Acute and Chronic Instability of the Elbow

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Abstract

Elbow instability is not a single entity, but rather a spectrum of injuries, both acute and chronic. While acute instability is usually quite easily diagnosed and treated, in virtually all instances the chronic condition is much more problematic. Nonoperative treatment and early motion are recommended for acute injuries. An associated fracture decreases the likelihood of a good result. A thorough knowledge of the normal and pathologic anatomy, as well as a clear understanding of the osseous and soft-tissue reconstructive options, is essential, particularly for the proper management of recurrent and chronic elbow instability. Even for patients with the latter, however, reasonable treatment options are available.

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Understanding and treating the full spectrum of elbow-dislocation disorders can be demanding because (1) a multiplicity of pathologic conditions are involved, many of which are uncommon; (2) the anatomy is complex; and (3) the biological environment is unforgiving. This review will deal with acute, chronic unreduced, and recurrent instability patterns. Emphasis will be placed on diagnosis and management of the most common entities. Our conceptualization of the spectrum of elbow instability is shown in Table 1.

The components of elbow instability are best considered in light of the relative contribution of the stabilizing elements of the elbow. Unlike many other joints, the elbow is rendered quite stable by virtue of its articular congruence. The ligaments provide roughly 50% of elbow stability.[1] The exact distribution varies between 45% and 55%, depending on the flexion/extension position of the elbow. Most simple instability patterns involve the ligamentous constraints. A rational approach to the management of complex instability must consider both the articular and the soft-tissue contributions.

Acute Ulnohumeral Dislocation

Acute elbow dislocation is a relatively common type of instability. According to the Malmö experience,[2] it is second in frequency only to shoulder dislocation, with an annual incidence of 6 cases per 100,000 persons.

Although the final position of the displaced ulna has been traditionally used as the basis for classification, we prefer a simpler definition, which describes the dislocation as either complete or perched (Fig. 1). A complete dislocation may be either straight posterior or posterolateral with the coronoid posterior to the trochlea. The perched dislocation is a subluxation of the ulnohumeral joint and implies less extensive ligament injury.[3]

Complete Dislocation

Acute complete ulnohumeral dislocation is commonly termed elbow displacement. It is typically caused by a fall on an outstretched hand. The diagnosis is usually suspected at the time of clinical inspection and is readily made on the basis of the radiographic appearance (Fig. 1). It is important to determine whether associated articular injuries are present. These have been variably reported as occurring in 25%[2,4] to 50%[5,6] of patients.

The essential lesion for complete dislocation of the elbow has been described from clinical experience as involving the medial collateral ligament. This is based on the universal presence of medial collateral ligament deficiencies observed with valgus stress, as well as consistent disruption found at the time of surgery.[4,5,7] Residual calcification after complete dislocation appears in the substance of the medial collateral

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Table 1
Classification of Elbow Instability

Acute instability
Dislocation
Complete
Incomplete (perched)
Angular (varus / valgus) instability
Chronic nonreduced dislocation
Recurrent instability
Redislocation
Subluxation
Posterolateral rotatory instability
Varus / valgus instability

ligament in approximately 85% of patients and in the lateral collateral ligament in about 75%.[4]

Incomplete (Perched) Subluxation

We have identified a clinical condition in which the coronoid does not slip behind the trochlea, which we call a perched dislocation. This has been shown experimentally to be possible with disruption of the lateral collateral ligament and maintenance of at least some continuity of the medial collateral ligament.[3] This condition occurs in fewer than 10% of patients with dislocation.

Treatment

Uncomplicated Injuries

An uncomplicated injury is defined as one without an associated fracture. Treatment is immediate reduction. For complete dislocations that are seen before significant muscle spasm or marked swelling, as well as for perched dislocations, reduction may be possible with the use of intravenous sedation. However, if there is a significant amount of swelling or muscle spasm, complete relaxation and either regional or general anesthesia are preferred. The technique consists of longitudinal traction in about 45 degrees of flexion. Pressure may be exerted directly to the olecranon to assist anterior reduction of the coronoid over the trochlea.

After reduction, an estimate of stability is appropriate. This is done by examining the joint through a range of motion to determine whether and at what positions it remains unstable. The elbow is then examined radiographically to ascertain whether there is an associated fracture. The elbow is placed in the position of stability, and motion within the previously defined stable arc is allowed after 5 to 7 days.[8] If the elbow is markedly unstable initially, sufficient flexion is obtained to provide immediate stability. The elbow is brought into extension starting on day 5 to day 7, followed by gradual progression of motion over the next 3 to 4 weeks. For patients younger than 18 years with marked initial instability, immobilization for 2 to 3 weeks is acceptable. If more than 40 to 50 degrees of extension loss is present at 6 weeks and the elbow is judged to be stable, we use a hyperextension brace at night, which the patient can adjust (Fig. 2). The patient is seen every 2 weeks until the contracture has been minimized. About 80% of motion will be attained by 3 months; 90%, by 6 months; and full motion, by 12 months.

Surgical intervention has very little value in the treatment of an uncomplicated dislocation. This has been well demonstrated by a

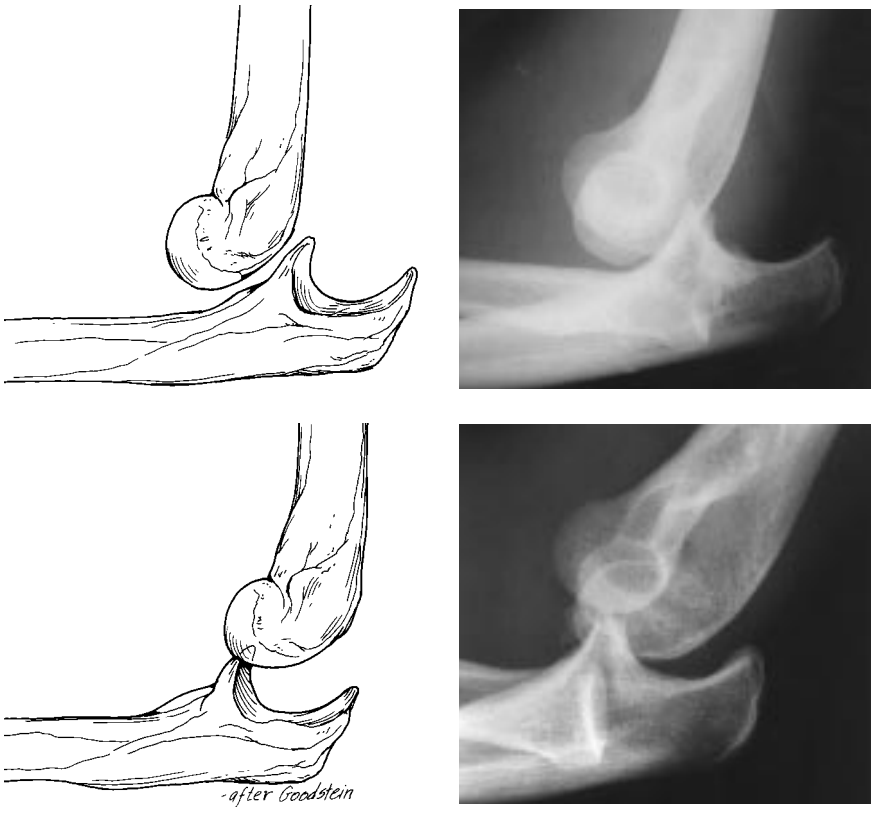

Fig. 1 **Top,** Complete posterior dislocation. **Bottom,** Perched dislocation.

Fig. 2 The hyperextension brace is particularly effective in minimizing flexion contractures.

prospective study by Josefsson et al,[9] in which nonsurgically treated elbows revealed less flexion contracture, averaging approximately 10 degrees at both 2 and 5 years, than surgically treated elbows, in which flexion contracture averaged more than 15 degrees at 2 and 5 years. Josefsson et al also found that 80% of the patients treated with surgical repair of the ligament considered the dislocated elbow "not normal," compared with fewer than 50% of those treated nonoperatively.

Recurrence is uncommon. Linscheid and Wheeler[10] documented a prevalence of residual instability of approximately 2%, and Josefsson et al[9] identified no recurrences in a series of 142 patients treated for dislocations, none of whom described significant elbow discomfort.

Mehlhoff et al[5] critically analyzed function and subjective satisfaction after closed treatment of simple dislocations in 52 patients. They found that 45% of patients had some pain, especially on valgus stress, and 15% lacked more than 30 degrees of extension. These investigators very carefully and accurately documented that residual pain and loss of motion was directly a function of the length of the period of immobilization (Fig. 3).

It is interesting to note that in the study by Josefsson et al,[9] the more severe injuries did not necessarily cause more severe symptoms over the long term. Myositis ossificans is uncommon in uncomplicated dislocations, occurring in fewer than 5% of cases.[2,6,10]

Dislocations With Associated Fractures

A dislocation with an associated fracture is a much more difficult entity to treat, and few detailed studies[11-13] have been done. Broberg and Morrey[11] reported satisfactory outcomes in 80% of 24 patients with dislocations associated with radial head fractures who were followed up an average of 10 years. In that study, no patient with a satisfactory result had been immobilized for more than 4 weeks. Vichard et al[13] reported that 90% of 22 patients had a satisfactory result after treatment of radial head fracture and elbow dislocation. If the radial head fracture was only one of several injuries, the number of patients with satisfactory results decreased to approximately 75%.

In general, the treatment of elbow dislocations with associated fractures consists of reduction of the elbow and management of the fracture on the basis of its individual characteristics, taking care to avoid prolonged immobilization. The recommended treatment for a Mason type I (nondisplaced) radial head fracture is reduction and early motion. Type II radial head fractures (those involving 30% of the articular surface) should be treated with fixation and early motion. In the case of a type III (comminuted) fracture, we recommend complete excision followed by motion as tolerated within the functional arc.[11] We prefer a hinged splint to unload the medial collateral ligament. An olecranon fracture should be treated with either tension-band wiring or, if comminuted, a neutralization plate; in both instances, early motion should be sought.

Regan and Morrey[14] have reported on 12 instances of elbow dislocation associated with a coronoid fracture.

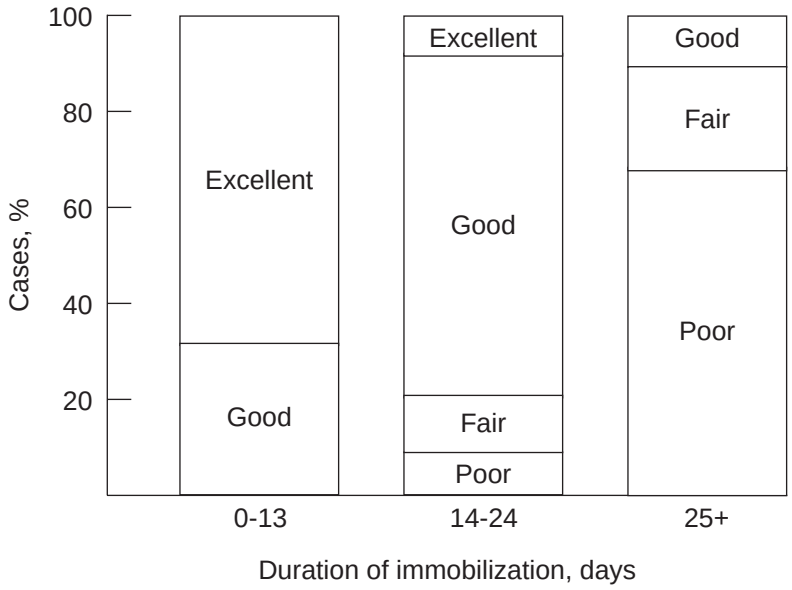

Fig. 3 Results as a function of period of immobilization, demonstrating the value of early motion. (Adapted with permission from Mehlhoff TL, Noble PC, Bennett JB, et al: Simple dislocation of the elbow in the adult: Results after closed treatment. *J Bone Joint Surg Am* 1988;70:244-249.)

The results of treatment were satisfactory in 75% of cases in which the fracture fragment was small (type I) and in 50% of cases of type II fractures (those involving 50% of the process), but in only 1 of the 5 (20%) cases of complete (type III) coronoid fracture.

In another study,[12] 32 of the 105 patients (approximately 30%) had injuries of the proximal ulna of varying severity. Of these 32 patients, 24 (75%) had a satisfactory result.

Fractures of the coronoid are the most difficult of the fracture-dislocations to treat because compromise of stability is referable to both the ligaments and the articular surface in type II or type III fractures. The treatment goals are mobility and stability. We use one of the several commercially available distraction joint devices to treat type II and type III fractures (Fig. 4). The use of such a device in treating unstable fracture-dislocations of the elbow has been recently reported to provide a satisfactory result in six of seven patients (86%) followed up for a mean of 3 years.[15]

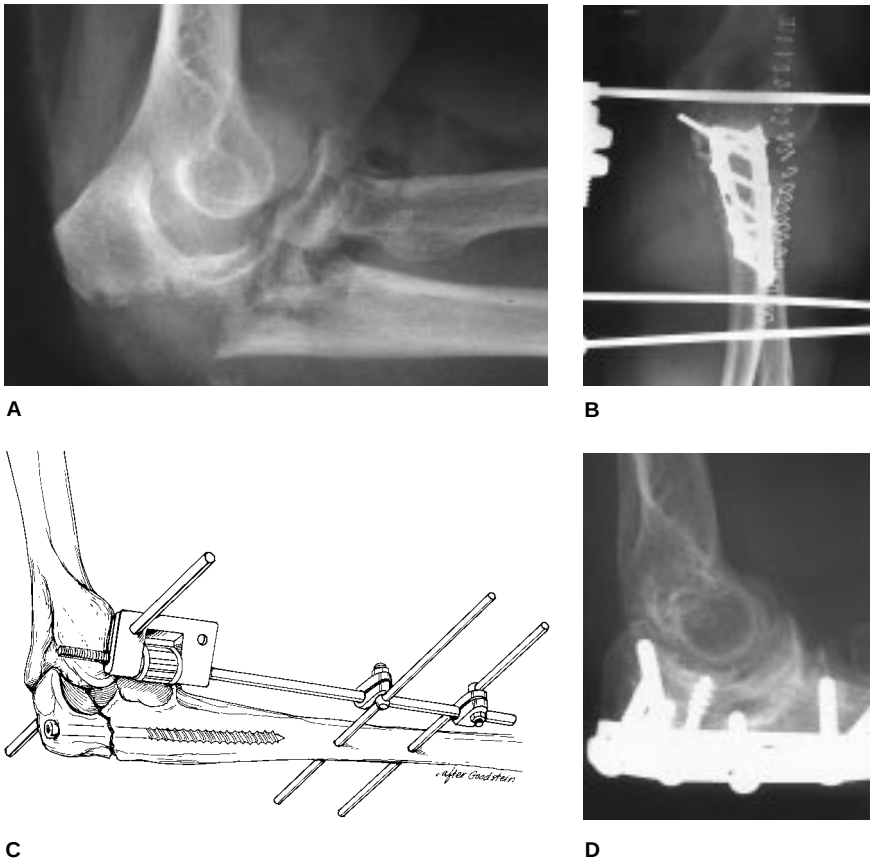

Fig. 4 **A,** Fracture-dislocation of the elbow involving the coronoid and olecranon. **B** and **C,** The elbow was stabilized with plates, a transfixing pin in the distal humerus and the application of a distraction device. **D,** Satisfactory result after the fracture had healed and the device was removed. (Parts **A, B,** and **D** reproduced with permission from Cobb TK, Morrey BF: Use of distraction arthroplasty in unstable fracture dislocations of the elbow. *Clin Orthop* 1995;312-201-210.)

Overview of Treatment Recommendations

The treatment of an elbow dislocation is reduction and early motion. If there is residual instability in an uncomplicated dislocation, an arc of motion in the stable range is allowed beginning 5 to 7 days after injury and continued for about 1 week, with gradual resumption of flexion and extension over the next 3 to 4 weeks. A residual or impending flexion contracture is treated with a hyperextension splint. A fracture-dislocation is treated with reduction, with the fracture being treated according to its individual characteristics. Improved techniques to fix small fragments of the radial head, stabilize proximal ulnar fractures with plates, and preserve motion with the use of a distraction device have all been used effectively in the past several years. The most important principle is to avoid prolonged immobilization.

Acute Varus/Valgus Angular Instability

An acute angular injury tears the medial collateral ligament or the lateral collateral ligament, causing varus or valgus instability but without complete dislocation. Such injuries are uncommon.

Medial Collateral Ligament Tears

An acute tear of the medial collateral ligament is the most frequent isolated ligamentous injury of the elbow. Originally described in javelin throwers, this is now almost always seen in throwing athletes (typically baseball pitchers).[16]

The patient may complain of acute or chronic pain along the medial aspect of the elbow. This is associated with a valgus stress to the joint, which most commonly occurs at the time of delivering a pitch in baseball or another throwing activity. Improper technique resulting in a valgus overload has been implicated as the major cause.[17]

The diagnosis is suspected on the basis of the history and the mecha-

nism of injury. Ecchymosis may be present. Local tenderness just inferior to the medial epicondyle, especially over the anterior band of the medial collateral ligament, is a constant finding.

We perform the varus/valgus instability tests with the elbow in approximately 10 degrees of flexion in order to relax the anterior capsule and remove the coronoid and olecranon from their respective fossae. Jobe recommends flexing the elbow 25 degrees.[17] The humerus is internally rotated for the valgus test and externally rotated for the varus test (Fig. 5) in order to minimize the humeral rotation. If there is any question, we prefer to perform this examination with the elbow completely relaxed. Local anesthesia may be necessary in the acute setting. With Jobe's examination technique,[17] the patient's hand is placed between the examiner's elbow and hip or in the axilla (Fig. 6). With the patient's arm abducted and externally rotated, palpation of the anterior band of the medial collateral ligament with valgus stress will demonstrate laxity or elicit pain.

Fig. 5 Medial collateral ligament deficiency demonstrated with valgus stress.

Plain films should be taken to assess the possibility of fracture. Fluoroscopy is also useful to ensure that accurate anteroposterior views have been obtained without rotatory distortion. Stress views are helpful if there is any question about the diagnosis. We see little value in arthrography, magnetic resonance imaging, or arthroscopy in the acute setting.

Acute injury of the medial collateral ligament is managed by immobilization for approximately 3 weeks. This is followed by allowing flexion and extension in a hinged splint that is molded into slightly varus angulation with the forearm in supination for about 4 weeks. At 8 weeks, flexion and extension are allowed without restriction, but valgus load is avoided. It is uncommon to develop a significant flexion contracture after this injury.

Although repair of the medial collateral ligament has been recommended and reported,[18] we believe it is of questionable value in the noncompetitive, nonathletic patient. This ligament is known to heal very soundly after elbow dislocation or after an acute tear from valgus stress.[19] In patients with high-demand activities, such as competitive pitchers, however, immediate repair or reconstruction is appropriate. The surgical management of medial collateral ligament injuries will be discussed in the section on recurrent subluxation.

Lateral Collateral Ligament Instability

This is a very infrequent acute isolated instability pattern, because a pure varus stress to the elbow is not commonly generated from routine activities. The diagnosis is made after a history of acute varus stress associated with point tenderness and varus instability on physical examination (Fig. 7).

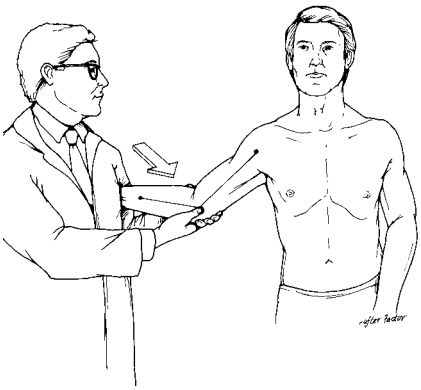

Fig. 6 Jobe technique for eliciting evidence of medial collateral ligament insufficiency.

Nonoperative management is similar to that described for medial collateral ligament tears. Complete immobilization for approximately 3 weeks, but with the forearm pronated rather than supinated, provides the best stability and chance for healing. This is followed by use of a removable hinged splint for an additional 4 weeks, again with the forearm in pronation. Protection for a total of 3 months is provided because the lateral collateral ligament is the ligament that most often displays residual laxity. The rotatory instability pattern is not well protected by the congruity of the ulnohumeral joint, unlike the situation with a medial collateral ligament injury.

Chronic Nonreduced Elbow Dislocation

This injury is not commonly seen, except in Third World countries. It is most typically observed in association with fractures that render the elbow unstable. This chronic instability pattern poses a most difficult

Fig. 7 Lateral collateral ligament insufficiency demonstrated with varus stress.

problem, because both the articular and the soft-tissue constraints have been violated.

The chronic unreduced elbow usually occurs in younger patients. In one series,[20] the mean age at the time of injury was 12 years. In the younger age group, the occurrence in boys greatly exceeds that in girls.

Etiology and Pathology

The cause of residual or chronic dislocation is a simple or, more commonly, complex elbow dislocation that either has never been reduced or, more typically, has redislocated without the knowledge of the patient or the physician.

The pathologic changes seen at surgery may consist of a shortened triceps, marked scarring about the anterior and posterior capsule, and attenuation of at least one of the two collateral ligaments, often with contracture of the other ligament (usually the medial collateral ligament). The articular surface may be surprisingly normal.[20,21]

Presentation

Not all patients with chronic unreduced elbow dislocations are dysfunctional.[20,21] Approximately 20% in the study by Fowles et al[20] had an arc of motion between 30 and 130 degrees without significant pain. An equal percentage, however, complained of marked rigidity. Ulnar nerve symptoms are reported in about 15% of cases,[20,21] and some form of ectopic bone is present in 20%[21] to 40%.[20] An associated fracture of the radial head or epicondyle is common and may contribute to the often-unrecognized recurrent instability.

Treatment

While it has been recommended that this lesion should be left alone, current practice suggests that if a patient has a functional but painful arc of motion, open reduction is indicated. Closed reduction is rarely successful.

Technique

We recommend a posterior skin incision. Kocher's interval between the anconeus and the extensor carpi ulnaris is identified, and the joint is entered from the lateral aspect of the triceps mechanism. The lateral collateral ligament is assessed and is typically released from the humerus. The contracted posterior capsule is released, and the anterior capsule is exposed and released. The elbow is then reduced and placed through an arc of motion. If there is a medial collateral ligament contracture, this is stretched or lysed with the flexion and extension maneuver. The lateral collateral ligament is attached to the lateral epicondyle through holes placed in bone, and a distraction device is then applied (Fig. 8).

Associated Fractures

An associated fracture is treated according to its individual characteristics, with the objective of attaining open reduction and internal fixation if possible. If there are chronically displaced fragments, the status must be reassessed, because they will never fit well anatomically. If the fractured portion provides a functional element of stability, it is preserved. If the radial head has been distorted and does not articulate with the capitellum, it is removed, and stability is obtained and maintained with a fixator until the periarticular reconstruction can heal. If there is any question regarding the radial head, we tend to leave it intact and perform a resection later, if necessary.

It should be remembered that the radial head provides little stability when the medial collateral ligament is intact, but is most important as a stabilizer of the medial collateral ligament–deficient joint.[22] Reconstruction of the medial collateral ligament is not typically necessary unless it has been replaced by ectopic bone. If this is the case, resection of the ectopic bone necessitates reconstruction of the soft-tissue structures and application of a distraction device, as previously described.

Results

Satisfactory results, defined as attainment of an arc of motion averaging approximately 60 to 115 degrees and a forearm rotational arc of about 90 degrees, may be anticipated in 70% of patients who undergo late reduction.[20,21,23] Potential complications of surgery include nerve injury and the development of ectopic bone, both of which occur in approximately 10% of patients. One of the most bothersome complications is infection, which has been reported to develop in as many as 10% of patients. In

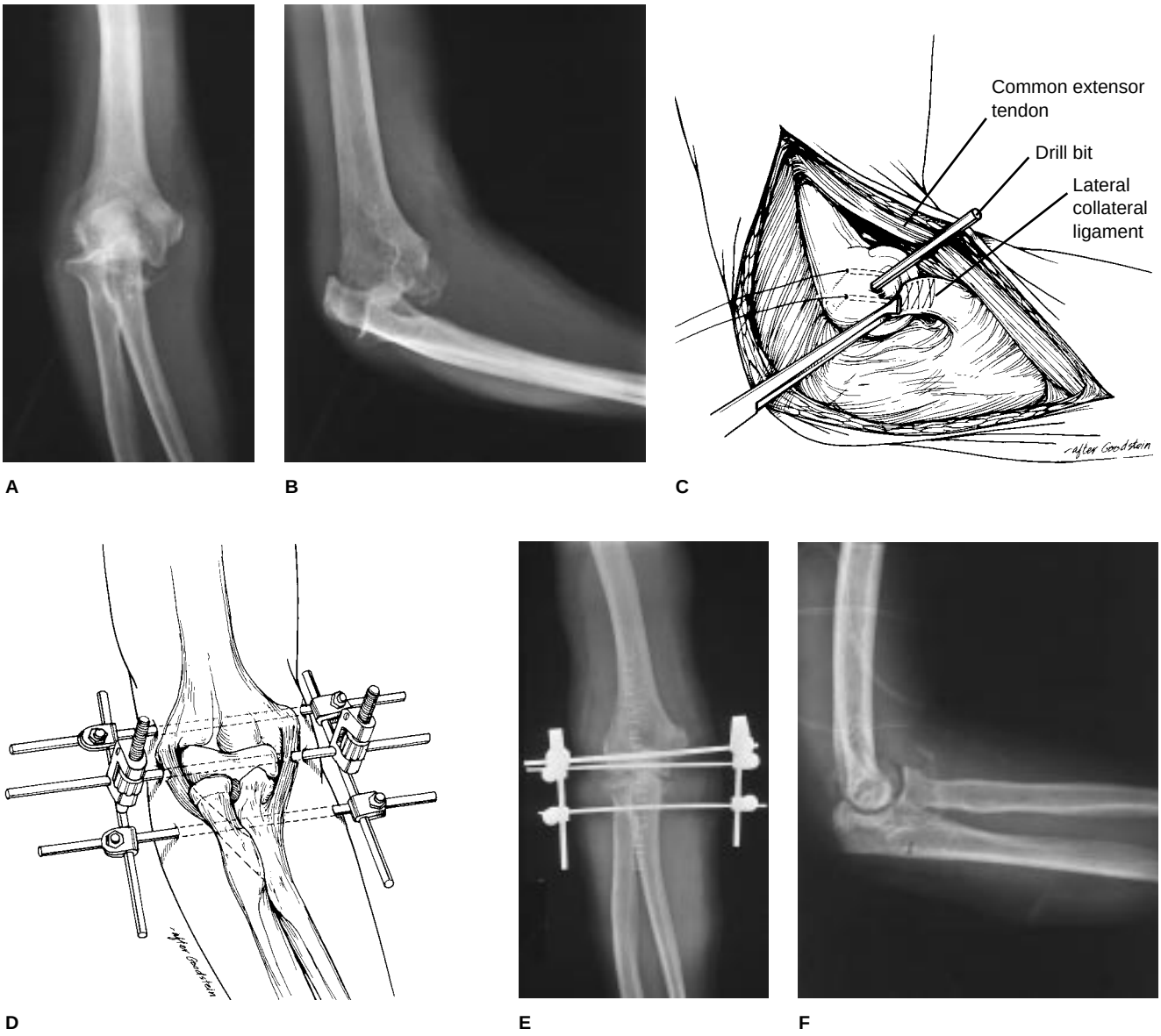

Fig. 8 **A** and **B,** Radiographs depict chronic nonreduced dislocation of the elbow with coronoid fracture. Repair begins with entry at Kocher's interval and reflection of the extensor mechanism. **C,** Relocation of the joint and repair of the medial and lateral collateral ligaments. **D** and **E,** Application of the distraction device. **F,** Successful outcome.

our experience, this has been particularly true after extensive dissection for the removal of ectopic bone in patients who have undergone radiation therapy. Given the formidable incidence and significance of complications and the fact that some patients will have deformity but reasonably functional extremities, careful discussion with the patient is necessary before making the decision to embark on this demanding surgical procedure.

Recurrent Dislocation

Redislocation of the ulnohumeral joint is uncommon. The results of a 100-year review of the orthopaedic literature published in 1981 disclosed only 63 documented cases.[24] Approximately 85% of affected persons are male, and the initial dislocation typically occurs before the age of 15. Loose bodies are present in up to 15% of patients, and a nonunited fracture of the lateral epicondyle is present in as many as 25%.

The pathologic basis of the condition has been analyzed experimentally by O'Driscoll et al,[25] who concluded that deficiency of the lateral collateral ligament is the most common cause of recurrent instability. This has been substantiated by clinical observations that reconstruction of the lateral ligament complex with a strip of triceps muscle[26] or reconstruction of the lateral collateral ligament itself[27,28] offers reliable success rates.

Chronic dislocation is most commonly treated with reconstruction of the lateral collateral ligament, which will be discussed in the section on recurrent subluxation.[25,29] In spite of its documented contribution to joint instability,[30] the medial collateral ligament is almost always intact in this condition. Bone-block augmentation of the coronoid is currently considered unnecessary unless the coronoid is absent due to resection or a type III fracture.

Recurrent Subluxation

Lateral Deficiency

Recurrent lateral instability is best considered as posterolateral rotatory instability. O'Driscoll et al[25] have identified deficiency of the lateral ulnar collateral ligament as the essential pathologic lesion, which most commonly occurs as a residuum of acute dislocation or an iatrogenic complication of tennis elbow release that has violated the lateral collateral ligament construct.

Diagnosis

The diagnosis is made on the basis of a history of elbow dislocation followed by the patient's becoming aware of a pop, catch, or "clunk" as the elbow goes from flexion to extension or, more commonly, from full extension to flexion. In some instances of collateral ligament deficiency, pain over the lateral aspect of the joint is a more dominant feature than frank or perceived instability. In infrequent instances, the patient may be able to demonstrate instability patterns.[16] The laxity is usually more subtle, however, this condition being the most subtle disorder in the instability spectrum. The patient may complain of pain in the posterolateral aspect of the elbow, but a varus stress test is often negative unless gross instability is present.

The posterolateral rotatory-instability test described by O'Driscoll et al[25] has been most reliable in our experience for suggesting or demonstrating this pathologic lesion. This is performed with the patient supine (Fig. 9). A valgus stress with axial load is administered with the elbow in full supination. With the elbow in the extended position, a dimple is demonstrated laterally, and the radial head becomes prominent. In some instances, the patient simply notices pain with this maneuver without demonstrable pivot; this is reported as "positive for pain" and is highly suggestive of the presence of the lesion.

Treatment

Reconstruction of the lateral ulnar collateral ligament is the treatment of choice. The patient is placed supine, and Kocher's interval is entered (Fig. 10). The anconeus muscle is reflected posteriorly, allowing identification of the crista supinatoris. The lateral collateral ligament complex is identified laterally. Two 3- to 4-mm drill holes are placed at the base of the tubercle of the crista supinatoris approximately 7 to 10 mm apart. A suture is placed through this tunnel, and the isometric point (typically in the midportion of the lateral epicondyle) is identified precisely with a hemostat. A drill hole is then placed at this point, and a tunnel is made in the lateral column, exiting both anterior and posterior to the crest of the lateral column.

The palmaris longus tendon is harvested if it is present; otherwise, the plantaris tendon is used. This is passed through the ulnar tunnel first and is sutured to itself

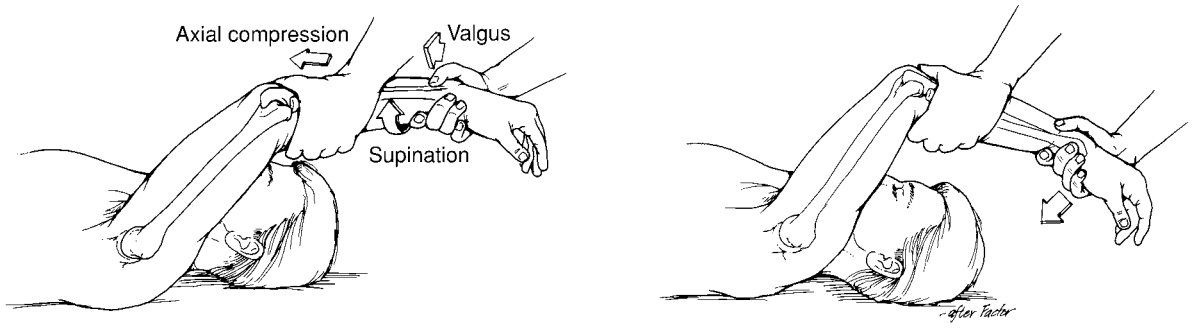

Fig. 9 The posterolateral rotatory-instability test will demonstrate deficiency of the lateral ulnar collateral ligament. **Left,** Subluxation. **Right,** Flexion-reduction.

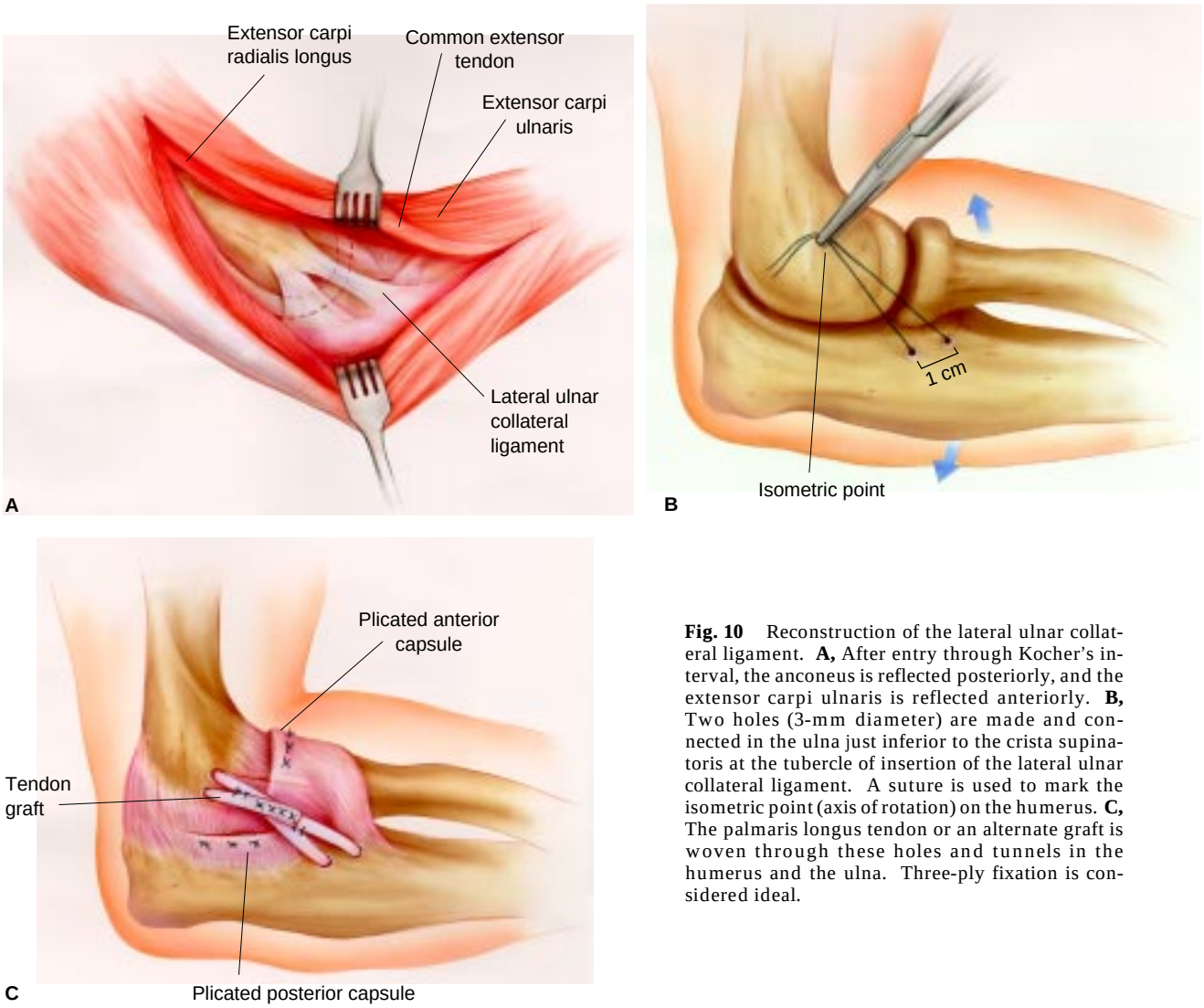

Fig. 10 Reconstruction of the lateral ulnar collateral ligament. **A,** After entry through Kocher's interval, the anconeus is reflected posteriorly, and the extensor carpi ulnaris is reflected anteriorly. **B,** Two holes (3-mm diameter) are made and connected in the ulna just inferior to the crista supinatoris at the tubercle of insertion of the lateral ulnar collateral ligament. A suture is used to mark the isometric point (axis of rotation) on the humerus. **C,** The palmaris longus tendon or an alternate graft is woven through these holes and tunnels in the humerus and the ulna. Three-ply fixation is considered ideal.

at a length that allows the short free end to enter the humeral canal. The free end is passed first through the anterior opening and then the posterior opening of the humeral tunnel and back through the isometric point and is finally sutured to itself. The goal is to have three plies of graft crossing the joint. With the elbow in approximately 30 degrees of flexion, the tendon graft is tightened and securely sutured to itself. Additional tightening may be obtained by closing the distal portion of the initial V-shaped graft.

Postoperative care consists of immobilization for approximately 2 weeks, followed by protection in a hinge splint for an additional 4 to 6 weeks (similar to the protective treatment of the acute injury). Thereafter, the patient is allowed the use of the extremity, but varus stress is avoided for 4 to 6 months.

Experience with reconstructing the lateral collateral ligament with a strip of triceps muscle or otherwise stabilizing the lateral column has been well documented as treatment for recurrent elbow instability.[12,27,28] Nestor et al[29] have reported the experience at the Mayo Clinic with this reconstruction for recurrent posterolateral rotatory instability. If no other injuries were present, approximately 90% of treated elbows were rendered stable. If there were significant degenerative changes, the likelihood of a satisfactory result decreased to approximately 50% (although stability was achieved).

Medial Collateral Ligament Insufficiency

Diagnosis

In the chronic condition, the patient may have no evidence of frank medial instability but will notice pain at the medial aspect of the elbow with stress, as occurs with throwing. In the competitive thrower, this is noticed with a sustained effort of greater than 75% of full potential. Pain on palpation of the anterior bundle of the medial collateral ligament is diagnostic of this lesion.

We examine the patient by placing the hand between the hip and the examiner's elbow and imparting a valgus stress. The reproduction of pain or palpable instability is diagnostic. Preoperative ulnar nerve symptoms are present in as many as 40% of patients.[16]

We use a fluoroscopically centered anteroposterior view of the distal humerus obtained while exerting a valgus stress to the elbow to confirm the diagnosis. If there is an additional 3 mm of laxity compared with the varus stress view, obtained with the elbow in approximately 10 degrees of flexion, the study is considered abnormal. Stress views are positive in about 75% of cases.

Arthrography and magnetic resonance imaging are of variable value, and we do not use them. About 40% of such studies will demonstrate some calcification of the anterior bundle of the medial collateral ligament. Associated injuries of the proximal pronator group may be seen in an additional 10% of cases.

Treatment

In cases of recurrent medial collateral ligament insufficiency, the reconstructive procedure described by Jobe is performed.[17] The patient is placed supine with the arm on an arm board or brought over the chest. The medial epicondyle is exposed with an incision 4 cm proximal and 5 cm distal to the epicondyle. Care is taken to avoid the medial antebrachial cutaneous nerve branches. The ulnar nerve is identified but is not translocated. The flexor pronator group is split, and the anterior portion is released from the medial epicondyle. This exposes the capsule and the anterior bundle of the medial collateral ligament. The latter inserts on a ridge of the ulna, which is identified by a tubercle at the base of the coronoid.

The soft tissue is then stripped, allowing exposure of the crest of bone. A tunnel is created across this ridge approximately 1 cm from the joint, and a suture is placed through this tunnel. The isometric point is identified with a hemostat by placing the tip at the medial epicondyle while moving the elbow in flexion and extension. The medial epicondyle is entered at the midpoint between its base and its tip, and a tunnel is created proximal to the medial epicondyle. This tunnel is joined by two additional tunnels, entering from the anterior aspect of the medial column. In this way, the ulnar nerve is not violated and, in fact, does not need to be exposed other than to observe and protect.

A palmaris longus graft or the plantaris tendon is then harvested. This is placed through the tunnel and sutured onto itself at a length that allows the short end to enter the medial epicondyle tunnel. The long free end is passed into the osseous tunnel and brought out through the proximal anterior hole. The graft is then placed through the distal anterior hole and brought back down through the isometric point. The free tendon is drawn across the joint and is sutured onto the ligamentous graft (Fig. 11). The elbow is placed in varus angulation, and all slack is taken out of the graft. The wide V-shaped portion is closed, providing at least three plies across the elbow joint. Capsular tissue remains between the reconstruction and the joint. The flexor pronator group is reattached, and the ulnar nerve is inspected to ensure that there is no tendency toward subluxation.

The elbow is immobilized in supination and 90 degrees of flexion for approximately 2 weeks. Flexion and extension are protected with a hinge splint for an additional 4 weeks, after which valgus stress is avoided, but flexion and extension are allowed. The detailed rehabilitation has been described by Jobe et al.[17]

A detailed analysis of the results of this reconstruction has been carried out by Conway et al.[16] In a series of 67 repairs and reconstructions, satisfactory results were analyzed according to whether prior surgery had been performed, whether reconstruction or repair was performed, and whether the symptoms were of gradual or sudden onset. Approximately 85% of patients who had not undergone prior surgery had satisfactory results, compared with 55% who had undergone prior surgery. Even more telling is the fact that 74% of the patients who had not undergone a prior procedure had excellent results, compared with 33% of those who had undergone an unsuccessful procedure. There was no difference in the rate of satisfactory results between reconstruction and repair, although there were approximately 20% more cases in which there was an excellent result after reconstruction. While the rate of satisfactory results was the same regardless of whether the onset of symptoms was sudden or gradual,

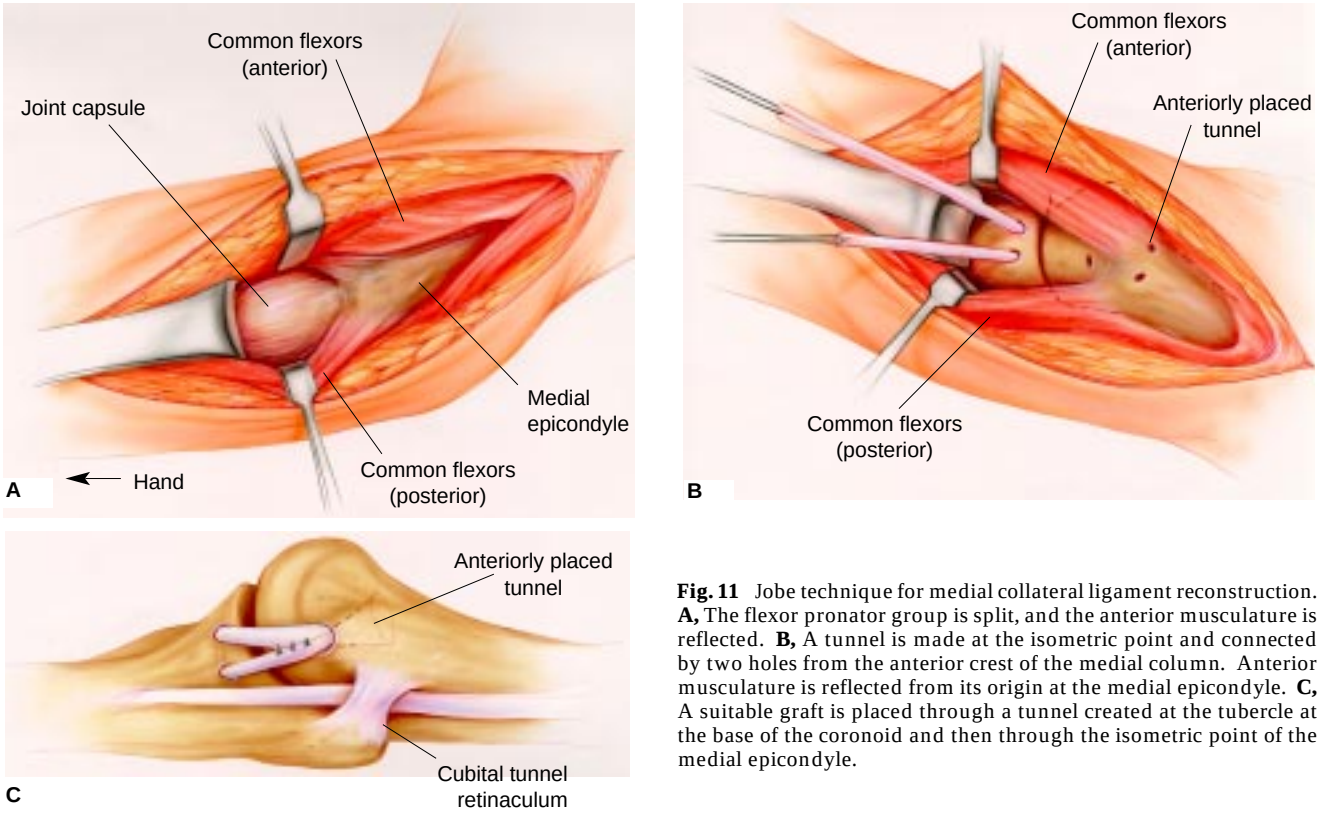

Fig. 11 Jobe technique for medial collateral ligament reconstruction. **A,** The flexor pronator group is split, and the anterior musculature is reflected. **B,** A tunnel is made at the isometric point and connected by two holes from the anterior crest of the medial column. Anterior musculature is reflected from its origin at the medial epicondyle. **C,** A suitable graft is placed through a tunnel created at the tubercle at the base of the coronoid and then through the isometric point of the medial epicondyle.

approximately 75% of patients with a sudden onset had an excellent result, compared with 60% of those with a gradual onset.

Kuroda and Sakamaki[19] reported an 11-year experience with 13 patients, 10 of whom underwent surgical repair. Only 1 patient had ulnar nerve symptoms after surgery. The patients' ages ranged from 7 to 43 years, and the follow-up periods ranged from 2 to 8 years. All who underwent repair were considered to have had a satisfactory outcome.

Summary

The diagnosis and treatment of elbow dislocations are challenging because of the variety of pathologic conditions that may be present and the exacting physiologic requirements that must be satisfied. The various types of elbow instability are best considered in light of the relative contributions of the stabilizing elements of the elbow. A rational approach to the management of complex instability recognizes both the articular and the soft-tissue contributions.

The treatment of an acute elbow dislocation is reduction and early motion. If there is residual instability in an uncomplicated dislocation, an arc of motion in the stable range is allowed beginning 5 to 7 days after injury and continued for about 1 week, with gradual resumption of flexion and extension over the next 3 to 4 weeks. Residual or impending flexion contracture is treated with a hyperextension splint. Fracture-dislocations are treated with reduction, with the fracture being treated according to its particular characteristics. Improved techniques to fix small fragments of the radial head, stabilize proximal ulnar fractures with plates, and preserve motion with the use of a distraction device have all been used effectively in the past several years. The most important principle is to avoid prolonged immobilization.

Acute tears of the medial and lateral collateral ligaments are uncommon and are generally treated nonoperatively. Chronic nonreduced elbow dislocation, which is rarely seen except in Third World countries, should generally be treated with open reduction. Chronic recurrent instability is most commonly treated with lateral collateral ligament reconstruction.

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