcome was achieved in eleven of twelve football players but in only four of eight hockey players. Pagnani reported on the open treatment of anterior shoulder instability in American football players after two to six years of follow-up. At the time of the final follow-up, no player had sustained a dislocation postoperatively and two players had had a subluxation. Fifty-two of fifty-eight patients returned to football for at least one year, and only one discontinued the sport because of recurrent instability. Neither study had a control group to allow direct comparison of arthroscopic and open stabilization in the contact athlete.

#### Posterior Instability

Williams evaluated the clinical results of arthroscopic repair of posterior Bankart lesions. The posterior part of the capsulolabral complex was found to be detached in all patients, and it was repaired with use of bioabsorbable tacks. One patient required revision open posterior stabilization. After a

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mean duration of follow-up of five years, twenty-four of twenty-six patients had no pain or instability and all patients had a normal range of motion. Modest deficits in external rotation strength were noted in two patients.

Walsh reported on the results of revision surgery after failed posterior shoulder instability repairs. Two groups of patients were analyzed: ten patients with multidirectional instability with the primary direction being posterior and seven patients with only primary posterior instability. The average Bigliani score improved from 0 to 5 points, and improvements were noted on two of the questions of the Simple Shoulder Test (SST).

### Complications

Weber discussed his experience in the surgical treatment of complications related to thermal capsulorrhaphy. Patients with complications related to thermal capsulorrhaphy that had been performed elsewhere were treated. Four patients with intractable stiffness were treated with arthroscopic lysis of adhesions and manipulation, and three had residual stiffness at the time of final follow-up. Seven patients with recurrent instability were treated with open stabilization; massive areas of capsular necrosis were identified in three patients at the time of surgery. Six of the seven patients had stability postoperatively, while the seventh had marked pain and instability despite having had a capsular shift repair. One patient had biceps subluxation, attributed to necrosis of the biceps anchor, that was treated with tenodesis. No axillary nerve injuries were encountered during electromyographic surveillance. Weber concluded that thermal capsulorrhaphy presents additional problems such as capsular necrosis, nerve injury, and refractory stiffness that are not normally encountered in association with suture capsulorrhaphy.

### Glenohumeral Arthritis

#### Nonprosthetic Treatment

Bishop evaluated arthroscopic abrasion arthroplasty as a temporizing procedure for patients with glenohumeral arthritis. Twenty-seven shoulders in twenty-six patients were evaluated at a mean of fifty-six months postoperatively. In eight cases, a congruous joint could not be created arthroscopically and a total shoulder arthroplasty was performed. In the remaining cases, forward elevation improved from 107° to 131°, external rotation with the arm at the side improved from 18° to 31°, and the ASES shoulder score improved from 45 to 75 points. Most patients had a good or excellent result, irrespective of age. Arthroscopic abrasion may be effective for delaying or obviating the need for shoulder replacement as long as strict selection criteria are met.

Yamaguchi presented the initial results associated with a novel nonprosthetic shoulder arthroplasty involving meniscal allograft interposition. The lateral meniscus was chosen for use as allograft tissue because of its established history for synovial-based healing, its structural characteristics, its

wedge shape (to compensate for glenoid wear), and its durability. Seven consecutive patients who underwent interpositional arthroplasty were evaluated after a mean duration of follow-up of twenty-four months. Postoperatively, all patients were satisfied and reported minimal or no pain and the average ASES score was 72 points. The technique was thought to be comparable with other interpositional techniques at the time of short-term follow-up while offering potential long-term advantages.

### Conventional Prosthetic Arthroplasty

Gross reported on a "weep-hole" technique designed to diminish radiolucent lines around keeled glenoid components. The technique involves the use of transcoracoid suction, which is created by drilling an osseous channel to improve cement penetration into the glenoid vault. After a preliminary cadaveric study, the technique was performed on twenty-nine consecutive shoulders, twenty-seven of which had no visible radiolucent lines. Creating the transcoracoid channel required a mean of only six minutes and allowed the evacuation of a substantial amount of fluid (mean, 64 mL).

Buss compared pressurization with finger-packing during the cementation of glenoid components in cadavers. Pressurized specimens demonstrated greater cement penetration, suggesting that the technique may improve glenoid stability and durability.

Glenohumeral component mismatch (that is, the difference in the radius of curvature between the humeral head and the glenoid) has important implications for joint-loading, durability, and stability. Edwards evaluated the effect of glenohumeral component mismatch on glenoid radiolucencies. A significant linear relationship was observed between mismatch and glenoid radiolucency scores, with lower scores occurring in association with radial mismatches of >5.5 mm. That study represents an important step in the establishment of recommendations regarding the optimal amount of component mismatch.

Edwards reported that patients who underwent biceps tenodesis at the time of total shoulder arthroplasty had significantly better overall Constant scores (75 compared with 68 points) and subjective scores (rate of good and excellent results, 98% compared with 92%) than those who did not after a mean duration of follow-up of forty-three months. No difference between the groups was detected with regard to pain, strength, or the rate of complications. Tenodesis appears to improve patient satisfaction following shoulder arthroplasty without improving pain relief.

### Outcomes of Arthroplasty

Prosthetic shoulder arthroplasty has been the subject of considerable clinical outcomes research. Boorman compared the improvement in self-assessed health status following total shoulder arthroplasty with that following other surgical procedures. The improvement was comparable with that reported

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after other procedures, including coronary artery bypass grafting, angioplasty, total hip arthroplasty, total knee arthroplasty, and laminectomy.

The choice of hemiarthroplasty or total shoulder arthroplasty for the treatment of glenohumeral arthritis continues to be studied. Edwards used a large multicenter database for a single type of prosthesis to compare the results of 102 hemiarthroplasties and 664 total shoulder arthroplasties performed for the treatment of primary glenohumeral osteoarthritis. After a minimum duration of follow-up of two years, patients who had had a total shoulder arthroplasty had significantly greater improvements compared with those who had had a hemiarthroplasty in terms of all measures, including the Constant score (70 compared with 64 points) and active range of motion. A good or excellent result was obtained after 94% of the total shoulder arthroplasties and after 86% of the hemiarthroplasties. The complication and revision rates in the two groups were comparable. That study echoed previous reports suggesting that total shoulder arthroplasty provides superior results for patients who have primary glenohumeral osteoarthritis.

Kirkley presented the results of a meta-analysis comparing hemiarthroplasty with total shoulder arthroplasty for the treatment of glenohumeral osteoarthritis. Using strict inclusion criteria, three randomized clinical studies including sixty-four total shoulder arthroplasties and fifty-three hemiarthroplasties were selected. At both one and two years postoperatively, the UCLA total score for the total shoulder arthroplasty group was significantly higher than that for the hemiarthroplasty group. The complication rates in both groups were comparable. The meta-analysis suggested that after two years of follow-up, total shoulder arthroplasty exceeds hemiarthroplasty in terms of providing pain relief and improved function for patients with primary osteoarthritis.

Other presentations focused on one type of shoulder arthroplasty. Bauer examined the long-term results of thirty-one hemiarthroplasties that were performed for the treatment of glenohumeral osteoarthritis and reported a 61% rate of satisfactory results. Four of sixteen nonconcentric shoulders required revision to a total shoulder arthroplasty because of substantial glenoid pain at a mean of 2.8 years following hemiarthroplasty, and an additional seven shoulders remained painful but had not yet been revised. The authors concluded that the results of hemiarthroplasty for osteoarthritis deteriorate over time so that the decision not to implant a glenoid component should be considered carefully. Weber also examined the results of hemiarthroplasty for the treatment of glenohumeral osteoarthritis in seventy-six patients. After a mean duration of follow-up of sixty-nine months, the average ASES score increased from 36 to 84 points; five patients required revision to a total shoulder replacement, with an average postrevision ASES score of 84 points. The author concluded that younger patients should

be counseled about the modest rate of late revision to total shoulder arthroplasty but that this procedure can be expected to be successful.

Some studies focused on a particular patient population. Orfaly evaluated the results of hemiarthroplasty in nineteen consecutive patients with rheumatoid arthritis. After a mean duration of follow-up of 4.2 years, the patients had significant functional improvement and little or no pain as measured with a visual analog scale (VAS). The ASES scores improved from 23 to 74 points postoperatively and were slightly lower among patients with a large cuff defect. The mean active elevation increased from 65° to 97°, and the mean external rotation increased from 9° to 34°. Despite the improved function, the mean humeral head offset decreased 7 mm during the study period, providing evidence of considerable glenoid erosion.

Bauer reported on prosthetic shoulder arthroplasty for capsulorrhaphy arthropathy. After a mean duration of follow-up of eight years, thirteen patients had had a reoperation, with conversion of seven hemiarthroplasties to total shoulder arthroplasties at a mean of 5.8 years. Three subscapularis repairs were performed for patients who had undergone two to six previous procedures. Late revision and complications render the results of arthroplasty for arthritis after instability repair inferior to those of arthroplasty for primary osteoarthritis.

Routman reported on the results of simultaneous rotator cuff repair and total shoulder arthroplasty in twenty-three patients. A separate deltoid split through the same skin incision was used to repair larger tears in seven shoulders. After a mean duration of follow-up of 5.3 years, the results for these patients were compared with those for a similar group of twenty-seven patients with primary osteoarthritis and an intact rotator cuff. Patients in the rotator cuff repair group fared significantly worse only in terms of dressing and sleeping. According to the criteria described by Neer, the rotator cuff repair group had thirteen excellent and ten satisfactory results and the rotator cuff intact group had twenty-one excellent and six satisfactory results.

#### Constrained Prosthetic Arthroplasty

Edwards presented the early results associated with a reverse ball-and-socket design that optimizes deltoid function for patients with cuff tear arthropathy. At a minimum duration of follow-up of twenty-four months, the Constant score for shoulder function improved significantly from 24 to 59 points and the mean forward elevation improved significantly from 70° to 138°.

Frankle presented the results associated with the use of a custom reverse ball-and-socket prosthesis in twenty-eight patients with an irreparable rotator cuff tear and a failed shoulder arthroplasty or an irreparable rotator cuff tear associated with anterosuperior instability. At a mean duration of follow-up of thirty months, the mean visual analog score for pain improved significantly and the mean ASES score improved

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significantly from 25 to 50 points. The mean forward elevation improved from 54° to 80°. An excellent result was reported by 53% of the patients, and a good result was reported by 30%. Substantial complications were noted, including liner dissociation in three patients and hardware failure in two.

Nicholson also presented the preliminary results associated with the use of a reverse ball-and-socket prosthesis for rotator cuff-deficient shoulders with anterosuperior instability. The mean ASES score improved from 30 to 74 points, and the mean Simple Shoulder Test (SST) score improved from 1.7 to 7. The mean active forward elevation improved dramatically from 35° to 99°, and the mean active external rotation improved from 6° to 31°. Taken together, these preliminary reports suggest that a reverse ball-and-socket design may provide a combination of pain relief, shoulder stability, and limited function to patients who have the very difficult problem of marked cuff deficiency and anterosuperior instability. Longer follow-up will help to address concerns regarding implant loosening and overall prosthetic durability.

### Complications and Revisions

Kalandiak reported on ninety-four shoulders that underwent revision surgery after a failed shoulder arthroplasty. Multiple causes of failure could be identified for most shoulders, and the mean number of causes was higher for hemiarthroplasties (2.7) than for total shoulder arthroplasties (2.0). Revision surgery significantly improved forward elevation, external rotation, the SST score, and the VAS scores for pain, function, and quality of life. Patients who had originally sustained a proximal humeral fracture fared significantly worse. Patients who had had an early failure of the arthroplasty were rated worse prior to revision but better at the time of the final follow-up.

Frankle reported on the use of a bulk allograft to reconstruct the osseous defect in sixteen patients who required revision total shoulder arthroplasty after glenoid component failure. The allografts were fixed internally with bioabsorbable screws in thirteen of the sixteen patients. Over time, allograft reabsorption occurred and the improvements in humeral offset were eventually lost in four of eleven patients, necessitating reoperation in one patient. A good or excellent result was reported for eleven of the sixteen patients.

Sanchez-Sotelo reported on the surgical treatment of recurrent instability following shoulder arthroplasty. After a mean duration of follow-up of 4.7 years, the result according to Neer's criteria was excellent in four patients, satisfactory in six, and unsatisfactory in twenty-three. The dismal results of revision for instability underscore the importance of thoughtful component positioning and soft-tissue balance at the time of the index arthroplasty.

Miller reported on the loss of subscapularis function following total shoulder arthroplasty in a retrospective study of forty-one patients. The subscapularis was repaired anatomically in nine patients and with use of transosseous sutures in

the other thirty-two patients. In nearly two-thirds of the patients, the lift-off and belly-press tests were abnormal. Twenty-eight of forty-one patients responded that they had difficulty tucking a shirt into the back of the pants. The authors concluded that further attention should be directed at subscapularis weakness following shoulder arthroplasty.

### Proximal Humeral Fractures

#### Treatment

Dimakopoulos reported on the fixation of displaced two, three, and four-part valgus impacted proximal humeral fractures with use of heavy nonabsorbable sutures. At a mean duration of follow-up of 5.5 years, thirty-six two-part greater tuberosity fractures, fifty-seven three-part greater tuberosity fractures, and twenty-one four-part valgus impacted fractures that had been treated with heavy nonabsorbable suture fixation were evaluated. On the basis of the Constant-Murley scoring system, 101 of the 114 patients had a very good result with no pain and good motion. The procedure offered the advantages of shorter operative time, less soft-tissue dissection, stable osteosynthesis through a tension-band effect, a low prevalence of osteonecrosis, avoidance of hardware, and adequate cuff repair enabling early joint motion.

Haddad described poor outcomes following percutaneous pin fixation for proximal humeral fractures. Initial radiographs revealed good fracture reduction in all cases. However, there were high rates of early complications, including pin migration (50%), stiffness (41%), pain (33%), infection (25%), nonunion (8%), and radial nerve palsy (8%). Complications were noted more frequently among patients who were more than fifty years old and those with osteopenia, suggesting that the technique should be reserved for younger patients with good bone quality.

### Clavicular Fractures

#### Basic Science

Stafford evaluated the effects of plate type and location on the stability of mid-shaft clavicular fractures in a cadaveric study involving thirty matched pairs. Clavicles that were plated on the superior aspect demonstrated significantly greater axial and torsional rigidity than did those that were plated on the anterior aspect. Furthermore, limited-contact dynamic compression plates exhibited greater strength and rigidity than did 3.5-mm reconstruction and 2.7-mm dynamic compression plates.

#### Treatment

Nowak found that the absence of osseous contact was the strongest radiographic predictor of an adverse outcome following a clavicular fracture. Fracture location and shortening predicted cosmetic but not functional outcome. Jensen evaluated the clinical importance of shortening following closed treatment of mid-shaft clavicular fractures. Initial shortening averaged 8 mm, and final shortening (after a mean duration of follow-up of sixty months) averaged 11 mm. Initial and

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final shortening were weakly correlated, but final shortening and functional outcome were not correlated.

Duckworth compared plate fixation with intramedullary fixation for the treatment of acute displaced mid-shaft clavicular fractures. There were no differences in functional outcome between the two groups as measured with use of the ASES and Constant scores. All twenty patients who were treated with intramedullary pin fixation had union within three months. Those patients also had fewer complications, had a shorter hospital stay, and tolerated earlier mobilization better than did patients who had plate fixation. Basmania presented the results of intramedullary fixation of symptomatic clavicular malunions. Clavicular shortening improved dramatically following surgery, and all twenty-four patients rated the result as good or excellent.

McKee reported on fifteen patients who had a symptomatic malunion after a high-energy clavicle shaft fracture. Thirteen patients had cosmetic complaints, twelve had complaints related to shoulder weakness, and eleven had neurologic complaints and symptoms of thoracic outlet syndrome. Clavicular shortening averaged nearly 3 cm. Ten patients underwent osteotomy, recreation of the fracture line, correction of deformity, and internal fixation. All patients had achievement of union at the osteotomy site, and all were satisfied with the result.

#### *Scapulothoracic Joint*

Silver reported on the results of open excision of the superomedial angle of the scapula for the treatment of painful scapulothoracic bursitis that was refractory to conservative treatment. The results for eleven consecutive patients (fourteen shoulders) who had undergone open bursectomy with resection of the superomedial angle of the scapula over a nine-year period were reviewed after a mean duration of follow-up of 2.5 years. Nine of the eleven patients reported a decrease in pain, and ten patients returned to their preinjury activity level. Lehtinen reported on the results of combined arthroscopic and open treatment in sixteen patients with symptomatic scapulothoracic bursitis that was refractory to conservative treatment. Six patients had arthroscopic bursectomy and open resection of the superomedial angle, six had open bursectomy and osseous resection, one had an isolated open bursectomy, one had isolated arthroscopic bursectomy, and two had arthroscopic bursectomy and arthroscopic osseous resection. After a mean duration of follow-up of twenty-nine months, the mean SST score was 9.9 and thirteen of the sixteen patients were happy with the relief of pain, suggesting that the combined open and arthroscopic approach may be effective.

#### *Neurologic Injuries*

Nicholson evaluated the effectiveness of transfer of the sternal head of the pectoralis major muscle for the treatment of irreversible long thoracic nerve injury. Sixteen shoulders were evaluated at a mean of 3.8 years after muscle transfer. In all

cases, fascia lata or hamstring tendon was used to extend the graft to the inferior angle of the scapula. Postoperatively, the ASES score improved from 38 to 95, the SST score improved from 3.4 to 10.9, and the visual analog score for pain improved from 6 to 0.3. The patients returned to work or sports activity at an average of 4.7 months after surgery. Scapular stability and shoulder function were restored, scapular winging was eliminated in all patients, and there were no instances of graft-site morbidity or other complications.

Pearl described glenohumeral deformities that occurred in children secondary to brachial plexus palsy. Magnetic resonance imaging was superior to arthrography for defining the severity of glenoid and humeral head deformity. Two-thirds of the children with internal rotation contractures had substantial glenoid deformities, including twenty-two biconcave glenoids and twenty-two dysplastic glenoids. Moreover, the severity of the contracture correlated with the severity of the deformity. In another study, twenty-five of these children who were 0.8 to twelve years old underwent arthroscopic release of the subscapularis and rotator interval for internal rotation contractures. Arthroscopy documented a progression from concentric conforming joints to deformed bifid glenoids with flattened oval humeral heads articulating with the posterior glenoid articular surface. Internal rotation contracture release was successful in improving passive external rotation and in reversing glenoid deformity. Timely release to avoid glenoid deformity may be necessary even within the first year of life.

#### *Miscellaneous*

Guanche, in a prospective, blinded, placebo-controlled study, evaluated the use of an anesthetic pump for postoperative care following shoulder surgery. The study was restricted to a continuous infusion pump, which is neither pulsed nor patient-regulated, that was implanted following subacromial surgery (excluding rotator cuff repair). There were no significant differences between the experimental and placebo groups with regard to time in the recovery room, subjective pain, demand for oral opioids, or recovery of active range of motion, except that patients in the experimental group spent thirty minutes less in the recovery room.

#### **Elbow**

##### *Instability*

##### *Basic Science*

Kamineni presented a kinematic analysis of partial posteromedial olecranon resection. The rationale for the study was that posteromedial osteophytes resulting from impingement in throwing athletes are often treated with débridement along with resection of varying amounts of normal olecranon but that information on the effects of excessive resection on elbow stability is lacking. No single critical amount of olecranon resection was identified, but valgus displacement increased following as little as 3 mm of resection and was markedly

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increased following 9 mm of resection. The findings challenged the rationale underlying the removal of any normal olecranon in throwing athletes and suggested any amount of resection may increase medial collateral ligament strain and the risk of injury.

Ahmad described a new medial collateral ligament reconstruction technique employing interference screw fixation of a two-strand palmaris longus tendon graft placed into a single 5-mm tunnel. The tunnel was created at the isometric anatomic insertion sites on the medial epicondyle and the sublime tubercle. Reconstruction restored valgus stability to within 1° of the intact elbow for all flexion angles tested. The technique minimized muscle dissection and the risk of ulnar nerve injury while allowing reliable placement of bone tunnels, straight-forward graft-tensioning, and secure graft fixation.

#### Clinical

O'Driscoll reported on the use of the moving valgus stress test for the diagnosis of a partial tear of the medial collateral ligament. This test, which simulates the stresses on the elbow that are experienced during throwing, is performed by quickly extending the fully flexed elbow while a valgus torque is applied. Pain as the elbow passes between 120° and 90° of flexion signifies a positive test. In a group of patients undergoing surgery for elbow instability, the sensitivity of the moving valgus stress test was determined to be 100%.

Pearce reported on stress ultrasonography of the ulnar collateral ligament in asymptomatic professional pitchers. Sonography was performed on both dominant and nondominant elbows under stressed and unstressed conditions. In the dominant elbow of professional pitchers, the ulnar collateral ligament was found to be thicker and less compliant. This portable, dynamic technique may be useful in evaluating acute elbow injuries in this population.

Sanchez-Sotelo reported on the long-term outcome of reconstruction for posterolateral rotatory instability. At the time of the most recent follow-up, the mean Mayo Elbow Performance Score (MEPS) was 85 points. The result was excellent in nineteen patients, good in thirteen, fair in seven, and poor in five. The results were significantly better for patients undergoing tendon graft augmentation of the lateral ligament complex repair.

McKee documented the lateral soft-tissue injury pattern in sixty consecutive elbows that had an absolute indication for surgery following dislocation (ten elbows) or fracture-dislocation (fifty elbows). All elbows demonstrated disruption of the posterolateral part of the capsule and the lateral collateral ligament complex. The injury patterns included proximal avulsion (thirty elbows), osseous avulsion of the lateral epicondyle (five), midsubstance rupture (eighteen), ulnar detachment of the lateral collateral ligament (three), ulnar osseous avulsion (one), and combined patterns (three). Concomitant rupture of the common extensor origin was noted in thirty-nine elbows. Disruption of the stabi-

lizing lateral soft-tissue structures was a universal finding, suggesting that the repair of these structures should be an integral part of the surgical treatment of elbow dislocations and fracture-dislocations.

Ring reported on the use of hinged external elbow fixation for the treatment of posttraumatic elbow instability in twenty-one patients. Stable concentric reduction was achieved in all but two patients, and the average arc of ulnohumeral motion was 105°. According to the Mayo Elbow Performance Score, the final result was rated as excellent in ten patients, good in five, fair in one, and poor in five. Patients with posterior Monteggia injuries fared the worst.

Nowinski reported on the use of hinged elbow fixation for patients with complex elbow conditions, including severe contracture, instability, and distraction arthroplasty. The average duration of follow-up was sixty-two months. For elbows that underwent contracture release, the mean arc of motion improved from 52° to 90° before treatment to 15° to 145° after treatment. For elbows that underwent instability repair, the final arc of motion was 25° to 140°, with stability achieved in all cases. The outcome was rated as good or excellent in twenty-nine of forty-three patients (forty-six elbows). Complications included pin-track infections (twelve patients), ulnar nerve paresthesias (four patients), and contracture requiring release (two patients).

#### Tendon Injuries

Seitz described intra-articular synovitis in association with lateral epicondylitis. Histologic examination revealed focal inflammatory changes and hypertrophy and erosive changes within the radial head. After the failure of traditional conservative treatment for tennis elbow, the presence of synovial bogginess, mild joint effusion, and radiocapitellar pain with pronation and supination should raise the suspicion of this entity, especially when lidocaine injection in the region of the lateral epicondylar ridge alone fails to ameliorate symptoms.

Pettrone evaluated the safety and efficacy of extracorporeal shock-wave therapy for chronic lateral epicondylitis. One hundred and fourteen patients with at least a six-month history of lateral epicondylitis were randomized into double-blinded active treatment and placebo groups. Active treatment consisted of three weekly treatments or sham treatment for twelve weeks. Significant pain reduction was observed in the active treatment group at twelve weeks, with 64% of the patients showing at least 50% reduction in pain, compared with 31% of the patients in the placebo group. This improvement persisted at the time of the six-month follow-up. The results suggest that shock-wave therapy may be a safe and effective treatment for chronic lateral epicondylitis.

#### Fractures and Dislocations

Ring reported on the treatment of distal humeral nonunions in thirty-eight patients who underwent plate fixation, autog-

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enous bone-grafting, ulnar nerve neurolysis and transposition, and elbow contracture release. Four nonunions failed to heal; of these, two were treated with total elbow arthroplasty and a third was treated with revision surgery. A second operation was required in nineteen additional patients; eleven underwent contracture release, eight underwent hardware removal, and two underwent ulnar nerve release. Despite the high reoperation rate, thirty-four of thirty-five patients who retained their native elbow had a good or excellent functional result at a mean duration of follow-up of fifty-four months according to the rating system of Broberg and Morrey.

Roidis described the soft-tissue injuries associated with Mason type-II and III comminuted radial head fractures in a study of twenty-four consecutive patients. Magnetic resonance imaging revealed the frequent presence of associated injuries, including disruption of both the medial and lateral ligaments (twelve patients), isolated medial collateral ligament disruption (one patient), isolated lateral collateral ligament disruption (six patients), capitellar osteochondral defects (seven patients), capitellar bone bruises (twenty-three patients), and loose bodies (twenty-two patients). A high level of suspicion for associated osseous and ligamentous injury should be employed when treating displaced or comminuted radial head fractures.

**Arthritis****Prosthetic Arthroplasty**

Because the medial and lateral condyles comprise the osseous origins of the flexor-pronator and common extensor muscles, respectively, the effect of condylar resection during total elbow arthroplasty has been questioned. Pugh evaluated the influence of condylar resection on strength and functional outcome following semiconstrained total elbow arthroplasty for traumatic and posttraumatic conditions. Of thirty-two patients with a mean age of sixty-seven years who met the criteria, sixteen had intact condyles and sixteen had resected condyles. Objective muscle strength-testing of the elbow, forearm, wrist, and hand was performed, with the normal contralateral limb serving as the control to eliminate bias. After an average duration of follow-up of sixty-four months, the author found that resection of the condyles had no significant effect on forearm, wrist, and hand strength and had no effect on the elbow outcome score.

**Outcome**

McKee investigated elbow extension weakness following semiconstrained total elbow arthroplasty in thirty patients after a mean duration of follow-up of forty-three months. The mean elbow extension strength was only 47% of that on the normal side and was thought to relate to triceps detachment during exposure, tentative postoperative rehabilitation, or alterations in the joint level affecting triceps tension.

Jones reported on the results of semiconstrained total

elbow replacement in twenty-nine patients. A high prevalence of radiolucent lines along both the ulnar and the humeral component was reported at a mean duration of follow-up of 3.5 years.

Smith reported on the functional improvements after total elbow arthroplasty in patients with rheumatoid arthritis. A standardized functional inventory, the Simple Elbow Test (SET), was completed by patients preoperatively and after elbow arthroplasty. Significant improvements in all twelve SET functions were seen after three years of follow-up, especially sleeping comfortably, washing the back of the contralateral shoulder, combing the hair, lifting one pound (0.45 kg), and using the arm to push up from a chair.

**Complications and Revisions**

Sanchez-Sotelo, in a study of eleven elbows, reported on the use of implant revision and strut allograft augmentation for the treatment of periprosthetic humeral fractures after total elbow arthroplasty. Complications included one additional nondisplaced periprosthetic fracture, one olecranon fracture, one permanent ulnar nerve injury, and one case of triceps insufficiency. At the time of the most recent follow-up, seven of eight patients with an intact reconstruction had a functional arc of motion and no or slight pain. The described technique provides high rates of fracture union and implant survival, but the complication rate is substantial.

**Arthroscopy**

Smith reported on the guidelines for arthroscopic tennis elbow release. In seven cadaveric elbows, the extensor complex was débrided arthroscopically with use of proximal-medial and anterolateral portals. Elbow stability was maintained as long as resection of the extensor origin was limited to the anterior one-half of the radial head. The study verified that complete resection of the common extensor origin can be achieved arthroscopically and provided guidelines for maintaining elbow stability.

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The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. One or more of the authors received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity (Smith and Nephew Endoscopy, Andover, Massachusetts). No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated.

## WHAT'S NEW IN SHOULDER AND ELBOW SURGERY

## Recent Publications of Interest

## Shoulder

## Rotator Cuff

## Basic Science

**Koh JL, Szomor Z, Murrell GA, Warren RF.** Supplementation of rotator cuff repair with a bioresorbable scaffold. *Am J Sports Med.* 2002;30:410-3.

## Impingement

**Sonnery-Cottet B, Edwards TB, Noel E, Walch G.** Results of arthroscopic treatment of posterosuperior glenoid impingement in tennis players. *Am J Sports Med.* 2002;30:227-32.

## Tears

**Fenlin JM Jr, Chase JM, Rushton SA, Frieman BG.** Tuberooplasty: creation of an acromiohumeral articulation—a treatment option for massive, irreparable rotator cuff tears. *J Shoulder Elbow Surg.* 2002;11:136-42.

**Burkhart SS, Tehrany AM.** Arthroscopic subscapularis tendon repair: technique and preliminary results. *Arthroscopy.* 2002;18:454-63.

**Sonnabend DH, Watson EM.** Structural factors affecting the outcome of rotator cuff repair. *J Shoulder Elbow Surg.* 2002;11:212-8.

**Murray TF Jr, Lajtai G, Mileski RM, Snyder SJ.** Arthroscopic repair of medium to large full-thickness rotator cuff tears: outcome at 2- to 6-year follow-up. *J Shoulder Elbow Surg.* 2002;11:19-24.

## Acromioclavicular Joint

**Barber FA.** Coplaning of the acromioclavicular joint. *Arthroscopy.* 2001;17:913-7.

## Glenohumeral Instability

## Basic Science

**Crockett HC, Gross LB, Wilk KE, Schwartz ML, Reed J, O'Mara J, Reilly MT, Dugas JR, Meister K, Lyman S, Andrews JR.** Osseous adaptation and range of motion at the glenohumeral joint in professional baseball pitchers. *Am J Sports Med.* 2002;30:20-6.

**Schiffert SC, Rozencwaig R, Antoniou J, Richardson ML, Matsen FA 3rd.** Antero-posterior centering of the humeral head on the glenoid in vivo. *Am J Sports Med.* 2002;30:382-7.

**McFarland EG, Kim TK, Banchasuek P, McCarthy EF.** Histologic evaluation of the shoulder capsule in normal shoulders, unstable shoulders, and after failed thermal capsulorrhaphy. *Am J Sports Med.* 2002;30:636-42.

## Clinical

**Karlsson J, Magnusson L, Ejerhed L, Hultenheim I, Lundin O, Kartus J.** Comparison of open and arthroscopic stabilization for recurrent shoulder dislocation in patients with a Bankart lesion. *Am J Sports Med.* 2001;29:538-42.

**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.

**Lephart SM, Myers JB, Bradley JP, Fu FH.** Shoulder proprioception and function following thermal capsulorrhaphy. *Arthroscopy.* 2002;18:770-8.

**Kim SH, Ha KI, Kim SH.** Bankart repair in traumatic anterior shoulder instability: open versus arthroscopic technique. *Arthroscopy.* 2002;18:755-63.

**Burkhart SS, Debeer JF, Tehrany AM, Parten PM.** Quantifying glenoid bone loss arthroscopically in shoulder instability. *Arthroscopy.* 2002;18:488-91.

## Complications and Revision

**Kim SH, Ha KI, Kim YM.** Arthroscopic revision Bankart repair: a prospective outcome study. *Arthroscopy.* 2002;18:469-82.

## Glenohumeral Arthritis

## Basic Science

**Sanchez-Sotelo J, O'Driscoll SW, Torchia ME, Cofield RH, Rowland CM.** Radiographic assessment of cemented humeral components in shoulder arthroplasty. *J Shoulder Elbow Surg.* 2001;10:526-31.

## Clinical

**Cameron BD, Galatz LM, Ramsey ML, Williams GR, Iannotti JP.** Non-prosthetic management of grade IV osteochondral lesions of the glenohumeral joint. *J Shoulder Elbow Surg.* 2002;11:25-32.

**Marx RG, McCarty EC, Montemurno TD, Altchek DW, Craig EV, Warren RF.** Development of arthrosis following dislocation of the shoulder: a case-control study. *J Shoulder Elbow Surg.* 2002;11:1-5.

**Green A, Norris TR.** Shoulder arthroplasty for advanced glenohumeral arthritis after anterior instability repair. *J Shoulder Elbow Surg.* 2001;10:539-45.

## Nerve Lesions and Tendon Transfers

**Klepps SJ, Goldfarb C, Flatow E, Galatz LM, Yamaguchi K.** Anatomic evaluation of the subcoracoid pectoralis major transfer in human cadavers. *J Shoulder Elbow Surg.* 2001;10:453-9.

## Elbow

## Instability

## Basic Science

**Andrews JR, Heggland EJ, Fleisig GS, Zheng N.** Relationship of ulnar collateral ligament strain to amount of medial olecranon osteotomy. *Am J Sports Med.* 2001;29:716-21.

**Dunning CE, Zarzour ZD, Patterson SD, Johnson JA, King GJ.** Ligamentous stabilizers against posterolateral rotatory instability of the elbow. *J Bone Joint Surg Am.* 2001;83:1823-8.

**Mullen DJ, Goradia VK, Parks BG, Matthews LS.** A biomechanical study of stability of the elbow to valgus stress before and after reconstruction of the medial collateral ligament. *J Shoulder Elbow Surg.* 2002;11:259-64.

## Clinical

**Rohrbough JT, Altchek DW, Hyman J, Williams RJ 3rd, Botts JD.** Medial collateral ligament reconstruction of the elbow using the docking technique. *Am J Sports Med.* 2002;30:541-8.

## Tendon Injuries

**Pereira DS, Kvitne RS, Liang M, Giacobetti FB, Ebrahimzadeh E.** Surgical repair of distal biceps tendon ruptures: a biomechanical comparison of two techniques. *Am J Sports Med.* 2002;30:432-6.

**Wang CJ, Chen HS.** Shock wave therapy for patients with lateral epicondylitis of the elbow: a one- to two-year follow-up study. *Am J Sports Med.* 2002;30:422-5.

## Fractures and Dislocations

**Ring D, Jupiter JB, Zilberfarb J.** Posterior dislocation of the elbow with fractures of the radial head and coronoid. *J Bone Joint Surg Am.* 2002;84:547-51.

**Jupiter JB, Ring D.** Treatment of unreduced elbow dislocations with hinged external fixation. *J Bone Joint Surg Am.* 2002;84:1630-5.

## Arthritis

**Sanchez-Sotelo J, O'Driscoll S, Morrey BF.** Periprosthetic humeral fractures after total elbow arthroplasty: treatment with implant revision and strut allograft augmentation. *J Bone Joint Surg Am.* 2002;84:1642-50.

## Arthroscopy

**Horiuchi K, Momohara S, Tomatsu T, Inoue K, Toyoma Y.** Arthroscopic synovectomy of the elbow in rheumatoid arthritis. *J Bone Joint Surg Am.* 2002;84:342-7.

## Upcoming Meetings

Nineteenth Annual Open Meeting of the American Shoulder and Elbow Surgeons. February 8, 2003. New Orleans, LA. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: cocalis@aaos.org

Arthroscopic Rotator Cuff Repair. Gartsman GM, course chairman. January 24-26, 2003; March 21-23, 2003; July 19-21, 2003; November 7-9, 2003. Houston, TX. Contact: Brenda Cockerham. E-mail address: brenda.cockerham@hcahealthcare.com

Arthroscopic Glenohumeral Reconstruction. Gartsman GM, course chairman. May 17-19, 2003; September 19-21, 2003. Houston, TX. Contact: Brenda Cock-

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- erham. E-mail address: [brenda.cockerham@hcahealthcare.com](mailto:brenda.cockerham@hcahealthcare.com)
- Upper Extremity: Fingertip to Shoulder. April 3-6, 2003. Bal Harbour, FL. Contact: Kim Fruehling, AAOS Course Coordinator. Telephone: 847-384-4081.
- The Shoulder: Open and Arthroscopic Techniques. May 30-June 1, 2003. Rosemont, IL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: [cocalis@aaos.org](mailto:cocalis@aaos.org)
- Twentieth Annual Meeting of the San Diego Shoulder Arthroscopy. June 25-28, 2003. San Diego, CA. Contact: James Esch, MD. E-mail address: [jesch@shoulder.com](mailto:jesch@shoulder.com)
- The Shoulder II: Open and Arthroscopic Techniques. September 12-14, 2003. Rosemont, IL. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: [cocalis@aaos.org](mailto:cocalis@aaos.org)
- Sports Clinic Orthopaedic Medical Associates, Inc. Shoulder Surgery Controversies. October 3-5, 2003. Laguna Hills, CA. Contact: Wesely Nottage, MD. E-mail address: [tscwmn@aol.com](mailto:tscwmn@aol.com)
- Shoulder and Elbow Arthritis—Arthroscopy to Arthroplasty. American Shoulder and Elbow Surgeons Focus Meeting. November 13-16, 2003. Las Vegas, NV. Contact: Emily Jones. E-mail address: [jones@aaos.org](mailto:jones@aaos.org)
- Fourth Biennial American Academy of Orthopaedic Surgeons and American Shoulder and Elbow Surgeons Shoulder Meeting. October 14-17, 2004. Monterey, CA. Contact: Nancy Cocalis, AAOS Course Coordinator. E-mail address: [cocalis@aaos.org](mailto:cocalis@aaos.org)
- Ninth International Congress on Shoulder Surgery. May 2-5, 2004. Washington, DC. Contact: Robert H. Cofield, MD. E-mail address: [cofield.robert@mayo.edu](mailto:cofield.robert@mayo.edu)