ELBOW INSTABILITY

S. W. M. O'DRISCOLL

An understanding of elbow instability is predicated on knowledge of the anatomy of the lateral collateral ligament complex and of the mechanism and kinematics of elbow subluxation and dislocation. The lateral collateral ligament complex is the key structure involved in recurrent elbow instability and it is virtually always disrupted in elbow dislocations that result from a fall. The *ulnar part* of the lateral collateral ligament complex (also known as lateral ulnar collateral ligament) is the critical portion of the ligament complex securing the ulna to the humerus and preventing posterolateral rotatory instability. The kinematics of elbow subluxation and dislocation are a three dimensional coupled motion referred to as posterolateral rotatory instability in which the forearm rotates off the humerus in valgus/external rotation during flexion from the extended position. Elbow instabiliy is diagnosed on clinical examination by the lateral pivot-shift test, the posterolateral rotatory apprehension and drawer tests and on radiographic examination by performing stress xrays. While the lateral pivot-shift test is difficult to perform, the posterolateral rotatory drawer test is much less difficult. The most sensitive test, however, is the posterolateral rotatory apprehension test. A positive apprehension test in a patient presenting with a history of recurrent painful clicking, snapping, clucking, or locking of the elbow should lead one directly to the suspected diagnosis of posterolateral rotatory instability. Treatment is surgical, by repair or reconstruction of the lateral collateral ligament complex, specifically the ulnar part. Deficiencies of the coronoid and/or radial head must be addressed.

Keywords : elbow ; instability ; dislocation ; ligament ; coronoid ; radial head.
Mots-clés : coude ; instabilité ; luxation ; ligament ; coronoïde ; tête radiale.

ELBOW INSTABILITY

Etiology

It had been traditionally taught that the mechanism of elbow dislocation is hyperextension, but this is not likely correct, and is not substantiated by data (32). Elbow dislocations or subluxations typically occur as a result of falls on the outstretched hand (21, 28). As the body approaches the ground, the elbow extends to place the hand on the ground. Upon contact, the elbow immediately begins flexing. This causes eccentric loading of the triceps, principally the medial head, which produces an external rotation moment at the ulnohumeral joint. Contraction of the adductors and internal rotators of the abducted shoulder internally rotate the humerus against the forearm and hand, which are stabilized by the ground. Further internal rotation torque develops as the body rotates internally with respect to the hand (i.e. forearm rotates externally on the humerus). A valgus moment results from the fact that the mechanical axis is medial to the elbow. This combination of supination or external rotation torque, along with valgus and axial compression during flexion is precisely the mechanism that results in a posterolateral rotatory subluxation or dislocation of the elbow (fig. 1A) and can be

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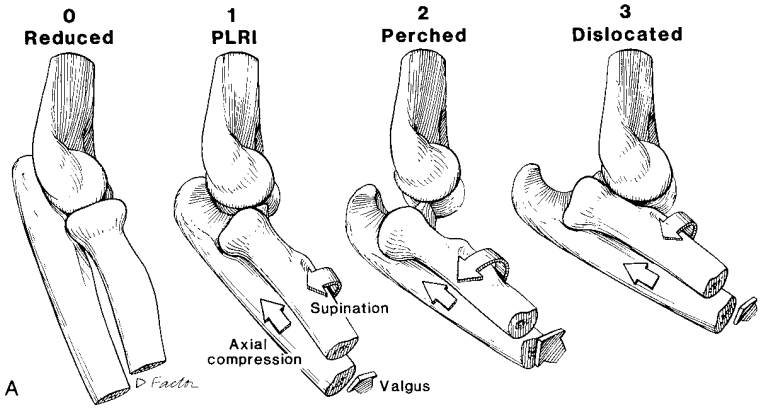


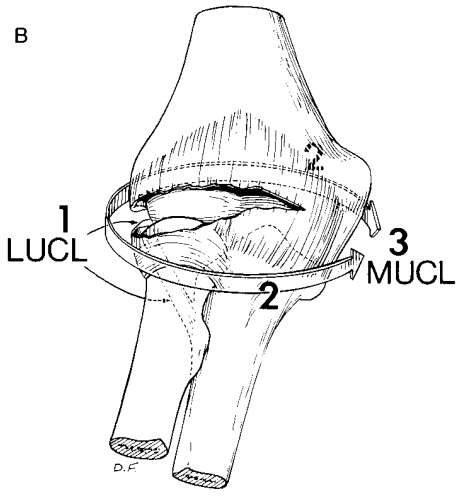


Fig. 1A,B. — **(A).** Elbow instability is a spectrum from subluxation to dislocation. The three stages illustrated here correspond with the pathoanatomic stages of capsulo-ligamentous disruption in figure 1B. Forces and moments responsible for displacements are illustrated. (From O'Driscoll S. W., Morrey B. F., Korinek S. and An K. N. Elbow subluxation and dislocation. Clin. Orthop., 1992, 280, 195 ; with permission). **(B).** Soft tissue injury progresses in a "circle" from lateral to medial in three stages correlating with those in figure 1A. In stage 1, the ulnar part of the lateral collateral ligament, the *lateral ulnar collateral ligament* (LUCL), is disrupted. In stage 2 the other lateral ligamentous structures and the anterior and posterior capsule are disrupted. Stage 3, disruption of the medial ulnar collateral ligament (MUCL) can be partial with disruption of the posterior MUCL only (3A), or complete (3B). The common extensor and flexor origins are often disrupted as well. (From O'Driscoll S. W., Morrey B. F., Korinek S. and An K. N. Elbow subluxation and dislocation. Clin. Orthop., 1992, 280, 194 ; with permission).

reproduced clinically by what is referred to as the "*lateral pivot shift test*" (24), which is described below. This clinical mechanism has been confirmed by video analysis of a college wrestler during an actual elbow dislocation.

The pathoanatomy can be thought of as a circle of soft tissue and/or bone disruption from lateral to medial in three stages (fig. 1B). In Stage 1 the lateral collateral ligament is partially or completely disrupted (the ulnar part is disrupted). This results in posterolateral rotatory subluxation of the elbow, which reduces spontaneously (fig. 1A). With further disruption anteriorly and posteriorly, the elbow in Stage 2 instability is capable of an incomplete posterolateral dislocation in which the concave medial edge of the ulna rests on the trochlea. In this situation the lateral xray gives one the impression of the coronoid being *perched* on the trochlea. This can readily be reduced with minimal force or by the patient manipulating the elbow him/herself. Stage 3 is subdivided into 3 parts. In Stage 3A all the soft tissues are disrupted around to and including the posterior part of the medial collateral ligament, leaving the important anterior band intact. This permits posterior dislocation by the previously described posterolateral rotatory mechanism. The elbow pivots around on the intact anterior band of the medial collateral ligament (MCL). Reduction is accomplished by gentle manipulation of the elbow in supination and valgus, temporarily recreating the deformity. During valgus testing, the intact AMCL provides valgus stability provided that the elbow is kept

in pronation to prevent posterolateral rotatory subluxation. This stage of instability is most commonly seen in the presence of radial head and coronoid fractures. In Stage 3B the entire medial collateral complex is disrupted. Varus, valgus and rotatory instability are present following reduction. In Stage 3C the entire distal humerus is stripped of soft tissues. This produces severe instability such that the elbow will dislocate or subluxate even in a cast at 90° of flexion. Reduction can be maintained usually only by flexing the elbow past 90-110°. The flexor/pronator muscle origin, which is an important secondary stabilizer of the elbow is disrupted in stage 3C. These pathoanatomic stages all correlate with clinical degrees of elbow instability. Most commonly, elbow dislocations involve disruption of both the medial and lateral collateral ligaments (13, 14, 16).

Thus, dislocation is the final of three sequential stages of elbow instability resulting from posterolateral ulno-humeral rotatory subluxation, with soft tissue disruption progressing from lateral to medial. In each stage, the pathoanatomy correlates with the pattern and degree of instability. This has been confirmed in a cadaver study which showed that 12 of 13 elbows could be dislocated posteriorly with the anterior medial collateral ligament (AMCL) intact.

This circle of disruption is referred to as the "Horii circle" and is analogous to the Mayfield spiral of soft tissue and/or bony disruption in carpal instability (fig. 1B). As disruption progresses from lateral to medial it may pass through the soft tissues and/or bone, i.e. the capsule is normally torn but may be intact if the coronoid is fractured. Similarly, the anterior bundle of the MCL is often intact when the radial head and coronoid are both fractured.

This explains the spectrum of instability, which progresses from posterolateral rotatory instability, to perched dislocation, to posterior dislocation with disruption of the AMCL (and eventually the common flexor/pronator origin) that occurs with further posterior displacement. Such a posterolateral rotatory mechanism for dislocation would be compatible with those suggested in the 1960's by Osborne and Cotterill and Roberts (29, 31).

Recurrent posterolateral rotatory instability usually is posttraumatic due to inadequate soft tissue healing following an elbow subluxation, dislocation, or fracture-dislocation. It can be iatrogenic (24), and is caused by violation of the lateral collateral ligament complex during release for tennis elbow. It can also result from chronic soft tissue overload in patients with longstanding cubitus varus deformity from childhood supracondylar malunions (1). It may also be seen in patients who bear weight on the upper extremities (paralysis due to polio, paraplegia, etc) and in those with connective tissue disorders such as Ehlers-Danlos syndrome.

CONSTRAINTS TO ELBOW INSTABILITY

The elbow has both static and dynamic constraints. There are three primary static constraints to elbow instability : the ulnohumeral articulation, the medial collateral ligament (MCL), and the lateral collateral ligament (LCL), especially the ulnar part of the LCL (also referred to as the *lateral* ulnar collateral ligament). The secondary static constraints include the radial head, common flexor and extensor origins, and the capsule. Dynamic stabilizers include the muscles that cross the elbow joint and produce compressive forces at the articulation. The anconeus, triceps and brachialis are the most important in this regard. Originating near the lateral epicondyle and inserting broadly on the ulna in a fan shape, the anconeus is perfectly designed to serve its major function as a dynamic stabilizer preventing posterolateral rotational displacement of the elbow. A word of caution — the nerve to the anconeus, which enters the muscle proximally, is divided with the traditional olecranon osteotomy for distal humeral fractures.

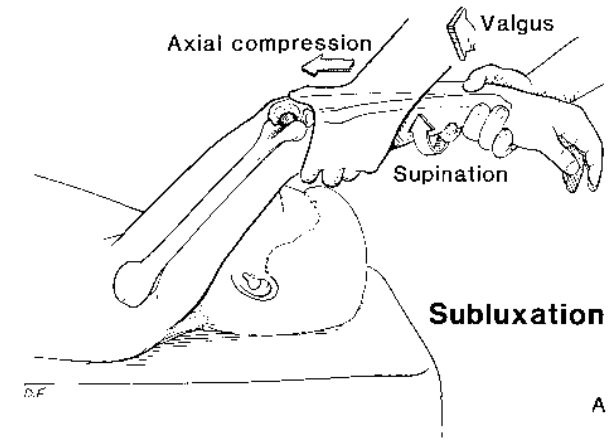
An elbow with its three primary constraints intact will be stable. If the coronoid is fractured or lost, the radial head becomes a critical stabilizer. The radial head must not be removed from dislocated elbows in which the coronoid is fractured, unless the coronoid and ligaments can be securely fixed. This is discussed more in the chapter on fractures of the proximal ulna.

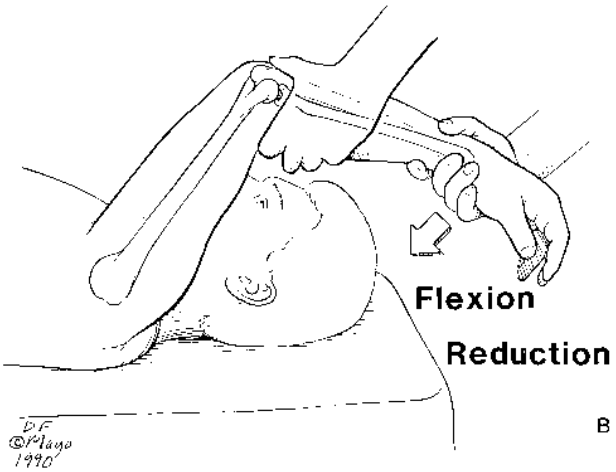
CLASSIFICATION OF ELBOW INSTABILITY

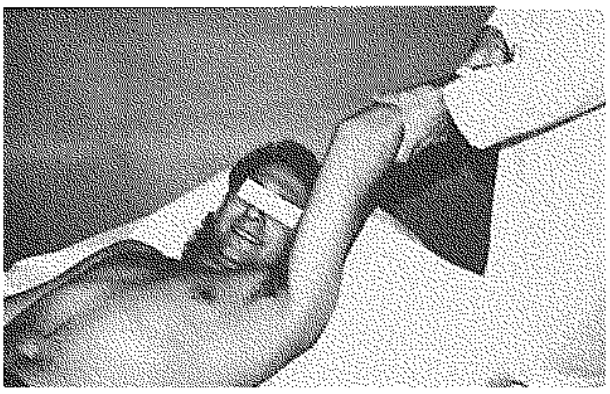
Elbow instability can be classified into different types according to five criteria : (i) the articulation(s) involved ("elbow" vs. radial head), (ii) the direction of displacement (valgus, varus, anterior, posterolateral rotatory), (iii) the degree of displacement (subluxation or dislocation), (iv) the timing (acute, chronic or recurrent), (v) the presence or absence of associated fractures (21).

Degree of displacement

As described in detail above in the section on etiology, elbow instability can be considered a spectrum consisting of three stages (fig. 1A). In Stage 1 the elbow subluxates in a posterolateral direction and the patient has a positive lateral pivot-shift test (fig. 2). In Stage 2 the elbow dislocates incompletely so that the coronoid is perched on the trochlea. In Stage 3 the elbow dislocates fully so that the coronoid rests behind



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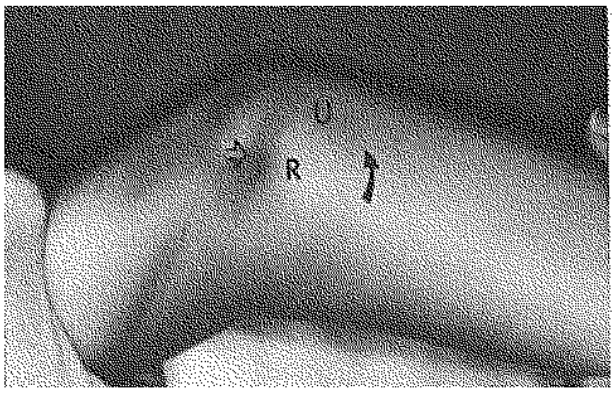


D

Figs. 2A-D. — **(A).** The "*lateral pivot-shift test of the elbow*" for posterolateral rotatory instability is performed with the patient supine and the arm overhead. A supination/valgus moment is applied during flexion causing the elbow to subluxate maximally at about 40° of flexion. (From O'Driscoll S. W., Bell D. F. and Morrey B. F. Posterolateral rotatory instability of the elbow. J. Bone Joint Surg., 1991, 73-A, 441 ; with permission). **(B).** Further flexion causes reduction (with a palpable visible clunk, if successful) (By permission of Mayo Foundation). **(C).** Performing this test also creates apprehension in the patient, who notes the sensation that the elbow is about to dislocate even if the elbow cannot be subluxated or reduced with a clunk. This posterolateral rotary *apprehension* test is highly sensitive, with false negatives having been observed only in patients with either profound instability or severe soft tissue laxity. (Reprinted with permission from O'Driscoll S. W. *Elbow Instability*. Hand Clinics, 1994, 10, 405-415). **(D).** If the patient is able to relax adequately, or is under general anesthesia, the elbow can be observed to subluxate so that the radius and ulna (R. & U.) rotate off the humerus (curved arrow). The skin is sucked in (hollow arrow) behind the radial head.

the humerus. Stage 3 is subclassified into two categories. In Stage 3A the anterior band of the medial collateral ligament is intact and the elbow is stable to valgus stress following reduction. In Stage 3B the elbow dislocates fully and the anterior medial collateral ligament is disrupted so that the elbow is unstable in varus, valgus and posterolateral rotation. It usually requires some flexion (30 - 45°) to prevent subluxation. In Stage 3c the entire distal humerus is stripped of soft tissues rendering the elbow unstable even in a cast. Reduction can be maintained usually only by flexing the elbow to about 90 - 110°. Each stage has specific clinical, radiographic and pathological features that are predictable and have implications for treatment. The pathology can be predicted from the degree of instability.

EVALUATION

Acute elbow dislocations

Dislocated elbows must be evaluated for stability after reduction of the dislocation. Following reduction, instability is assessed by gently moving the elbow through a range of motion. If the elbow does appear to subluxate or dislocate, a splint is applied and AP and lateral radiographs obtained. If they show no subluxation, the patient is treated in a split or a sling temporarily, and reevaluated in 5 - 7 days. If the elbow subluxates or dislocates in extension or is noncongruent on the xray, it should be pronated and reassessed. If stability is restored, a hinged brace or cast brace with the forearm in full pronation is applied. An extension block of 30° is sometimes necessary. If the elbow requires more than 30° to 45° of extension block, one should consider surgery. Extension blocks should be gradually eased so that by 3 weeks full motion is permitted by the brace. At each follow-up exam, the elbow should be reevaluated in exactly the same manner.

Assessment of instability may be inadequate in the awake patient, secondary to guarding, and need to be assessed with the patient under general anesthetic. This is easiest to perform and interpret with the arm in the overhead position, as it now resembles a leg, and the elbow resembles a knee. To most surgeons, this is extremely helpful. The elbow is examined for valgus, varus, and posterolateral rotatory instability. Valgus testing is performed with the elbow fully pronated so that posterolateral rotatory instability is not mistaken for valgus instability (22). This happens because the ulna and radius as a unit rotate away from the humerus in response to valgus stress when the LCL is disrupted. Forced pronation prevents this by using the intact medial soft tissues as a hinge or fulcrum, just as the periosteum is used for this purpose during the reduction of a supracondylar fracture in a child. Varus testing is easiest to perform with the shoulder fully internally rotated. Both valgus and varus testing are performed with the elbow in full extension and about 30° of flexion to unlock the olecranon from the olecranon fossa. Posterolateral rotatory instability is diagnosed by the lateral pivot-shift test of the elbow, which is described in the next section on recurrent instability. If there is severe soft tissue disruption, this test can be falsely negative. A positive test is manifested by a clunk that is seen and felt when the ulna and radius reduce on the humerus. With severe soft tissue disruption, the elbow can sometimes remain dislocated even when flexed past 90°. This can be avoided when one suspects it by the examiner's thumb pushing down on the olecranon to prevent the elbow from fully dislocating (or limiting the degree of subluxation during pivot-shift testing).

Stress radiographs are performed in the AP plane in valgus and varus with arm overhead as described above. With the shoulder in 90° of abduction and full external rotation, stress radiographs are also performed in supination and pronation to detect posterolateral rotatory instability and to determine if the medial side opens up with pronation (indicating disruption of the medial soft tissues).

Recurrent instability

Recurrent instability of the elbow, once enigmatic, is now understood to involve a common pathway of posterolateral rotatory subluxation. In virtually all cases the ulnar part of the lateral collateral ligament is detached or attenuated. The medial collateral ligament is usually intact. Even

when the medial collateral ligament is also disrupted, it is usually the lateral ligament that does not heal — perhaps because of gravitational varus stress.

Posterolateral rotatory instability is being diagnosed with increasing frequency since its discovery, probably due to increased awareness of the condition. Patients typically present with a history of recurrent painful clicking, snapping, clunking, or locking of the elbow and careful interrogation reveals that this occurs in the extension half of the arc with the forearm in supination. A preceding history of trauma or surgery is usually present unless there is a connective tissue disorder or chronic stretching due to crutch-walking. The typical cause is a previous dislocation but can be as subtle as a "sprain" resulting from a fall on the outstretched hand. Surgical causes include radial head excision and lateral release for tennis elbow (due to violation of the ulnar part of the lateral collateral ligament).

The physical examination may seem unremarkable except for a positive lateral pivot shift apprehension test (posterolateral rotatory apprehension test) (fig. 2C) (24). With the patient a in the supine position and the affected extremity overhead, the wrist and elbow are grasped as though one might think of holding the ankle and knee when examining the leg. The elbow is supinated with a mild force at the wrist and a valgus moment is applied to the elbow during flexion. This results in a typical apprehension response with reproduction of the patient's symptoms and a sense that the elbow is about to dislocate. Reproducing the actual subluxation and the clunk that occurs with reduction can usually only be accomplished with the patient under general anesthetic or occasionally after injecting local anesthetic into the elbow joint. The lateral pivot shift test performed in that manner results in subluxation of the radius and ulna off the humerus which causes a prominence posterolaterally over the radial head and a dimple between the radial head and the capitellum (fig. 2D). As the elbow is flexed to approximately 40° or more, reduction of the ulna and radius together on the humerus occurs suddenly with a palpable visible clunk. It is the reduction that is apparent.

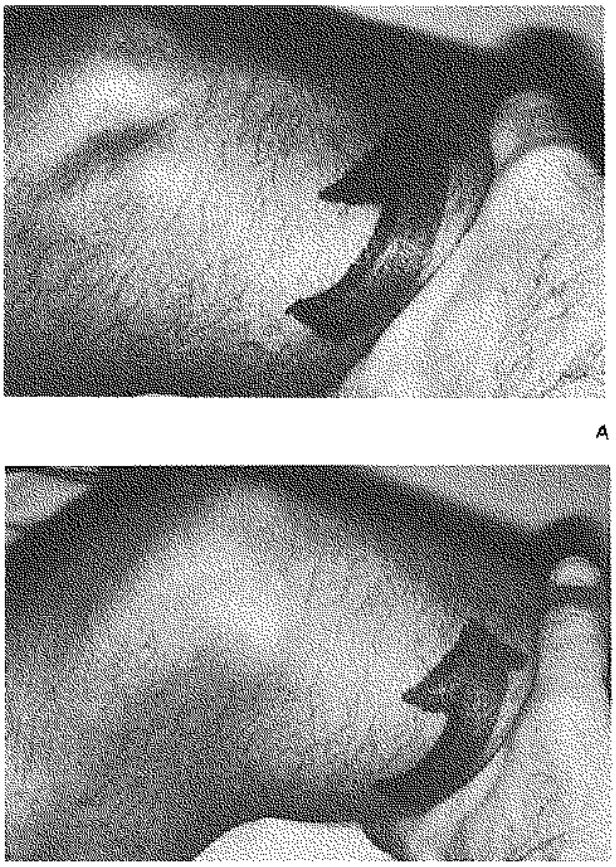
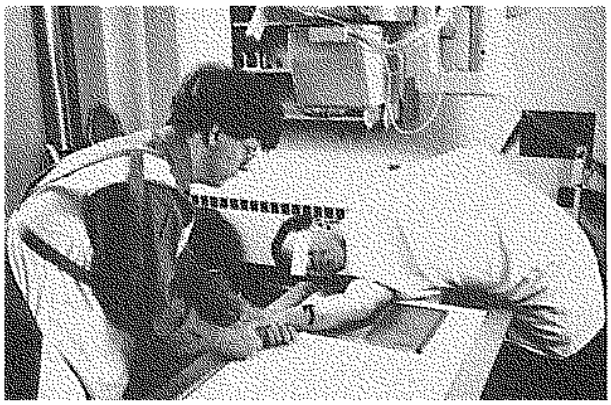


Fig. 3A,B. — Posterolateral rotatory drawer test. The lateral side of the forearm is translated posteriorly **(A)**, pivoting around the intact medial soft tissues, and reduced again **(B)**.

The posterolateral rotatory drawer test is also useful and resembles the drawer test in the knee. With the patient supine, and the arm in the overhead position, the lateral forearm is translated posteriorly at the elbow, pivoting around the intact medial soft tissues (fig. 3). A lateral stress radiograph taken prior to the clunk can be helpful to demonstrate the rotatory subluxation (fig. 4). Arthroscopic examination will confirm excessive opening of the ulnohumeral articulation and posterior subluxation of the radial head with supination stress applied to the elbow.

Valgus instability

This condition has been extensively documented by Jobe and his coworkers (5, 6, 9, 10, 11, 12).



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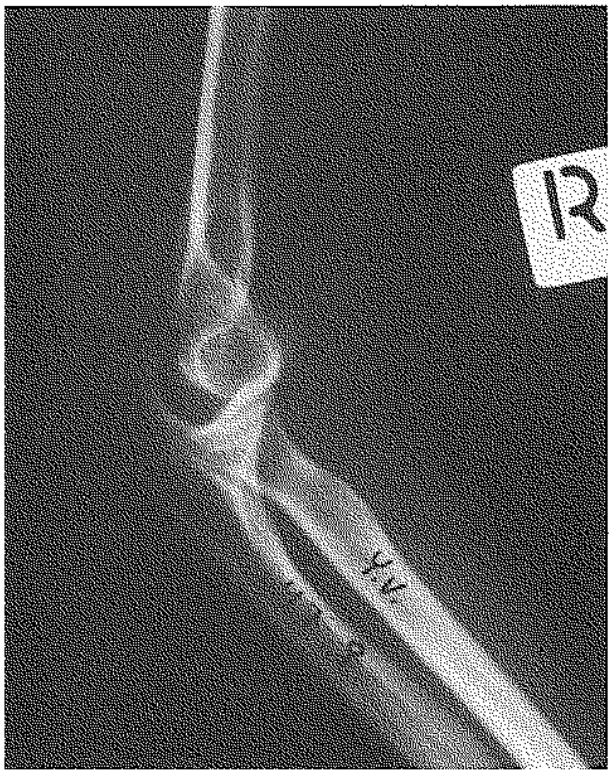

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Fig. 4A,B. — **(A).** Patient positioning for lateral stress radiograph. It is difficult to control humeral rotation adequately when the xray beam is directed from lateral to medial. Instead, stress xray is best obtained by placing the lateral side of the elbow against the xray plate with the shoulder and wrist in the same plane as the elbow, then directing the xray beam from medial to lateral **(B).** Corresponding lateral stress radiograph showing posterolateral rotatory instability. A lateral stress radiograph taken during the lateral pivot-shift test reveals the radius and ulna to have supinated away from the humerus (dark arrow) leaving a gap in the ulnohumeral articulation (hollow arrow) and the radial head posterior to the capitellum.

Chronic valgus overload with rupture or attenuation of the MCL is diagnosed by the history, physical examination and stress radiographs. With a history of repetitive valgus loading, as in pitching, the patient typically complains of medial elbow pain and may have actually heard and/or felt a "pop" at the time of ligament rupture. Physical examination confirms tenderness over the MCL just anterior to the ulnar nerve and distal to the epicondyle. In contrast to medial epicondylitis, MCL insufficiency is more commonly tender at the ulnar insertion of the ligament. Valgus stress is painful. The valgus instability can often be confirmed by a valgus stress radiograph, although Jobe emphasizes that a normal stress radiograph does not rule out symptomatic ligament attenuation ; the diagnosis is thus more dependent on the history and physical examination. This can be performed manually with the elbow flexed 30° or with the "gravity stress xray". Manual stress testing is most reliably performed by fully pronating the forearm, internally rotating the shoulder and directing the xray beam from posterior to anterior. This permits better control of humeral rotation. The arthroscopic valgus stress test, performed with the elbow flexed 70°, is specific for MCL injuries, and one cadaver study showed that any opening of more than 1 millimeter indicates damage to at least the anterior band of the MCL (7). Despite these tests, the diagnosis can remain elusive. A test that has proven highly reliable in the author's experience is called the "*moving valgus stress test*". Starting with the elbow in full flexion, a moderate valgus torque is applied to the elbow and maintained while the elbow is extended. A positive test reproduces the patient's pain between 120° and 90° of flexion. In most cases, the pain is reproduced again in the same arc as the elbow is flexed back through the 90° to 120° arc.

TREATMENT

Treatment of acute dislocations

Reduction and post-reduction management

The initial treatment of a dislocation that is not complicated by the presence of fractures is a closed

reduction of the dislocation. This should be done in supination to clear the coronoid under the trochlea, thereby minimizing additional trauma to the medial soft tissues that have not yet been disrupted. Essentially, one "recreates the deformity" to make reduction possible and easy. A simple principle to follow in managing the patient following reduction is that the elbow is briefly splinted (for 3 - 5 days) then started moving unless it tends to subluxate or dislocate. One must be vigilant. Subluxation or dislocation must be detected by careful examination throughout the comfortable range of motion and with AP and lateral radiographs initially and every 5 - 7 days for the first 3 weeks. If at any time subluxation or dislocation is detected clinically or radiographically, a change of treatment is required.

Treatment is dictated by the "stage", or degree of instability, outlined above. Valgus stability following reduction is present when the forearm is fully pronated in Stages 1 to 3-A. These are treated by immediate unlimited flexion and extension in a cast brace, which is applied with the forearm in full pronation. If the elbow feels stable in any position of forearm rotation, a cast brace is not necessary. Such stability is usually due to the dynamic stabilizing effects of the muscles crossing the elbow joint (8). In stage 3-B or 3-C, the elbow is unstable in extension and a cast brace (usually in neutral rotation) is applied with an extension block incorporated to prevent extension beyond the point of instability. This is gradually extended during the healing phase. A total of three to six weeks of protected motion is adequate (18). The reason that 3-B and 3-C dislocations are not pronated is that the medial soft tissue disruption is sufficient to permit the medial side to open up with forearm pronation.

Fractures

The presence of fractures usually changes the management. Fractures of the olecranon usually do not cause clinical instability if less than 50% of the joint surface is involved. However, there is a measurable decrease in stability that is proportional to the percentage of the olecranon that is lost or fractured (2). Fractures involving the joint surface anteriorly toward the coronoid or insertion of the ligaments on the ulna are unstable. An unstable elbow associated with a fracture of the olecranon should be treated by open reduction and internal fixation of the olecranon. This can done by plating the ulna posteriorly with a 8-hole 3.5 DC plate bent at an angle of 80° between the last two holes at the tip of the olecranon (23). This permits excellent fixation on the proximal fragment and acts as a buttress to prevent anterior subluxation.

The coronoid is an important part of the force-bearing surface of the elbow and important for stability. Fractures of the coronoid have been classified by Regan and Morrey (30). Type I fractures are small shear fractures that are caused by subluxation or dislocation as the coronoid passes beneath the trochlea. (They are not actually avulsion fractures as previously thought ; nothing is attached to the tip of the coronoid (3)). They do not destabilize the joint, but signify the ligamentous disruption that has occurred. Type II fractures (less than 50% of the coronoid) should be fixed if the joint is subluxated or dislocated. Type III fractures (more than 50% of the coronoid) cause instability and should be fixed. Type III fracture-dislocations have a poor prognosis. In general, the approach to the unstable elbow is to fix the bones so that the only limitation is the ligaments and then to repair them if the elbow isn't stable enough to permit early motion. Malunions or nonunions of the coronoid sometimes cause recurrent instability and must be reduced and fixed in such cases.

Fractures of the radial head associated with an elbow dislocation or subluxation are best managed by internal fixation where possible. If the radial head is comminuted and has to be excised, prosthetic replacement is indicated if the elbow is unstable and can't be rendered stable by ligament reconstruction alone.

Intraarticular fractures and supracondylar fractures of the distal humerus with intraarticular extension often have severe displacement of the joint surfaces. This is not necessarily due to ligamentous disruption. The soft tissue and lig-

ament attachments should be preserved. This will permit the elbow to be stable when the bones are reduced and rigidly fixed.

Acute ligament repair

The indication for acute ligament repair is instability that does not permit early protected motion in a cast brace. This is usually the case when there are associated fractures. In such cases, the ligament(s) may have been avulsed and can be repaired directly to bone with heavy sutures. In some cases, the tissue can be repaired but not strongly enough to stabilize the joint. In such cases the repair is augmented by passing a heavy absorbable suture (# 2 PDS) through the same course as for a ligament reconstruction (see below) and fixing it to the normal ligament attachments on the epicondyle and ulna.

Treatment of recurrent dislocations or subluxations

Ligament reconstruction

Surgical correction is performed by reattaching the avulsed lateral ulnar collateral ligament or reconstructing it with a tendon graft such as that of the palmaris longus or the semitendinosus (20, 25, 27). The reconstruction technique that is currently employed involves isometric placement of the origin on the lateral epicondyle and fixation to bone at either end. Surgery is performed in young patients in such a way so as to prevent violation of the epiphyseal plate on the lateral side of the humerus. Patients with valgus as well as posterolateral rotatory instability must have the anterior band of the medial collateral ligament reconstructed as well. Typically motion in a cast brace can be commenced in the first week following surgery with the forearm in full pronation (unless the AMCL was also reconstructed). An extension block is sometimes used. In patients with severe instability or in revision cases, the elbow is sometimes immobilized in a cast for three weeks. In children, and in those patients who have previously undergone prolonged immobilization for up to six weeks without developing contractures, immobilization might be continued for six weeks.

Treatment of valgus instability

The treatment for MCL injuries includes anterior transposition of the ulnar nerve and reconstruction of the anterior band of the MCL with a palmaris longus tendon graft (6, 9, 10, 12, 26).

Chronic instability

We now know that all that is required for valgus, varus, and rotatory stability of the elbow is the presence of a normal articular surface, the anterior band of the medial collateral ligament, the ulnar part of the lateral collateral ligament and the annular ligament. Thus there is no need for unusual, non-anatomic procedures for ligament reconstruction in recurrent or chronic instability. Also, trans-articular pinning of the elbow for subluxation is no longer indicated. Thus, the approach to a chronically dislocated elbow is to reconstruct the bony articulation and then the medial and lateral ligaments. Active and passive motion in a cast brace is commenced immediately. If the joint surface itself is destroyed, it is resurfaced with periosteum for cartilage regeneration in young patients or fascia lata as an interposition arthroplasty in older patients whose periosteum does not have adequate chondrogenic potential. The articulation is held stable by use of a hinged external fixator in cases where the bony anatomy is inadequate to do this (4).

Results

Treatments have varied, and so the interpretation and predictability of the long-term results of closed treatment of dislocations not complicated by associated fractures merits scrutiny. They are satisfactory provided that motion is commenced early. The large majority of patients appear to regain excellent function and strength unless they are immobilized and become stiff, or develop recurrent instability, as discussed under complications below.

The results of treating fracture-dislocations, especially those involving both the radial head and coronoid, have been poor enough to intimidate

most surgeons. However, early clinical results from aggressive ligament reconstruction in combination with internal fixation in complex fracture dislocations of the elbow have been very promising. Immediate motion is possible and stability has been maintained. The current approach is to start immediate motion in all injured and operated elbows ; some perform repair or reconstruction to permit such early motion. Future studies will be necessary to validate these observations. Further, the role of hinged external fixators is evolving (4).

Clinical outcomes of ligament reconstruction for recurrent instability of the elbow in patients from age four to forty-six years have been successful. The authors who described the technique reported success in 10 of 11 patients whose clinical presentations included recurrent subluxations and/or dislocations.

Complications

The two main complications of simple dislocations (no fractures) are contractures and recurrent instability (15, 17). Stiffness can be minimized by starting early motion. Melhoff *et al.* (19) showed in a long-term study of 52 patients with dislocations not complicated by associated fractures, that 60% of patients had some symptoms at final follow-up. These included pain or stress pain in 45% and significant flexion contractures or more than 30° in 15%. Stiffness was directly related to the duration of immobilization, and was predictable if the elbow was immobilized for 3 weeks or more.

Recurrent instability has caused great confusion for years but has recently become better understood. It is probably more common than previously thought, and indeed two long-term series reported symptoms of recurrent instability in 15% and 35% of their patients respectively, though they could not usually demonstrate the instability on examination (15, 17). (These exams were performed prior to publication of the concept of posterolateral rotatory instability).

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SAMENVATTING

S. W. M. O'DRISCOLL. Instabiliteit van de elleboog.

Om de instabiliteit van de elleboog te verstaan moet men zich baseren op de kennis van de anatomie van het collateraal ligamentair apparaat enerzijds en het mechanisme en de kinematica van de subluxatie en de luxatie van de elleboog anderzijds. De complexe ligamentaire laterale structuren is de sleutelstructuur welke tussenkomt bij recidiverende ellebooginstabiliteit en het is praktisch altijd geruptureerd bij de traumatische ellebooglуxatie. Het ulnair deel van het lateraal collateraal ligament is het kritische deel van het ligamentaire complex welke de ulna met de humerus verbindt en posterolaterale rotatoire instabiliteit verhindert. De kinematica van de elleboogsubluxatie en luxatie is 3-dimensioneel gekoppeld aan de beweging, gekend als posterolaterale rotatoire instabiliteit. Daarbij roteert de onderarm van de humerus weg in valgusexorotatie tijdens de beweging of volledige extensie naar volledige flexie. Ellebooginstabiliteit wordt gediagnosticeerd op basis van het klinische onderzoek met de laterale pivot-shift-test, de posterolaterale rotatoire schuiflade test en radiologisch door stress-opnames te verrichten. De laterale pivot-shift-test is moeilijk uit te voeren terwijl de posterolaterale rotatoire schuiflade makkelijk is. De meest gevoelige test echter is de posterolaterale rotatie aprehensie-test. Een positieve test bij patiënt met geschiedenis van recurrent kliks, verspringen, of blokkage van de elleboog zou moeten leiden tot de diagnose van posterolaterale rotatoire instabiliteit. De behandeling is chirurgisch bij herstel of reconstructie van het lateraal collateraal complex, voornamelijk het ulnaire deel.
Ook moeten deficiënties van het coronoïd en van de radiuskop worden behandeld.

RESUMÉ

S. W. M. O'DRISCOLL. L'instabilité du coude.

Pour comprendre l'instabilité du coude, il faut se baser sur la connaissance de l'anatomie du complexe ligamentaire collatéral externe et du mécanisme et de la cinématique de la subluxation et de la luxation du coude. Le complexe ligamentaire externe est la structure clef impliquée dans les instabilités récidivantes du coude, il est pratiquement toujours rompu dans les luxations du coude qui résultent d'une chute. La partie ulnaire du complexe ligamentaire collatéral externe (également connue sous le nom de ligament collatéral externe ulnaire) est la portion critique de ce complexe ligamentaire, qui fixe le cubitus à l'humérus et prévient l'instabilité rotatoire postéro-latérale. La cinématique de la subluxation et de la luxation du coude comporte un mouvement de couple, que l'on décrit comme une instabilité rotatoire postéro-latérale, dans lequel l'avant-bras se désolidarise de l'humérus en valgus/rotation

externe pendant un mouvement de flexion à partir d'une position en extension. L'instabilité du coude est diagnostiquée à l'examen clinique par le test du «pivot shift» latéral, le test du tiroir rotatoire postéro-latéral et, radiologiquement, par des radiographies dynamiques. Le test du «pivot shift» latéral est difficile à réaliser ; le test du tiroir rotatoire postéro-latéral l'est beaucoup moins. Le test le plus sensible est cependant le test d'appréhension à la rotation postéro-latérale. Un test d'appréhension positif chez un patient qui présente une histoire de claquement, de ressaut, de blocage du coude, devrait faire envisager directement un diagnostic d'instabilité rotatoire postéro-latérale. Le traitement est chirurgical : réparation ou reconstruction du complexe ligamentaire collatéral externe, et spécifiquement de sa partie ulnaire. Il faut aussi corriger d'éventuelles pertes de substance de l'apophyse coronoïde et/ou de la tête radiale.