Elbow Instability

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Applied Anatomy

The stability of the elbow is provided by the osseous anatomy, supported by the ligaments around the elbow, which are thickenings of the capsule. The muscles that cross the elbow joint provide a dynamic stability.

Osseous Anatomy

The ulno-humeral joint is one of the most constrained joints in the body. The trochlea notch is deep with the anterior coronoid process and the posterior olecranon process providing significant stability to the elbow. The coronoid process is the most important stabilizer of the elbow. On the lateral side of the elbow the curvature of the head of the radius provides stability on the curvature of the capitellum.

Ligamentous Anatomy

The primary ligamentous restraints of the elbow are usually defined as being the anterior band of the medial collateral ligament (MCL) and the lateral ulnar collateral ligament (LUCL). On the medial side the anterior band of the MCL is the primary restraint against a valgus force and the posterior band of the MCL is the primary restraint against pronation.

On the lateral side of the elbow the lateral collateral ligament (LCL), which inserts into the annular ligament, is the primary restraint against varus. The LUCL is also postulated to be the primary restraint against supination. The anterior capsule is only important for stability with the elbow in extension.
Pathoanatomy and Instability Theory

There have been many theories of elbow instability, which have developed over more than 100 years. These have often been divided into medial and lateral sided instability theories.

Medial sided instability theory

Medial sided instability theories have largely related to patients having a valgus force applied to the elbow with associated rupture of the medial collateral ligament. In 1987 Joseffson reported on a patient population of elbow dislocations treated with either operative or non-operative treatment. In their operative group they identified that patients who had a medial muscular rent would often have an elbow that could be re-dislocated. They also noted that the MCL was often torn in these patients. They reported that the results were the same in the two groups and recommended that patients with elbow dislocation did not require surgery.

Lateral sided Instability theory

Osborne and Cotterill published a paper on the theories of recurrent elbow instability in 1966. They reported that patients with recurrent instability usually had avulsion of the lateral ligament complex, which had failed to heal. They also noted that there was often some laxity of the medial collateral ligament.

In 1991 O’Driscoll et.al. reported on the theories of lateral sided instability. They proposed that the LUCL was the primary restraint and patients with elbow instability usually had a tear of the lateral ligament complex. This tear is thought to propagate from the lateral side through to the medial side. They described the importance of supination in the etiology and assessment of the instability. The pivot shift test was described, based on the assumption that an intact MCL would act as a hinge around which the elbow would subluxate. A technique of surgical reconstruction with an isometric extra-articular autologous graft was also described.

Global instability

From our observations;

a) Injuries to the medial and lateral ligament complexes are common.
b) For those patients who have required an open surgical procedure it is our experience that a medial muscular rent will extend down to the elbow joint and involve the MCL and the coronoid process.
c) The MCL will be avulsed from the humeral attachment if there is a dislocation. If the coronoid process is fractured, the anterior capsule will be attached to the coronoid fragment distally and the humeral shaft proximally. However the Posterior band of the MCL will be avulsed from the humerus. Therefore there is a “Z” tear of the medial capsule.
d) In the delayed presentation case the shortened, avulsed, MCL is sitting in articular joint fluid and does not reach the medial epicondyle. The authors postulate that failure of this capsule to heal to the epicondyle leads to persistent medial instability. This is different to the knee, where the medial ligament has a large footprint on the metaphyseal region of the proximal tibia and hence a greater chance of healing.

e) On the lateral side a ligamentous tear is usually a global avulsion of the entire lateral capsular sheet leaving a completely bare lateral condyle.

f) In the delayed presentation cases, the shortened lateral capsule sits on the articular cartilage of the capitellum, onto which it will not heal. The authors postulate that failure of this capsule to heal to the epicondyle is the cause of PLRI.

g) Those patients that have had a ligamentous stabilization of the LUCL do not receive a good restraint against supination. It is the author’s opinion that this is because the primary restraint against supination must be between the epicondyle and the proximal lateral facet of the olecranon. It is the authors’ recommendation that when performing a lateral ligament reconstruction that there should be a ligamentous band which also replicates the posterior lateral capsular.

h) If the radial head is also fractured it is common for the posterior humeral capsule to be avulsed and the anterior humeral capsule to remain intact, unless it is a high energy injury. This is a “Z” capsular injury.

1st Time Dislocation

Presentation

Dislocations of the elbow are reasonably common in clinical practice and usually occur following a sporting injury. More complex injuries can occur following high energy injuries such as industrial accidents and significant falls.

Assessment includes:

a) Examining for localized bruising over the medial and lateral aspects of the elbow, interosseous membrane, and the wrist. It is important that Essex-Lopresti injuries are not overlooked.

b) Assessment of the neurovascular structures is important. Anterior interosseous nerve injuries are not uncommon.

c) Plain radiographs must be reviewed to identify the direction of instability and associated fractures including those of the coronoid process and radial head.

Reduction

a) Can be performed under a neuroleptic agent, general or local anesthetic. The authors often use local anesthetic, which is infiltrated into the joint under sterile conditions. After 10 minutes the elbow can usually be reduced with no extra
analgesia.

b) **The reduction maneuver** is performed with an able assistant who can stabilize the humerus. The proximal ulna needs to be translated over the top of the distal humerus with the elbow positioned at approximately 30° at flexion. A thumb placed on the olecranon can be used to guide the maneuver. Once the coronoid process has passed anterior to the distal humerus the elbow can be simply reduced and placed into a sling.

c) Good quality post-reduction radiographs **MUST** be performed to ensure that the joint is reduced and congruent. Any associated fractures of the coronoid and radial head must be identified.

d) The elbow should also be taken through a range of motion. If there is any crepitus then further investigation including the use of a CT scan is required.

e) A gentle assessment of the stability should be performed. The MCL is assessed by placing the arm into pronation and placing a gentle valgus force on the elbow. A posterolateral rotatory instability test should be gently performed.

### Aftercare with sling

If the joint is stable,

- a) It is the authors’ preference to provide a sling for comfort and to advise the patient to progressively mobilize the elbow.
- b) Repeat radiographic assessment is performed at approximately 1 week in the office.
- c) Patients who are at high risk of developing heterotopic bone formation such as those with a history of heterotopic bone formation, repeated manipulations, and associated spasticity in the upper limb from a head or spinal injury should be managed with anti-inflammatory medications if these are not contraindicated.

### Indications for hinge brace

- a) Unstable in the last 30° of extension - a hinged brace with an extension block so the patient can mobilize within stability range.
- b) Unstable in supination - a hinged brace can be used with the forearm in pronation.

### Indications for surgery

Indications for surgery include:

- a) Associated fractures that require stabilization, such as those of the radial head and coronoid process.
- b) Patients who have gross instability (unstable at >30° of flexion or supination).
- c) Intra-articular free fracture fragments that are producing crepitus or are a block to reduction.
d) Recurrent instability symptoms or dislocations

**Coronoid process fractures**

Grade 2 and 3 acute fractures require fixation and fractures that extend medially can include the MCL attachment. Surgical repair has previously been mainly with sutures or screws inserted from the dorsal ulna, which do not get a good grasp of the coronoid fragment. Various companies also have devices designed to capture the coronoid fragment/s from a dorsal exposure, but these are often technically difficult to apply.

The authors' prefer to use a locking hand set plate as a buttress, applied to the anterior proximal ulna. This can be performed by reflecting the medial muscular wad from the proximal ulna, or as we have recently been performing an exposure through the bed of the biceps tendon, with reflection of brachialis.

**Chronic Instability**

The instability can be in a number of directions. Medial, lateral, posterolateral rotatory and combined instability.

**Posterolateral Rotatory Instability**

Posterolateral rotatory instability (PLRI) is a clinical syndrome first described by O’Driscoll in 1991. The patient usually has a history of injury or dislocation and presents with mechanical symptoms such as clicking, catching and locking with or without recurrent dislocations.

**Pathoetiology**

O’Driscoll postulated that the instability was due to a fall onto the outstretched hand where the elbow becomes loaded with an axial, valgus and supination force. The circle of Horii describes a pattern of soft tissue injury, which is analogous to the Mayfield perilunate instability of the wrist.

a) **Stage 1** is a disruption of the LUCL, which can produce posterolateral rotatory instability.

b) **Stage 2** is disruption of the anterior and posterior capsule, which allows the elbow to become “perched”.

c) **Stage 3** includes injury is to the medial side of the elbow. 3a the MCL is intact, 3b the anterior band of the MCL is disrupted, 3c the entire distal humerus soft tissue is stripped leading to gross instability of the joint so it is stable only at greater than 90° of flexion.

**Evaluation**
a) History of injury to the elbow, including dislocation.
b) Assess the level of disability including apprehension about performing activities with the elbow in the extension arc, e.g. rising a chair.
c) There may very little abnormal to find on standard examination. There is usually a full range of motion and often some recurvatum of the elbow. The elbow is usually stable to varus and valgus stressing.
d) Assess signs of generalized ligamentous laxity.
e) Specific provocation tests help confirm the diagnosis.

**Posterolateral rotatory instability test.** With the patient supine the arm is positioned above the patient’s head. The examiner grasps the forearm, which is placed into full supination. In this position, the elbow looks like a knee and the maneuver is analogous to the pivot shift test described to assess the anterior cruciate ligament instability. With the elbow positioned in supination and extension the elbow is then slowly flexed while the examiner applies a slight valgus and axial load to the elbow. This produces a rotatory supination torque on the forearm, which can produce a rotatory subluxation of the radio-ulnar joint. A positive sign is when the radial head can be seen to subluxate dorsally and is often associated with a characteristic dimple just proximal to the subluxated radial head.

However, in clinical practice most patients are too apprehensive to allow this maneuver to be completed. Assessment can be aided by infiltrating the joint with local anesthetic to reduce proprioceptive feedback. Fluoroscopy allows the examiner to more precisely identify any subtle instability. The test can also be performed under sedation or general anesthetic. If the patient is apprehensive about this maneuver, it can be considered a positive test.

When the elbow is flexed to approximately 40° the rotatory displacement is at its maximum. At this point the subluxated radial head produces a posterior prominence. The increased flexion in the triceps becomes taut and forces the radiocapitellar joint to reduce. The head translates interiorly over the prominence of the capitellum and reproduces with a sudden reduction clunk that is more obvious to the patient and the examiner than the initial subluxation. This reduction clunk is accentuated with the axial load, which is placed across the radio-humeral joint.

Other clinical tests include the **prone push up and chair push up test.** The patient attempts to rise from the prone position or from a chair armrest. The maneuver is attempted first with the forearms maximally pronated and then repeated with the forearms maximally supinated. If the symptoms are manifest with forearm supination but not with pronation, then the tests are positive for posterolateral rotatory instability.

g) Fluoroscopy can be valuable to evaluate the instability in “real-time”. It is common for
the patient to have instability of supination which is corrected with pronation.

h) For complex cases and those with a coronoid process fractures a 3D CT scan may be of some assistance. The author does not routinely use MRI.

Treatment

Patients will instinctively learn to avoid activities that cause instability in the extension arc due to their apprehension. Patients are unlikely to be satisfied with a brace. There is a significant disability with PLRI and the majority of patients prefer surgery.
The relative contraindications to surgery include:

- children who have an open physis
- concomitant arthritis of the joint
- generalized ligamentous laxity
- habitual recurrent dislocations

**Surgical management**

A) Examination under anesthetic. This is best performed with the assistance of fluoroscopy. The MCL is assessed with a valgus force placed on the pronated arm. The LUL is assessed with a varus force placed on the elbow and the PLRI test is performed.

B) Arthroscopy is very useful in helping to understand the details of the instability.

a) Allows assessment of associated injuries and debridement of osteochondral lesions.
b) Assessment of valgus and varus instability is best performed in the anterior compartment.
c) Assessment of rotatory instability is best performed in the posterior compartment.
d) Instability of the anterior bundle of the MCL is best assessed with a scope in the anterior compartment looking for widening between the coronoid process and the trochlea. Widening of approximately 1mm is normal, widening of 3mm is indicative of an isolated tear of the MCL and gross instability is indicative of the entire MCL complex being ruptured (based on published cadaveric work).
e) The same principles apply for varus instability by identifying the joint space opening between the lateral aspect of the coronoid process and the trochlea.
f) Instability due to rupture of the posterior bundle of the MCL is best assessed in the posterior medial aspect where the forearm is pronated and looking for abnormal widening between the medial olecranon and the trochlea.
g) Instability due to PLRI is best assessed in the posterior lateral aspect where the forearm is supinated and looking for abnormal widening between the lateral olecranon and the capitellum. In PLRI the scope can be driving into the joint through this interval.
h) It is the authors’ experience that in PLRI there will be abnormal widening on the medial side of the joint as well.

Symptomatic patients in whom the scope can be introduced into the lateral joint compartment require a lateral stabilization. Patients in which the scope can be introduced into the lateral and medial aspects of the joint are likely to have instability including the MCL and may require a circumferential graft. Patients with associated degenerative osteoarthritis may not obtain a good outcome from just a ligamentous reconstruction and need to be individually assessed.

**Surgical repair** of the lateral ligamentous complex was recommended by Osborne and
Cotterill. They recommended an exposure of the lateral supracondylar ridge and epicondyle and then plicating the lateral ligamentous complex. In patients poor quality tissue a ligamentous reconstruction is preferred to a repair.

**Lateral ligament reconstruction** (Authors’ preferred method)

a) Is usually performed with the palmaris longus tendon, (plantaris or toe extensor if PL absent).
b) The humerus is prepared with a 4.5mm drill hole through the centre of rotation over the lateral aspect of the distal humerus. Two drill passes are created to the posterior aspect of the lateral humeral condyle taking care to ensure there is an adequate bone bridge between the two posterior holes.
c) The first ulna drill hole is placed into the supinator tubercle and is advanced through medial cortex of the proximal ulna taking care to preserve the ulnar nerve. A second drill hole is placed just off the posterior lateral facet (to act as the best supination restraint for the forearm) through to the medial aspect of the proximal ulna.
d) The two ends of the tendon graft are advanced from the posterior humerus through the centre of rotation hole. The tendon ends are then advanced through the ulnar holes. The graft is cut to the correct length so that it remains in the intramedullary canal. The sutured ends are then tied over Endobuttons on the medial side of the proximal ulna.
e) The capsule is plicated and the patient is placed into an above elbow plaster slab with the elbow in pronation. Following surgery the patient is placed into an extension block orthotic splint for approximately 6 weeks.

**Combined Instability**

Instability involving the medial and lateral ligamentous complex.

It is the authors’ preferred technique to use a circumferential graft.

a) A hamstring tendon graft is passed through the centre of rotation of the distal humerus.
b) The free ends are advanced through drill holes in the proximal ulna
c) The hamstring graft can be split into two strands on both the medial and lateral sides. On the medial side it reconstructs the anterior and posterior bundles of the MCL. On the lateral side it reconstructs the LUCL and posterior capsular band, which the authors believe is important as a supination restraint.
**Dynamic External Fixateurs**

Dynamic external fixateurs provide mechanical stability to the joint, while allowing mobilization. Indications for dynamic external fixateurs include:

a) Acute injuries with tissue loss. In those cases in which there is no tissue loss usually the fractures can be fixed and the ligaments repaired to provide stability of the joint

b) Patients with a delayed presentation in which standard ligamentous repairs will be unsuccessful due to the soft nature of the ligamentous structures

c) Patients who require interposition arthroplasty.

Interposition arthroplasty has also been used, achilles tendon allograft and strips of fascia lata have been used. In those patients who require interposition arthroplasty, the authors’ preferred technique is to use anterior capsule as the interposition material.

a) This is a vascularized graft that is already attached at one end, it is and readily available and does not require further surgical exposure. In the majority of patients who require this type of surgery, the capsule is thick and robust.

b) A circumferential graft is then utilized as described above.

c) The dynamic external fixateur is then applied to provide stability while the soft tissues are stabilizing.

**References**


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Global instability

From our observations;

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b) For those patients who have required an open surgical procedure it is our experience that a medial muscular rent will extend down to the elbow joint and involve the MCL and the coronoid process.
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d) In the delayed presentation case the shortened, avulsed, MCL is sitting in articular joint fluid and does not reach the medial epicondyle. The authors postulate that failure of this capsule to heal to the epicondyle leads to persistent medial instability. This is different to the knee, where the medial ligament has a large footprint on the metaphyseal region of the proximal tibia and hence a greater chance of healing.

e) On the lateral side a ligamentous tear is usually a global avulsion of the entire lateral capsular sheet leaving a completely bare lateral condyle.

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h) If the radial head is also fractured it is common for the posterior humeral capsule to be avulsed and the anterior humeral capsule to remain intact, unless it is a high energy injury. This is a “Z” capsular injury.

1st Time Dislocation

Presentation

Dislocations of the elbow are reasonably common in clinical practice and usually occur following a sporting injury. More complex injuries can occur following high energy injuries such as industrial accidents and significant falls.

Assessment includes:

a) Examining for localized bruising over the medial and lateral aspects of the elbow, interosseous membrane, and the wrist. It is important that Essex-Lopresti injuries are not overlooked.

b) Assessment of the neurovascular structures is important. Anterior interosseous nerve injuries are not uncommon.

c) Plain radiographs must be reviewed to identify the direction of instability and associated fractures including those of the coronoid process and radial head.

Reduction

a) Can be performed under a neuroleptic agent, general or local anesthetic. The authors often use local anesthetic, which is infiltrated into the joint under sterile conditions. After 10 minutes the elbow can usually be reduced with no extra
analgesia.

b) **The reduction maneuver** is performed with an able assistant who can stabilize the humerus. The proximal ulna needs to be translated over the top of the distal humerus with the elbow positioned at approximately 30º at flexion. A thumb placed on the olecranon can be used to guide the maneuver. Once the coronoid process has passed anterior to the distal humerus the elbow can be simply reduced and placed into a sling.

c) Good quality post-reduction radiographs **MUST** be performed to ensure that the joint is reduced and congruent. Any associated fractures of the coronoid and radial head must be identified.

d) The elbow should also be taken through a range of motion. If there is any crepitus then further investigation including the use of a CT scan is required.

e) A gentle assessment of the stability should be performed. The MCL is assessed by placing the arm into pronation and placing a gentle valgus force on the elbow. A posterolateral rotatory instability test should be gently performed.

**Aftercare with sling**

If the joint is stable,

a) It is the authors’ preference to provide a sling for comfort and to advise the patient to progressively mobilize the elbow.

b) Repeat radiographic assessment is performed at approximately 1 week in the office.

c) Patients who are at high risk of developing heterotopic bone formation such as those with a history of heterotopic bone formation, repeated manipulations, and associated spasticity in the upper limb from a head or spinal injury should be managed with anti-inflammatory medications if these are not contraindicated.

**Indications for hinge brace**

a) Unstable in the last 30º of extension - a hinged brace with an extension block so the patient can mobilize within stability range.

b) Unstable in supination - a hinged brace can be used with the forearm in pronation.

**Indications for surgery**

Indications for surgery include:

a) Associated fractures that require stabilization, such as those of the radial head and coronoid process.

b) Patients who have gross instability (unstable at >30º of flexion or supination).

c) Intra-articular free fracture fragments that are producing crepitus or are a block to reduction.
d) Recurrent instability symptoms or dislocations

**Coronoid process fractures**

Grade 2 and 3 acute fractures require fixation and fractures that extend medially can include the MCL attachment. Surgical repair has previously been mainly with sutures or screws inserted from the dorsal ulna, which do not get a good grasp of the coronoid fragment. Various companies also have devices designed to capture the coronoid fragment/s from a dorsal exposure, but these are often technically difficult to apply.

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The instability can be in a number of directions. Medial, lateral, posterolateral rotatory and combined instability.

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**Pathoetiology**

O’Driscoll postulated that the instability was due to a fall onto the outstretched hand where the elbow becomes loaded with an axial, valgus and supination force. The circle of Horii describes a pattern of soft tissue injury, which is analogous to the Mayfield perilunate instability of the wrist.

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b) **Stage 2** is disruption of the anterior and posterior capsule, which allows the elbow to become “perched”.

c) **Stage 3** includes injury is to the medial side of the elbow. 3a the MCL is intact, 3b the anterior band of the MCL is disrupted, 3c the entire distal humerus soft tissue is stripped leading to gross instability of the joint so it is stable only at greater than 90° of flexion.

**Evaluation**
a) History of injury to the elbow, including dislocation.
b) Assess the level of disability including apprehension about performing activities with the elbow in the extension arc, eg rising a chair.
c) There may very little abnormal to find on standard examination. There is usually a full range of motion and often some recurvatum of the elbow. The elbow is usually stable to varus and valgus stressing.
d) Assess signs of generalized ligamentous laxity.
e) Specific provocation tests help confirm the diagnosis.

**Posterolateral rotatory instability test.** With the patient supine the arm is positioned above the patient’s head. The examiner grasps the forearm, which is placed into full supination. In this position, the elbow looks like a knee and the maneuver is analogous to the pivot shift test described to assess the anterior cruciate ligament instability. With the elbow positioned in supination and extension the elbow is then slowly flexed while the examiner applies a slight valgus and axial load to the elbow. This produces a rotatory supination torque on the forearm, which can produce a rotatory subluxation of the radio-ulnar joint. A positive sign is when the radial head can be seen to subluxate dorsally and is often associated with a characteristic dimple just proximal to the subluxated radial head.

However in clinical practice most patients are too apprehensive to allow this maneuver to be completed. Assessment can be aided by infiltrating the joint with local anesthetic to reduce proprioceptive feedback. Fluoroscopy allows the examiner to more precisely identify any subtle instability. The test can also be performed under sedation or general anesthetic. If the patient is apprehensive about this maneuver, it can be considered a positive test.

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Other clinical tests include the **prone push up and chair push up test.** The patient attempts to rise from the prone position or from a chair armrest. The maneuver is attempted first with the forearms maximally pronated and then repeated with the forearms maximally supinated. If the symptoms are manifest with forearm supination but not with pronation, then the tests are positive for posterolateral rotatory instability.

f) Plain radiographs are performed to identify coronoïd process fractures, which needs to be fixed if they are sizable, as part of any reconstructive procedure.

g) Fluoroscopy can be valuable to evaluate the instability in “real-time”. It is common for
the patient to have instability of supination which is corrected with pronation.

h) For complex cases and those with a coronoid process fractures a 3D CT scan may be of some assistance. The author does not routinely use MRI.

**Treatment**

Patients will instinctively learn to avoid activities that cause instability in the extension arc due to their apprehension. Patients are unlikely to be satisfied with a brace. There is a significant disability with PLRI and the majority of patients prefer surgery.
The relative contraindications to surgery include;

- children who have an open physis
- concomitant arthritis of the joint
- generalized ligamentous laxity
- habitual recurrent dislocations

Surgical management

A) Examination under anesthetic. This is best performed with the assistance of fluoroscopy. The MCL is assessed with a valgus force placed on the pronated arm. The LUL is assessed with a varus force placed on the elbow and the PLRI test is performed.

B) Arthroscopy is very useful in helping to understand the details of the instability.

a) Allows assessment of associated injuries and debridement of osteochondral lesions.
b) Assessment of valgus and varus instability is best performed in the anterior compartment.
c) Assessment of rotatory instability is best performed in the posterior compartment.
d) Instability of the anterior bundle of the MCL is best assessed with a scope in the anterior compartment looking for widening between the coronoid process and the trochlea. Widening of approximately 1mm is normal, widening of 3mm is indicative of an isolated tear of the MCL and gross instability is indicative of the entire MCL complex being ruptured (based on published cadaveric work).
e) The same principles apply for varus instability by identifying the joint space opening between the lateral aspect of the coronoid process and the trochlea.
f) Instability due to rupture of the posterior bundle of the MCL is best assessed in the posterior medial aspect where the forearm is pronated and looking for abnormal widening between the medial olecranon and the trochlea.
g) Instability due to PLRI is best assessed in the posterior lateral aspect where the forearm is supinated and looking for abnormal widening between the lateral olecranon and the capitellum. In PLRI the scope can be driving into the joint through this interval.
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Symptomatic patients in whom the scope can be introduced into the lateral joint compartment require a lateral stabilization. Patients in which the scope can be introduced into the lateral and medial aspects of the joint are likely to have instability including the MCL and may require a circumferential graft. Patients with associated degenerative osteoarthritis may not obtain a good outcome from just a ligamentous reconstruction and need to be individually assessed.

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Cotterill. They recommended an exposure of the lateral supracondylar ridge and epicondyle and then plicating the lateral ligamentous complex. In patients poor quality tissue a ligamentous reconstruction is preferred to a repair.

**Lateral ligament reconstruction** (Authors’ preferred method)

a) Is usually performed with the palmaris longus tendon, (plantaris or toe extensor if PL absent).

b) The humerus is prepared with a 4.5mm drill hole through the centre of rotation over the lateral aspect of the distal humerus. Two drill passes are created to the posterior aspect of the lateral humeral condyle taking care to ensure there is an adequate bone bridge between the two posterior holes.

c) The first ulna drill hole is placed into the supinator tubercle and is advanced through medial cortex of the proximal ulna taking care to preserve the ulnar nerve. A second drill hole is placed just off the posterior lateral facet (to act as the best supination restraint for the forearm) through to the medial aspect of the proximal ulna.

d) The two ends of the tendon graft are advanced from the posterior humerus through the centre of rotation hole. The tendon ends are then advanced through the ulnar holes. The graft is cut to the correct length so that it remains in the intramedullary canal. The sutured ends are then tied over Endobuttons on the medial side of the proximal ulna.

e) The capsule is plicated and the patient is placed into an above elbow plaster slab with the elbow in pronation. Following surgery the patient is placed into an extension block orthotic splint for approximately 6 weeks.

**Combined Instability**

Instability involving the medial and lateral ligamentous complex.

It is the authors’ preferred technique to use a circumferential graft.

a) A hamstring tendon graft is passed through the centre of rotation of the distal humerus.

b) The free ends are advanced through drill holes in the proximal ulna

c) The hamstring graft can be split into two strands on both the medial and lateral sides. On the medial side it reconstructs the anterior and posterior bundles of the MCL. On the lateral side it reconstructs the LUCL and posterior capsular band, which the authors believe is important as a supination restraint.
**Dynamic External Fixateurs**

Dynamic external fixateurs provide mechanical stability to the joint, while allowing mobilization. Indications for dynamic external fixateurs include:

a) Acute injuries with tissue loss. In those cases in which there is no tissue loss usually the fractures can be fixed and the ligaments repaired to provide stability of the joint.

b) Patients with a delayed presentation in which standard ligamentous repairs will be unsuccessful due to the soft nature of the ligamentous structures.

c) Patients who require interposition arthroplasty.

Interposition arthroplasty has also been used, achilles tendon allograft and strips of fascia lata have been used. In those patients who require interposition arthroplasty, the authors’ preferred technique is to use anterior capsule as the interposition material.

a) This is a vascularized graft that is already attached at one end, it is and readily available and does not require further surgical exposure. In the majority of patients who require this type of surgery, the capsule is thick and robust.

b) A circumferential graft is then utilized as described above.

c) The dynamic external fixateur is then applied to provide stability while the soft tissues are stabilizing.

**References**


Instability of the elbow in athletes.

D. Eygendaal

In the normal elbow joint, stability is maintained by the combination of joint congruity, capsuloligamentous integrity and balanced intact musculature. The olecranon and olecranon fossa articulation provides primary stability at less than 20° of elbow flexion or flexion greater than 120° degrees. In between stability is provided by soft tissue constraints, mainly the MCL.[1,2] The MCL consists of an anterior part or AMCL, a posterior part or PMCL and a transverse band. Figure 1. This transverse band is also known as Coopers ligament and originates and inserts on the ulna and doesn’t provide stability.

The AMCL has been shown to be the most important soft-tissue constraint to valgus instability of the elbow and is the strongest and stiffest of the collateral ligaments of the elbow with an average failure load of 260 N.[2,3]

The mean length of the AMCL is 27.1 mm and that of PMCL 24.2 mm, the mean widths are about 4.7 mm and 5.3 mm respectively.[4,5,6,7,8] The AMCL originates from the inferior edge of the medial epicondyle and inserts on the medial aspect of the coronoid process of the ulna. The flexor carpi ulnaris muscle, pronator teres and flexor digitorum
superficialis form predominantly the musculo-tendinous unit overlying the AMCL; all three muscles have been described to contribute to medial support.[9]

**The three most common causes of MCL injury are elbow dislocation, chronic attenuation in athlete’s or acute valgus injury.**

The incidence of elbow dislocation in the general population is estimated to be 6/100,000. More than 95% of all dislocations occur in a posterolateral direction. Posttraumatic chronic ligamentous instability can be divided further into medial or valgus instability and posterolateral rotatory instability (PLRI).

**As the signs and symptoms of both entities are often subtle, the examiner must have a high index of suspicion and a thorough knowledge of symptoms and expected findings at physical examination to make the diagnosis.**

Another important group of patients, in which insufficiency of the MCL has been described extensively, is in athletes. [11,12,13,14,15,16,17] During throwing motion, in for example, baseball, the elbow moves during late cocking and acceleration phases from 110° to 20° of flexion with velocities up to 3000 deg/sec.[10]. This combination of valgus forces and rapid extension result in tensile forces along the medial side, compression on the lateral portion of the elbow and shear forces in the posterior compartment. This combination is called ‘valgus extension overload’ syndrome and forms the basic pathologic model behind most injuries in the athletes elbow. See chapter 11. Chronic overuse of the elbow in
athletes can result in progressive attenuation of the MCL leading to ligamentous insufficiency even in the absence of a single catastrophic episode of ligament failure.

Commonly, however, athletes may note a history of recurrent elbow pain after or during throwing without a specific injury, and finally present after an acute episode of pain during throwing – an “acute-on-chronic” presentation. These athletes present with tenderness over the medial aspect of the elbow especially during late cocking or early acceleration phase of throwing, and postero-medial pain.

The third reason for MCL insufficiency is acute injury after trauma in valgus direction. Findings in acute medial collateral ligament injury are moderate to severe elbow pain, acute onset of pain during throwing, a popping sensation during throwing, medial ecchymosis, and acute ulnar nerve symptoms. Athletes sometimes report a previous severe injury, suggestive of acute ligament rupture which was not diagnosed or where definitive treatment was not carried out. In young athletes avulsion of the medial apophysis rather than rupture of the ligament can occur. Figure 2.

**The work-up of MCL insufficiency**

History taking is of utmost importance in the work-up of MCL insufficiency. Has there been a dislocation in the past? Has the technique of overhead throwing changed recently? Is this a chronic elbow problem, an acute or an ‘acute on chronic’? Which movement of the elbow is most painful?

At physical examination the axis of the arm must be described.

Figure 3.
The joint must be tested for valgus instability in 30° and in 90° of flexion.

**Comparison with the uninvolved elbow should always be performed to differentiate between physiologic and pathologic laxity. The degree of laxity is often underestimated.**

In patients with insufficiency of the MCL a typical painful arc can be produced using the ‘milking manoeuvre’ and the modified moving valgus test. Figure 4 and 5. The diagnosis is confirmed by positive elbow MRI, dynamic stress radiographs, dynamic ultrasonography or positive valgus test at anesthesia [19,20] Stress radiographs, often felt to be the gold standard in the assessment of MCL injury, have proven to be inconsistent. MRI can contribute to the decision making in medial instability with a sensitivity of 57% and specificity of 100% for MCL injury. [22,23] MRI arthrography appears to improve the sensitivity of detection of MCL tears. Figure 5.

**Don’t treat a patient for medial epicondylitis until you have ruled out insufficiency of the MCL.**

**Treatment of MCL insufficiency.**
Conservative treatment of acute isolated MCL injury consists of short immobilization in a long arm cast or placement in a hinged elbow brace to control initial pain and inflammation.

**In acute injuries, in both adults and children, standard radiographs must be done to rule out bony avulsions of the medial epicondyle as this might be an indication for surgical refixation.**

**Figure 2.**

After a short period of immobilisation an intensive exercise program is started with avoidance of valgus load for three to 6 months. In non throwing athletes or low demand individuals, a conservative regime shows acceptable results. Athletes involved in high demand throwing sports do respond less well to non operative treatment. [24,25] Rettig et al reported a 42% success rate of non-operative treatment in throwing athletes with UCL injuries.[26] Persistent symptomatic instability after non-operative treatment is an indication for reconstruction. Jobe et al.reported a follow-up study in 71 athletes with valgus instability; 14 patients had a direct repair of the ligament, 56 had a reconstruction of the ligament using the Jobe technique with a free palmaris tendon graft. The result was excellent or good in 10/14 patients in the repair group and in 45/56 of the reconstruction group. 7 of 14 who had direct repair returned to the previous level of participation in their sport. 15 patients had postoperative ulnar neuropathy, this was transient in 6 patients, and the other 9 patients had an additional operation for the neuropathy. Rohrbough et al, who first
described the humeral docking technique had excellent results in 33/36 of his cases.[30] Triceps tendon can be use as a graft as well [ 31]

Figure 6.

'Taking home message':
- medial or valgus instability of the elbow joint does exist
- medial sided pain of the elbow is not always a tendinosis of the flexor tendons or 'medial epicondyritis'
- medial instability occurs especially in athletes and after dislocation of the elbow joint; signs and symptoms of both entities are often subtle, the examiner must have a high index of suspicion and a thorough knowledge of symptoms and expected findings at physical examination to make the diagnosis
- treatment is conservative in most cases; reconstruction can be an option if conservative treatment fails

Figure 1:
The medial collateral ligament complex.
1. Anterior medial collateral ligament (AMCL).
2. Posterior medial collateral ligament (PMCL).
3. Transverse ligament

Figure 2: In young athletes avulsion of the medial apophysis rather than rupture of the ligament can occur

Figure 3:
Pronounced valgus angulation of the elbow can result in chronic attenuation of the MCL.

Figure 4: Milking manoeuvre

Figure 5: Modified moving valgus test

Figure 6: Rupture of MCL at the humeral side at MRI

Figure 7: Opening of the medial side of the ulno-humeral joint at valgus stress test under fluoroscopy (arrow); bony avulsions are sometimes seen at plain radiographs.

Figure 8:

Reconstruction of the MCL using triceps tendon as a graft.
References:


ARTHROSCOPIC MANAGEMENT OF ELBOW INSTABILITY

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PLRI

• Dysfunction of the RUHL complex
  – Radio-ulnohumeral ligament
  – Annular ligament
  – Lateral collateral ligament
Anterior View

- Abnormal radial head shift on the capitellum
- Laxity of the annular ligament
View of posterolateral gutter
Anchor placed at origin site
Suture Retrieval
Outside view of suture tying
Re-look anteriorly Pre repair
Anterior view post repair
CHRONIC PLRI

- Laxity of entire RUHL complex
- Requires plication + repair or grafting
- Arthroscopy is beneficial to evaluate local tissue and confirm PLRI
LATERAL INSTABILITY
PLRI RECONSTRUCTION
Postop Protocol

• Splint in extension
• Brace 0-30 for 2 weeks
• Brace 0-60 for 2 weeks
• Brace 0-90 for 2 weeks
• Progressive therapy for 6 weeks
• Return to activity @ 4 months
RESULTS

- Dzugan et al: 52 pts: PLRI
  - Acute: 10 Patients: AC score > 190
  - Subacute 12 pts: AC score 188, 1 failure
  - Chronic 30 Pts: AC score 180, 3 failures

Gurley et al: mixed open and arthroscopic: 88% satisfactory
SUMMARY

- Elbow arthroscopy is beneficial in instability
- Most lateral instability can be managed by arthroscopy
- Elite athletes may do better with early reconstruction
- Poor tissue quality, especially in revision cases may require grafting
Complex instability and fractures dislocations

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After elbow dislocations or fractures dislocations real complex clinical pictures can be determinated. Observing the proper roles that medial and lateral collateral ligaments, radial head, coronoid play in stabilizing elbow joint, several clinical pictures can be evidenced. Reviewing the casuistry from 2006 to 2010 we have been treated 8 cases of complex instability. Medial and lateral collateral ligament reconstructions, coronoid reinsertion (screw), coronoid transplant were performed singularly or in association in order to obtain a new stability. Gracilis and or semitendinosus were harvested to reconstruct medial and or lateral collateral ligaments. All the patients were immobilized in an above elbow fully plaster for 3 weeks and started a passive FKT at 22 days mantaining an above elbow backslab up to six weeks. Only one case presented a decrease extension (10°) at six months follow-up.
Acute dislocations: management and return to sport

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Definition
simple elbow dislocations involve soft tissue injury only without associated fractures of
the radial head, proximal ulna or distal humerus. Small coronoid tip fractures and bony
avulsions fractures representing ligament injuries still within classification as simple.

Elbow stability
- primary stabilizers
  ulnohumeral joint, anterior band of medial collateral ligament (MCL),
lateral ligaments
- secondary stabilizers
  radial head, capsule, muscular support

Biomechanics
failure sequentially in 3 stages - LCL, anterior and posterior capsule and MCL intact or
lesion of the MCL.

Classification
posterior or posterolateral dislocation most common (90%)
other types - lateral, medial anterior and divergent

ER evaluation
inspection - swollen, deformed elbow
check the entire extremity
neurovascular examination - document examination before and after reduction
evaluate for interosseous membrane disruption or associated wrist injury (variant Essex-
Lopresti injury).

Imaging
AP and lateral radiographs - identify direction of the dislocation. Repeat post-reduction
to evaluate fractures.
CT - helpful in complex fracture patterns
MRI - usually not necessary in acute settings.

Management
closed reduction, ideally done in the OR with general or regional anesthesia
ideally to have a portable image intensifier in the room to check stability after reduction

evaluate stability by taking it through a full range of motion - note position of flexion at which elbow begins to subluxate

Stable range of motion - remains reduced from at least 60° of flexion to full flexion
If elbow stable within this range, evaluate forearm rotation to see how it affects stability
   LCL torn - more stable with the forearm pronated
   MCL torn - stability increased with forearm supinated
   Both ligaments torn - immobilize with neutral rotation

**Non-operative treatment** - elbow stable from 45° to 60° to full flexion
sling if completely stable or splint elbow if unstable at the end range
3 to 5 days - x-ray, concentric reduction, start range of movement within stable range, may use a sling or static brace for support 1 to 2 weeks maximum
may need a hinged brace with an extension static stop if elbow unstable past 45° to 60° of flexion. Increase flexion 10°-20°/week to full range of motion at 3-6 weeks

**Operative** - global capsulo-ligamentous injury
   repair LCL and test elbow stability
   if stable is not necessary to repair MCL

**Technique** - supine position
midline posterior incision - allow repair of MCL if necessary and better cosmetic aspect
repair MCL usually detached from the humerus (bare area) associated in 50% with detached extensor origin, generally through bone tunnels using nonresorbable suture
rarely necessary to perform a ligament reconstruction using a graft
test stability - if elbow stable is not necessary to approach the MCL
if unstable identify the FCU and ulnar nerve, make a muscle split and repair the MCL similar to LCL through bone tunnels in the medial epicondyle or with suture anchors
If the elbow is still unstable through range of motion with these repairs completed
  hinged external fixator
technique - axis pin is critical step; fixator is assembled around this pin;
humerus and ulna pins; reduction and test range of motion

Outcomes
- early mobilization associated with superior results, with better range of motion and less flexion contracture
- prospective randomized trial comparing 3 weeks of splint immobilization to early mobilization in 50 patients showed 96% of those mobilized early had full elbow range of motion compared to 81% of those immobilized
- systematic review of studies of simple elbow dislocations recommend "functional treatment" (minimal immobilization) over plaster splint immobilization due to improved outcomes and range of motion
- surgical treatment of a group of simple elbow dislocations with post-reduction instability treated with anatomical surgical repair - after two years of follow-up MEPS of 93/100; extension loss averaged 14° and 65% of heterotopic ossification but none required surgical treatment
- no studies specifically evaluates hinged fixation for simple elbow dislocations which failed surgical ligament fixation

Complications
- elbow contracture - most commonly reported is loss of extension
- heterotopic ossification - seen in up to 55% patients usually in the collateral ligaments and are asymptomatic
- Essex-Lopresti lesions - little literature about this condition
- nerve injury - ulnar nerve is the most commonly seen generally resolves after reduction. Persistent symptoms is less than 10%
- artery injury - brachial artery injuries are rare
- instability - majority of patients do well post reduction for simple dislocations, a minority experience residual instability and require operative ligament fixation +/- hinged fixation; minimal varus instability can be tolerated
References