modalities in foreign body detection of the extremities, sonography is now a well-described technique.[1-8, 10] It not only provides a less expensive, time-saving advantage over both MRI and CT, but it also provides the additional advantage of intraoperative use in the retrieval of foreign bodies.

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Elbow arthroscopy in a mostly athletic population

The effectiveness of elbow arthroscopy was assessed in 35 consecutive patients (primarily weight lifters and baseball players) treated by one surgeon. The most commonly treated lesions were loose bodies and impinging spurs. Most elbow problems resulted from repetitive or acute athletic trauma. Repetitive stress injuries usually involved the athlete's dominant arm (91%). A standardized rating system demonstrated significant improvement at 24 months' average follow-up. Flexion and extension improved an average of 9 and 6 degrees, respectively. Elbow arthroscopy appears to be a safe and effective treatment for athletes, allowing most a full return to participation in sports. (J HAND SURG 1993;18A:220-4.)

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The majority of articles on elbow arthroscopy are concerned with technique or case reports[1-8]; few have described therapeutic results in a series of cases.[9-13] Of those few, only one reported a follow-up averaging more than 1 year.[10] Morrey[5] reported that elbow arthroscopy provided diagnostic information in about 80% of his cases and influenced his treatment in 62%; however, arthroscopy represented only 10% of his elbow surgery practice. Guhl[12] reported good and excellent results in 75% of 20 therapeutic elbow ar-

Table I. Analysis of symptoms*

Symptom/category	*No. with symptom or abnormality*	*%*	*Score analysis*			
			Pretreatment	*Posttreatment*	*% increase*	*p value*
Pain	35	100	8	17	124	0.0001
Range of motion*	31	89	18	16	40	0.0001
Function	30	86	13	18	47	0.0001
Locking/catching	25	71	12	19	54	0.0001
Swelling*	20	57	15	18	19	0.0008
Total Score	NA	NA	59	89	50	0.0001

*Based on the subjective report by the patient, not an objective measurement.

Table II. Suspected preoperative diagnosis

Diagnoses	*No.*	*%*
Loose bodies	28	80
Degenerative spurs	21	60
(with olecranon impingement)	14	40
Osteochondritis dissecans of the capitellum	2	6
Other	3	9

Table III. Operative findings (not mutually exclusive)

	No.	*%*
Loose bodies	22	63
Isolated (no associated spurs)	8	23
Concomitant (associated spurs)	14	40
Pedunculated mobile fragments (olecranon)	13	37
Spurs	24	69
Isolated (no associated loose bodies)	10	29
Concomitant (associated loose bodies)	14	40
Impinging—olecranon	21	60
Impinging—coronoid	14	40
Impinging—olecranon and coronoid	11	31
No impinging spurs	11	31
Accompanying synovitis	25	71
Capitellar abnormality	7	20
Radial head abnormality	5	14
Isolated synovitis	2	6
No abnormality	0	0

throscopies, and Parisien[13] reported excellent results in 92% and good results in 8% of 25 cases, but neither of those reports described the follow-up period.

To determine the therapeutic results of arthroscopic elbow surgery in a primarily athletic population, a consecutive series of elbow arthroscopies by one surgeon was retrospectively reviewed. Cases were also investigated to determine factors that predisposed the elbows to injury.

Materials and methods

Patient population and follow-up. All 36 cases of elbow arthroscopy performed by one surgeon (T. E. A.) between September 1983 and November 1989 were retrospectively reviewed. Follow-up information on 35 patients was obtained by the lead author (W. G. W.); one patient treated in 1985 could not be located.

The study group consisted of 33 men and 2 women with a mean age of 29 years (range, 16 to 69 years). Follow-up averaged 24 months (range, 6 to 77 months). Preoperative duration of symptoms averaged 18 months (range, 1 to 92 months). The preoperative symptoms and diagnoses are shown in Tables I and II. All patients had preoperative pain; loose bodies and impinging spurs were the most common preoperative and postoperative diagnoses (Tables II and III). Eleven patients returned for repeat examination specifically for this report. The remaining follow-up data were taken from the last follow-up visit. All but four of the patients had actively participated in sports preoperatively.

All 35 patients completed a comprehensive subjective questionnaire covering the preoperative and postoperative elbow status. The questionnaire was divided into five categories: *pain, swelling, range of motion, use/function,* and *locking/catching*. Twenty points were allotted each category. For pain, use/function, and locking/catching, values of 20, 15, 10, 5, and 0 points corresponded, respectively, to normal function, minimal occasional limitation, moderate limitation with heavy activity, frequent limitation with even light activity, and constant or severe limitation. For swelling, the points corresponded to the responses of no swelling

(20 points), occasional swelling with heavy activity (15 points), persistent swelling with heavy activity (10 points), swelling with any activity (5 points), or constant swelling (0 points). For range of motion, the points corresponded to the response of full range of motion (20 points), mild limitation of motion (15 points), moderate limitation of motion (10 points), severe limitation of motion (5 points), or no motion (0 points). The maximal score achievable was 100, and a respondent could conceivably have a score of 0.

Patient evaluation. All patients were evaluated preoperatively with physical examination and standard posteroanterior, lateral, and axial x-ray films. Special oblique views were obtained occasionally. Arthrotomograms were obtained in 15 patients and were especially helpful in demonstrating loose bodies and impinging spurs. Computerized tomographic arthrograms were obtained in four patients and demonstrated loose bodies and articular surface defects. However, if the patient's symptoms and plain x-ray films were consistent with loose bodies or impinging spurs and arthroscopy was indicated by symptoms regardless of special radiographic study findings, these special studies were not obtained routinely. Range of motion was evaluated in standard fashion by the examining physician with a handheld goniometer. Swelling was rated subjectively by the patient. There was no objective measurement of swelling because frequently it occurred only after athletic activity.

Operative technique. The basic surgical technique has been previously described.[1, 4, 5, 7-10, 12, 13] In brief, the supine patient's forearm is suspended by hand or forearm traction with the elbow flexed approximately 90 degrees. Intraoperative flexion or extension can be modified as needed during the procedure. After saline distention, two anterolateral portals are created just anterior to the radial head. Two 5.5 mm cannulas are inserted, one for gravity inflow and one for a 30-degree, 4.5 mm arthroscope. Distention is usually inadequate without the second portal. The optimal anteromedial portal site is determined with an arthroscopically visualized percutaneous needle just anterior to the medial joint line. Entering the joint capsule near the capsular margin avoids having a synovial fold obscuring the arthroscopic view. With these three portals, most anterior procedures can be accomplished. Posterior arthroscopy is performed after all anterior work is completed.

For posterior compartment arthroscopy, the anterior inflow portals are used unless swelling prevents flow from anterior to posterior. A posterior central portal is made directly through the triceps approximately 2 to 3 cm proximal to the olecranon tip and a posterolateral portal is created about 1 to 2 cm proximal to the olecranon at the border of the triceps.

Inadequate visualization is the greatest obstacle. It is most commonly caused by inadequate distention, obstructing hypertrophied or folded synovium, or intraarticular bleeding. Adequate distention is best accomplished with a standard-sized portal devoted to inflow. When inflow is directed through small inflow portals or the arthroscope, distention is usually inadequate, especially when motorized resectors are used. Good distention will usually tamponade the bleeding, or a tourniquet can be used. Hypertrophied synovium should be resected, and obstructing folds can be minimized by placement of the portals near the capsular margins, by changing portals as needed, or by manipulation of the synovial folds with the tip of the inflow cannula.

After arthroscopy, the elbow is irrigated and drained, and the portals are sutured. A padded dressing is applied, and a sling is provided for use as needed. Activity is permitted as desired.

Results

The overall subjective functional score improved from 59 preoperatively to 89 postoperatively ($p = 0.0001$), an increase of nearly 50%. The rating score increased in each of the five categories, with the greatest increase being in the pain score (124%) (Table I). All differences were statistically significant (Student's t test).

By the objective physician's measurements, flexion improved an average of 7 degrees (from 9 degrees less than the opposite uninvolved arm to a 2-degree difference, $p = 0.027$) and extension improved an average of 6 degrees (from a difference of 15 degrees to a difference of 9 degrees, $p = 0.06$). The changes in pronation and supination were not significant (an average pronation loss of 1 degree and an average supination gain of 2 degrees).

To better evaluate the pain intensity, patients were asked to rate their pain on a scale of 0 to 10 (0 = no pain; 10 = most severe pain imagineable). The score improved from a preoperative mean of 6 (median, 7) to a mean of 1 (median, 0) at follow-up ($p = 0.0001$).

When the different diagnostic groups were compared, there were no differences in the overall scores among patients with loose bodies, with spurs, or with other diagnoses. However, because of the frequent concomitant occurrence of spurs and loose bodies, many patients had to be excluded when these two diagnostic categories were compared (see Table III).

Coronoid spurs were associated with an average preoperative flexion restriction of 17 degrees, which improved to an average 0-degree restriction on follow-up

Table IV. Sports participation (not mutually exclusive)

Sport	*Preoperative participation*		*Postoperative return to sports*	
	No. of patients	*%*	*No. of patients*	*%*
Weight lifting	23	66	19	83
Baseball pitching	9	26	7	78
Baseball (other positions)	11	31	11	100
Football	5	14	4	80
Golf	4	11	3	75
Racquet sports	3	9	3	100
Basketball	3	9	3	100
Wrestling	2	6	2	100
No sports	4	11	—	—

($p = 0.0075$, paired t test). Olecranon spurs were associated with an average preoperative extension restriction of 13 degrees, which improved only to 12 degrees postoperatively.

The median recovery time was 0.3 month for activities of daily living, 1.3 months for strenuous sports participation, and 3 months for maximal improvement. Recovery times did not vary by diagnostic category.

Elbow and arm function was considered improved by 33 patients (94%); two considered it unchanged; and none considered it worsened. Substantial pain decrease was reported by 30 patients (86%), minimal pain decrease by three, and no change in pain by two; none considered their pain to be worse. Knowing the results, all but one of the 35 patients would have the surgery again if needed.

To determine whether there had been late deterioration, the patients were asked to rate their overall elbow status at follow-up as compared with that status 3 months postoperatively. Twenty-three (66%) had additional improvement; one reported worsening; and eleven (31%) reported no subsequent change.

Some form of repetitive stress was identified as causative of preoperative symptoms in 27 of the 35 patients (77%); an acute injury was noted in 8 (23%), including direct trauma sustained in a fall (4), sprain (2), dislocation (1), and a direct blow from a baseball (1). Four patients had sustained both an injury and repetitive stress. No identifiable predisposing factor was identified in 4.

The dominant elbow was involved in 4 of 8 acute injuries (50%) but was the side of involvement in 23 of 26 patients (88%) without acute injury ($p = 0.037$, Fisher's Exact Test). In the 23 patients with repetitive stress as the only predisposing factor, the dominant arm was involved in 21 (91%) ($p = 0.013$, Fisher's Exact Test). One patient was ambidextrous and was excluded from dominance analysis.

Sports participation

Sports participation was determined from both chart review and questionnaire. The predominant sports activities among the 31 athletes were weight lifting and baseball. However, we were unable to assign these patients to a primary sport category because they typically participated in multiple sports and their prolonged symptoms had affected their performance in multiple sports. Twenty-three (66%) of the patients actively participated in a weight-lifting program or lifted weights as their primary sport activity. Twenty (57%) of the patients played baseball, mostly professional or collegiate level; nine were pitchers, and 11 played other positions (Table IV). Thirty-one patients participated in at least one sport that required vigorous use of the upper extremities. After arthroscopic treatment, 26 of the 31 athletes (84%) were able to return to their sporting events and to their level of proficiency in 52 of 60 sporting activities reported.

A return to weight lifting was reported by 83% and a return to baseball pitching by 78%. All baseball players playing other positions were able to return to their sports (see Table IV).

Complications. There were four complications: two chondral abrasions; one broken instrument, which was retrieved arthroscopically; and one suspected superficial infection, which responded promptly to antibiotics. No nerve injuries occurred.

Discussion

This is one of few reports of elbow arthroscopy to provide follow-up averaging more than 1 year. It is encouraging that 97% of the patients were satisfied with the results of elbow arthroscopy and that 84% were able to return to their premorbid sports activities. Both of the two patients who had a relapse of their symptoms were high-performance professional athletes on heavy weight-training programs. One of the two (a profes-

sional football lineman) had a recurrence of loose bodies and spurs 40 months after arthroscopy. He had already had two previous arthrotomies on each elbow for removal of spurs and loose bodies; it was not surprising that spurs and loose bodies again recurred with his continued football playing and weight lifting. He missed less than 1 month of the professional season and had complete resolution of his symptoms after a repeat elbow arthroscopy. The other patient (an avid weight lifter) also had complete resolution of his symptoms after repeat arthroscopy.

A low complication rate was noted, and none of these complications were serious. This low complication rate has been reported previously by others, although occasional serious complications, such as infection or nerve injury, also have been reported.[3, 14] The low complication rate, along with the athletes' early return to sports participation, has enabled arthroscopic procedures to be performed during the season for athletes with disabling pain or other symptoms.

Of particular note was the primary involvement of the dominant-arm elbow, a finding not previously reported. This predisposition was presumably due to repetitive trauma, especially baseball throwing. The only two patients with nondominant arm involvement in the repetitive-stress-only group were heavy-weight lifters, an activity that applies repetitive stress to both elbows. Of the remaining five patients with nondominant elbow problems, four had discrete injuries and only one lacked a history of injury or repetitive stress. Thus, in this series, rarely did an elbow problem arise without a predisposing factor.

Most loose bodies probably arose from impinging spurs that subsequently broke off. This theory is supported by the finding of pedunculated mobile bony fragments on the olecranon tip and margins in 13 patients and the finding of concomitant spurs and loose bodies in 14 patients. The olecranon tip is subjected to repetitive impingement when weight lifters "lock out" the elbow in extension and when baseball throwers reach terminal extension. The olecranon tip was the site of the most severe lesions in this series.

According to the questionnaire responses, loose bodies caused the greatest subjective restriction in range of motion. However, this finding was not substantiated by objective measurements. We were unable to elucidate any other significant differences in the therapuetic results between the different diagnostic groups. Since patients with coexisting diagnoses (both spurs and loose bodies) were excluded from analysis comparing the different diagnostic groups, only relatively small groups were available for comparison. This high degree of diagnostic overlap was presumably due to the common cause of the spurs and loose bodies, as previously mentioned.

The one dissatisfied patient was a 69-year-old man who had moderately advanced degenerative joint disease of the radiocapitellar joint. Failure in this case probably reflects poor patient selection. Arthroscopic debridement of advanced degenerative disease is not recommended, and no synovectomies for diseases of the rheumatologic type were performed in this series.

Purely diagnostic arthroscopy is rarely performed. Arthroscopy is usually performed for known or suspected lesions, and the routine use of diagnostic elbow arthroscopy is discouraged.

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