Treatment of Combined Medial and Lateral Collateral Ligament Insufficiency

13

Lawrence Camarda and Gregory I. Bain

Background

The most common mechanism of elbow ligament injuries occurs with a dislocation. The most common types of elbow dislocations are those that occur posteriorly (simple dislocations) involving only soft-tissue injuries, whereas complex dislocations have associated fractures. In these specific cases, medial and lateral ligament insufficiency could be observed, despite osteosynthesis of the skeletal injury. Further, outcome studies demonstrate that injuries resulting in significant ligamentous disruption have worse results than isolated fractures [1, 2]. Key aspects such as instability patterns, pathoanatomy, diagnosis, and treatment options of elbow ligament insufficiency are reviewed.

L. Camarda, MD, PhD
Department of Orthopedic Surgery, Univerità degli Studi di Palermo, Via del Vespro, Palermo 90100, Italy
e-mail: lawrence.camarda@unipa.it

G.I. Bain, MBBS, FRACS, PhD (✉)
Department of Orthopedic Surgery, Flinders University of South Australia, Adelaide, Australia
e-mail: greg@gregbain.com.au

Instability Classification

Lateral Instability

(a) *Posterolateral rotatory instability* (*PLRI*)—Described by O'Driscoll, it is considered to be the most common pattern of symptomatic chronic instability of the elbow [3]. Most commonly it results from a simple elbow dislocation [4, 5]. The primary cause of PLRI involves the disruption of the LCL complex, more specifically the LUCL. However, MCL and overlying flexor–pronator muscle group rupture could also be observed, depending on the degree of the trauma progression.

(b) *Varus*—This is caused by disruption of the LCL complex. It is seen in acute elbow dislocations and in severe cases where the LCL has failed to heal. The physiological forces across the elbow are principally valgus because of the anatomical alignment, and therefore this pattern of instability may not be clinically obvious. PLRI is a more likely clinical problem with disruption of the LCL complex [6]. Chronic attenuation of the lateral ligament complex may also be secondary to overuse, such as in patients who use their arms as weight-bearing extremities (e.g., polio with crutch-walking) [6].

R.Z. Tashjian (ed.), *The Unstable Elbow*, DOI 10.1007/978-3-319-46019-2_13

Medial Instability

(a) *Posteromedial varus instability*)—This is a rare instability pattern and it is associated with anteromedial facet fractures of the coronoid secondary to varus/posteromedial injuries of the elbow with axial loading. They almost always present with an associated injury to the LCL. Generally, the posterior band of the MCL is ruptured while the anterior band is intact and attached to the anteromedial coronoid facet. The lateral joint space is usually widened and there is no radial head or neck fracture.

(b) *Valgus*—This instability pattern involves disruption of the MCL complex. It is uncommon in the general population and it is often seen in most athletes (throwing athletes) as a result of repetitive micro-trauma and chronic overload. However, it could be observed following an acute trauma such as a dislocation. In these patients, MCL insufficiency is usually associated with radial head fractures and possibly disruption of the common flexor origin.

Anterior Instability

This is typically seen in association with olecranon fractures [6]. Because of good outcomes of treatment of olecranon fractures, chronic anterior instability is rarely encountered.

Global Instability

This is a rare condition and it is characterized by a severe multidirectional instability of the elbow. It usually follows severe trauma such as fracture-dislocation. It is associated with rupture of both collateral ligament complexes and circumferential capsular stripping of the elbow.

Pathoanatomy

PLRI

Posterolateral rotatory instability [3] classically refers to an injury to the lateral ulnar collateral ligament (LUCL) that results in external rotatory subluxation of the ulna on the humerus, with posterior and valgus displacement. Specifically, the radial head rotates away from the capitellum, and the ulna essentially "pivots" on the MCL rotating off the lateral trochlea.

The LCL complex most commonly fails by avulsing the capsule and common extensor origin from the lateral epicondyle [7]. LCL injury is most commonly the result of trauma such as a fall on an outstretched hand or any other mechanism that imparts axial compression, valgus force and supination. Other causes of injury to the LCL complex include chronic cubitus varus, multiple steroid injections for lateral epicondylitis, and/or connective tissue disease [8–10]. Iatrogenic causes can include an open or arthroscopic procedure to the lateral side of the elbow with inadequate repair/reconstruction of the lateral ligaments or of the common extensor, providing some dynamic stability [8, 11]. Resection of the radial head, even in the presence of intact ligament, has also been shown to be a risk factor for the development of PLRI [12]. A staging system (Table 13.1) developed

Table 13.1 Staging of posterolateral rotatory instability

Stages	Degrees of capsuloligamentous disruption
1	Subluxation of the elbow in a posterolateral direction
2	Subluxation of the elbow joint with the coronoid perched underneath the trochlea
3	Complete dislocation with the coronoid resting behind the trochlea
3A	Includes the posterior band of the medial collateral ligament tear
3B	Includes the anterior and posterior bands of the medial collateral ligament tear

for PLRI has been described by O'Driscoll [3] and may influence a patient's history, clinical examination and choice of treatment. Disruption of the LCL complex (particularly the LUCL) results in posterolateral rotatory subluxation of the elbow. With further injury, there is a disruption of the anterior and posterior capsules, and finally the MCL. When the lateral and medial soft tissues are disrupted, the joint can dislocate even with immobilization of the elbow in 90° of flexion. This progression of injury is also referred to as the Circle of Horii [12].

Medial Instability

MCL complex injury occurs when the elbow is subjected to a valgus force, which disrupts the medial side of the elbow, exceeding the tensile properties of the MCL. The chronic injury is more commonly seen in athletes, in particular overhead athletes, such as pitchers, javelin throwers, tennis, and water polo players. Acute disruption of the MCL can occur following a significant traumatic event.

Like the LCL, the MCL most commonly avulses from the humeral origin [13]. Cadaveric studies indicate that 100 % of the anterior bundle of the MCL must be sectioned before demonstrating significant valgus or rotatory elbow instability [14]. In the presence of an associated coronoid process fracture, the MCL complex may fail in a "Z" configuration where the anterior band of the MCL remains intact at its distal insertion on the coronoid fragment while the posterior band avulses from the proximal origin on the humerus. If there is no fracture of the coronoid process, then there is a rent in the anterior capsule that extends to the medial epicondyle, and the entire MCL complex is then avulsed from the medial epicondyle [13].

Evaluation

The first step in assessment is acquiring a good history and examination. A detailed history of the event must be obtained, including the mechanism of injury and the position of the arm at the time of the trauma. Beginning with inspection, clinicians may observe an effusion or ecchymosis over the elbow. Elbow deformity and swelling on the medial or lateral side of the elbow suggest injury to the underlying soft tissue and bony structures. A neuromuscular examination should be performed. Two-dimensional X-ray images should be taken before and after repositioning maneuvers and should include evaluation of the radial head and the olecranon. On a true lateral radiograph, lateral ligament instability may be identified by subtle opening of the trochlea–trochlear notch interval, and is referred to as the "drop sign"[15]. Furthermore, fluoroscopy represents an additional valuable tool to assess instability. It allows the surgeon to observe medial or lateral joint space widening, while a varus or valgus force is applied to the elbow. When the level of suspicion is high and radiograph results are normal, magnetic resonance imaging (MRI) could be performed. While the utility of MRI is still controversial [16–18], damage of the LCL complex can be typically seen in the presence of a significant injury.

Arthroscopic evaluation can be used for direct visualization of the elbow joint and its surrounding structures as an adjunct procedure to reconstruction. The primary advantage includes the evaluation of the joint space opening of the ulnohumeral joint during rotational, varus, and valgus stresses to the elbow [14]. This can allow for accurate clinical staging and appropriate corrective surgery. Further, arthroscopy may also help to identify elbow joint arthritis and loose fragments associated joint injuries [19].

PLRI Assessment

Diagnosis can be made historically based upon presentation of painful, recurrent clicking, snapping, or locking of elbow with pain located posterior to the proximal radioulnar joint as the elbow moves into supination and extension. Patients often report their elbow feels loose or like it is sliding out of place. On physical exam, patients often have normal upper extremity strength and elbow range of motion. Often the only abnormality in the examination is a positive pivot shift test. During this test the radial head is subluxed with a combination of full supination, axial compression, and valgus load as the elbow is placed in 40° flexion. The patient would have apprehension when performing this maneuver, which may mask the instability and make the assessment difficult. Discomfort and the sensation of instability can be reduced with local anesthetic, and fluoroscopy can identify subtle forms of instability. Surgery is indicated in patients with symptomatic instability and involves a LCL repair in the acute setting or a reconstruction in those cases without adequate ligamentous tissues.

Medial Instability Assessment

Patients with medial instability usually report medial elbow pain and decreased strength during overhead activity. Further, patients may complain about ulnar neuropathy, generally owing to a valgus stretching of the nerve. In case of an isolated MCL injury, patients can present with tenderness 2 cm distal to the medial epicondyle. Valgus instability is tested with the patients' elbow flexed between 20° and 30° to unlock the olecranon from its fossa as valgus stress is applied. The test is positive if there is a loss of a firm end point and increased medial side joint opening, comparing with the contralateral upper extremity. The test produces pain in approximately 50 % of patients with a torn MCL, and it has a sensitivity and specificity of 66 % and 60 % respectively [20, 21]. The "milking maneuver" is performed by either the patient or the examiner pulling on the patient's thumb to create valgus stress with the patients' forearm supinated and elbow flexed beyond 90° [22]. The "moving valgus stress test" is a modification of the milking maneuver where valgus stress is applied constantly, while the elbow is moved through an arc of flexion and extension [23]. For both tests, the subjective feeling of apprehension, instability, or localized pain to the MCL indicates MCL injury.

Nonoperative Treatment

In acute setting, simple elbow dislocations without associate fractures should be managed with closed reduction. It can be completed with or without sedation [24]. The reduction is performed by flexing the elbow to approximately 25° while applying longitudinal traction combined with supination at the forearm and countertraction at the upper arm provided by an assistant [25, 26]. Complete range of motion of the elbow should be evaluated as well as the joint stability. Crepitus during joint motion suggests a fracture or an osteochondral fragment trapped in the joint. If the elbow is unstable, the point of instability should be noted. Specifically, valgus and varus instability should be assessed with the elbow in 30° of flexion and full extension. If dislocation occurs during extension, the elbow should be reassessed with the forearm in pronation. If greater than 45° of pronation is required to maintain the reduction, operative intervention is indicated [6, 25, 26]. For stable elbows, short-term immobilization should be followed by early ROM exercises. For unstable elbows, initial management includes immobilization for approximately 2–3 weeks, followed by flexion and extension in a hinged split for 4 weeks. Afterwards, complete ROM may be allowed. Lateral injuries should be treated by placing the forearm in pronation with the elbow flexed at 90° for 1–2 weeks, followed by use of an elbow brace. For incomplete injuries that involve disruption of the MCL complex, the forearm should be placed in supination for 2–3 weeks. However, after elbow immobilization care should be taken to avoid excessive valgus load.

In asymptomatic patients, chronic instability could be managed nonoperatively with avoidance of instability-causing activities, elbow bracing to limit supination and valgus loading, application of a sugar tong cast, pain control, and/or physical therapy [8, 27]. If symptoms or instability persist, operative intervention is then indicated.

Surgical Management

Approach to the Elbow

The patient is placed in the lateral decubitus position with the arm supported over a bolster. The lateral structures are approached through the Kocher interval between anconeus and extensor carpi ulnaris. The anconeus is reflected exposing the LCL complex remnants. Typically, in acute trauma, this procedure reveals an avulsion of the majority of the soft tissue off the lateral epicondyle in one soft tissue sleeve, exposing the joint. In chronic situations, the avulsion ligament may be partly healed or attenuated.

A number of methods to access the MCL complex have been described. In cases of acute injuries, there is usually a rent in the common flexor muscles that leads to the joint. In the chronic case the muscle rent will be healed and a muscle-splitting approach through the common flexor muscles could be performed [28]. Independently from the approach used, the ulnar nerve should be identified and protected throughout the entire procedure. It is important to not leave the nerve unstable or in a hostile bed, in which case an ulnar nerve transposition is required.

Acute Injuries

LCL and MCL Repair

In the acute setting a repair is performed. Acute primary repair of the LCL and MCL can be performed within the first few weeks following the injury. Anatomic repair of soft-tissue avulsions from bone can be performed with transosseous suture or suture anchors. Our preferred technique of LCL repair is an anatomical repair using grasping sutures and tensionable suture anchors [29]. In the sub-acute setting the ligaments are soft and do not hold sutures well. In chronic cases there may be significant scar tissue and the ligaments may be retracted so that they cannot be delivered onto the epicondyle.

The advantages of using tensionable anchors are as follows:

1. Tensioning of the ligaments can be performed in a controlled manner.
2. Sequential tensioning of the MCL and LCL may be performed.
3. They allow cycling of the elbow and on-table clinical assessment of stability and balance before final tensioning.
4. They allow locking of the repair at the desired tension.

Once having identified the lateral capsule complex, grasping sutures (e.g., Bunnell or Krackow) are placed in the avulsed LCL complex. The suture ends are then loaded into the eyelet of the tensionable anchor. The anchor is then placed into the lateral epicondyle at the anatomical insertion site of the LCL. At this point, the sutures remain unlocked and un-tensioned in the anchor. We term this “prefabrication” where all anchors and sutures are initially placed, before final tensioning. The elbow is examined for the full ROM and a gentle assessment of stability is performed. If there is any persistent instability, then further stabilization is required. This may include stabilization of the medial structures.

Once having identified the MCL instability, grasping sutures are placed in the avulsed ligament. The anchors are then deployed into the anatomical MCL footprint before any tensioning is performed. That is the mid-position of the sharp distal surface of the medial epicondyle. If both the MCL and LCL are being repaired, the authors recommend tensioning each side alternatively. During a combined repair, the MCL is tensioned first with the elbow in flexion and the forearm in supination. The LCL is then tensioned with the forearm in pronation. The surgeon should perform repeated reassessments of elbow stability and range during tensioning. It is important not to over tension one side as this may lead to an inability to reduce the opposite side [29]. During MCL repair, the ulnar nerve should be protected without transposition.

Chronic Injuries

LCL Reconstruction

Open ligament reconstruction is indicated in patients with poor ligamentous tissue quality, when a prior repair has failed, or in the presence of chronic recurrent instability. Ligament reconstruction using graft tissue can offer an isometric, extracapsular and anatomic solution [30] Many techniques and choices of graft have been described, including advancement and imbrication of the LCL, autologous palmaris longs tendon, a strip of the triceps tendon, plantaris tendon, and synthetic ligament augmentation [30–32].

Surgeons preferred technique: The technique we use is different from the Nestor or docking technique [30]. We know that the site of primary failure of the acute instabilities is usually from the humerus. We therefore use a technique that "wraps around the lateral condyle" so that it is intrinsically stable, so that the weakest point is distal. The final construct obtained is extremely stable on the table (Fig. 13.1).

Graft selection: The authors prefer to use an autogenous hamstring graft, which is robust and gives the required length (15–20 cm) needed for the technique. However if allograft is available, it is a reasonable alternative with comparable outcomes in the literature.

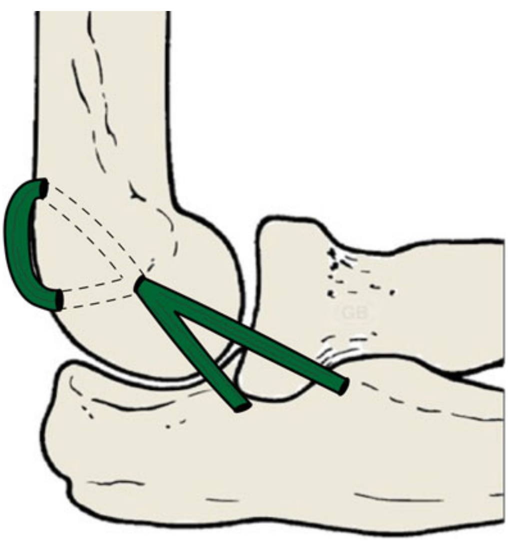

Fig. 13.1 Lateral view of the elbow demonstrating the LCL reconstruction. © Gregory I. Bain

Ulna drill holes: Two full 4.5-mm drill holes are created in the insertion point of the LUCL on the supinator crest of the ulna. We place them just proximal and just distal to the ulnar insertion of the LUCL, just distal to the capsular attachment. The exit sites of the drill holes are identified on the medial side of the ulna.

Humeral drill holes: The isometric point of the origin of the LCL complex is identified, on the lateral epicondyle, at the center of the capitellum as seen from the lateral side. A position 2 mm proximal is identified and a 4.5 mm drill is advanced through this point. The drill is directed from anterior to posterior, and exits posterosuperiorly. The drill is then removed and advanced again through the isometric point to create a second drill hole that exits posteroinferiorly.

We smooth the entrance of the hole with a curette, so the tendon graft can easily pass through the drill holes. If the ulnar cortex is particularly hard, we will "tap" the hole so that the screw does not cut the graft.

Tendon passage: Both free ends of the tendon graft are sutured with a nonabsorbable suture allowing graft hole transfer and tensioning. One free end of the graft is passed through the posterior inferior hole and exits the anterior hole. The other through the posterior superior hole and exits the anterior hole. This creates a loop of tendon around the posterior condyle.

Each end of the graft is then advanced through the drill holes in the ulna from lateral to medial. At this point, the graft is tensioned while the elbow is cycled through a range of motion and the stability is assessed.

Graft fixation: The graft is secured into the drill holes with interference screws. The first screw is inserted into the anterior humeral drill hole. The graft is again tensioned and cyclic loading is performed. Interference fit screws are then inserted into the ulna drill holes. We usually use the 5.5 mm screws in the humerus and either 4.0 or 5.5 mm screws in the ulna. Any redundant capsule is then plicated.

We use the above principles of osseous preparation, graft preparation and fixation for all of the ligamentous elbow reconstructions described in this manuscript.

MCL Reconstruction

MCL Reconstructive surgery is indicated in patients in which conservative therapy fails, in patients with delayed presentation of acute traumatic ruptures, or in chronic dislocations where it is not possible to perform a primary repair. Further, it has been shown that in competitive throwing athletes, MCL reconstruction using a free tendon graft yields better results over direct repair of the tendon.

Jobe developed the original MCL reconstruction and described the technique with initial results [33]. The technique used a tendinous detachment and reflection of the flexor-pronator muscle group, sub muscular transposition of the ulnar nerve, and creation of humeral tunnels that penetrated the posterior humeral cortex. Since then different modifications of the original technique have been described.

Surgeons Preferred Technique

Ulna drill holes: Two full 4.5-mm drill holes are created in the ulna and placed in the site of the anatomic origin of the anterior and posterior bundles of MCL. Specifically, one drill hole is made adjacent to the sublime tubercle and another at the medial margin of the greater sigmoid notch.

Humeral drill holes: On the humeral side, the medial epicondyle is drilled in a "V" fashion creating two proximal divergent tunnels. The base of the "V" is at the origin of the MCL on the anteroinferior aspect of the medial epicondyle and the limbs diverge proximally in a posterior and posterosuperior direction. In this fashion, two separated tunnels that connected to the primary humeral tunnel at the origin of the MCL are created.

Tendon passage: At this point, the hamstring graft is passed through the drill holes in the medial epicondyle, with the two limbs of the graft passed then through the drill holes in the ulna side. Finally, graft is tensioned with the elbow in varus and supination and fixed with interference screws both in the ulna and in the medial epicondyle.

Graft fixation: We use the same size screws as used for the lateral side reconstruction. The elbow is brought to full range of motion, and care is taken to smooth any rough edges that might abrade the graft. Any part of the native MCL remaining is sutured and incorporated into the bone tunnel to reinforce stability.

Complications

Good or excellent results following surgery have been reported for isolated MCL and LCL surgery. However, despite an accurate repair or reconstruction up to 11 % of patients may have complications [31, 34]. Specifically, instability can still occur after ligament reconstruction. Other reported complications include infection, bony bridge fracture, ulnar neuropathy, cutaneous nerve injury, and arthrofibrosis resulting in flexion contracture. Primary ligament repair combined with early postoperative exercise have been reported to produce satisfactory outcomes in unstable elbow dislocation, with low rate of residual instability [35–37]. Jones et al. reported residual instability in eight patients (25 %) treated for PLRI with the docking technique at a mean of 7 years. Nestor et al. described results on 11 patients (three repairs and eight reconstructions) who underwent surgery for PLRI reporting excellent outcomes in patients that underwent ligaments repairs. Further, four patients that underwent ligament reconstruction noted fair and poor outcomes. Sanchez-Sotelo et al. reported their outcomes in 44 patients (12 repairs and 22 reconstructions) that underwent surgery for PLRI. Five patients (11 %) noted further instability, and 27 % of patients described fair or poor results [31].

Combined LCL and MCL Reconstruction for Global Instability

In some cases, the soft-tissue injury is not limited to the medial or lateral aspect of the joint, but rather presents as multidirectional elbow instability with insufficiency of the entire collateral ligament complex. For these patients, the authors have developed a less invasive reconstruction technique using a single circumferential tendon graft technique that addresses both the medial and lateral instability with a single tendon graft [38]. This technique may also be used in patients with complex fracture dislocations or terrible triad injuries, when there is residual instability following fixation of fractures. This may also be used as an alternative to dynamic or static external fixation when fracture fixation and ligament repairs have failed to restore stability [38]. Finally, it may also be considered in cases of severe elbow stiffness where heterotopic ossification involves the ligaments and needs removal in order to restore motion but in doing so will compromise the function of the ligaments.

Limited data is reported on the results of a double ligament reconstruction. Van Riet et al. originally reported on the surgical technique of simultaneous medial and lateral collateral ligament reconstruction utilizing a single or double loop technique [38]. More recently, Finkbone et al. has reported on a similar technique of reconstruction [39]. The authors described this as a “box-loop” reconstruction where a donor tendon is passed through a humeral tunnel along its flexion-extension axis and an ulnar tunnel connecting the sublime tubercle and supinator crest. The graft is then tied back on itself creating one continuous graft. The technique was performed on 14 patients with an average follow-up of 64 months. The authors reported an average ASES score of 81. The average Quick DASH was 13 and the average MEPS was 88. Radiographs showed all ulnohumeral joints were congruent without signs of instability and no patients required additional surgery for instability, range of motion or arthritis.

Surgeons Preferred Technique

A midline posterior skin incision is preferred because it allows access to medial and lateral structures [40]. Full-thickness fasciocutaneous flaps are created and elevated to expose the medial or lateral aspect of the elbow. Laterally, structures are approached through the Kocher interval between anconeus and extensor carpi ulnaris. On the medial side, a muscle-splitting approach through the common flexor muscles could be performed. Following the circumferential tendon graft technique, a single-loop or a double-loop technique could be performed depending on the severity of the elbow instability. The single-loop technique provides a reconstruction of the anterior band of the MCL and the LUCL, while the double-loop technique reconstructs all four ligament units (LUCL, posterolateral capsule, and anterior and posterior bands of the MCL).

Circumferential Single-Loop Technique

Humeral drill holes: A 2-mm guidewire is drilled through the lateral epicondyle to the anteroinferior aspect of the medial epicondyle, which is the isometric points that make up the axis of rotation. A 4.5-mm drill hole is reamed through the humerus over this guidewire.

Ulna drill holes: A 4.5-mm drill hole is created passing from the sublime tubercle on the medial side to the supinator crest on the lateral side.

Tendon passage and fixation: The hamstring tendon graft is passed through the humeral tunnel and secured with 5.5 mm interference screws on the medial and lateral sides. Each tendon end is then passed through the ulnar tunnel and also secured with a single 4.0 mm interference screw (Fig. 13.2). The flexor-pronator mass is repaired back to the medial epicondyle, and the Kocher interval is closed.

Circumferential Double-Loop Technique

This is similar to the single-loop technique but also reconstructs the posterior band of the MCL and the posterolateral capsule. This is accom-

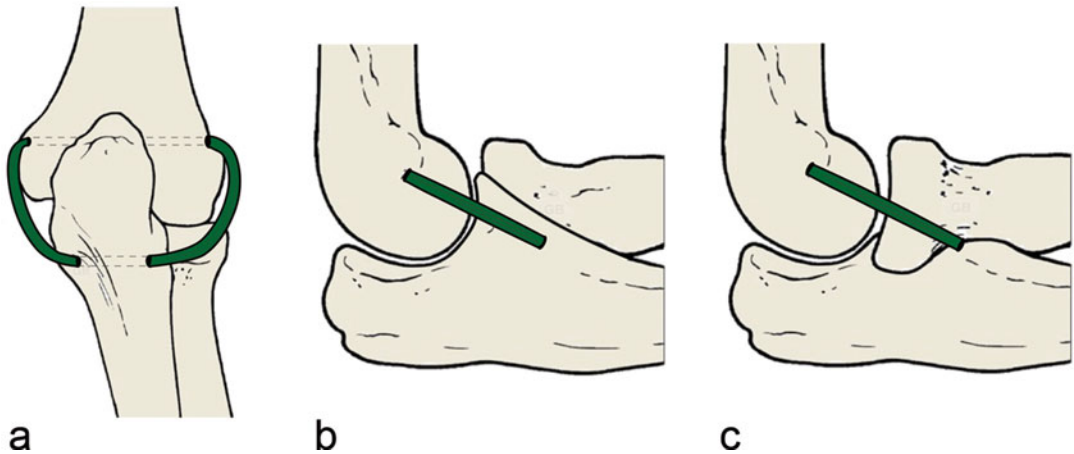

Fig. 13.2 AP (**a**), medial (**b**), and lateral view (**c**) of the elbow demonstrating the single-loop circumferential graft reconstruction. © Gregory I. Bain

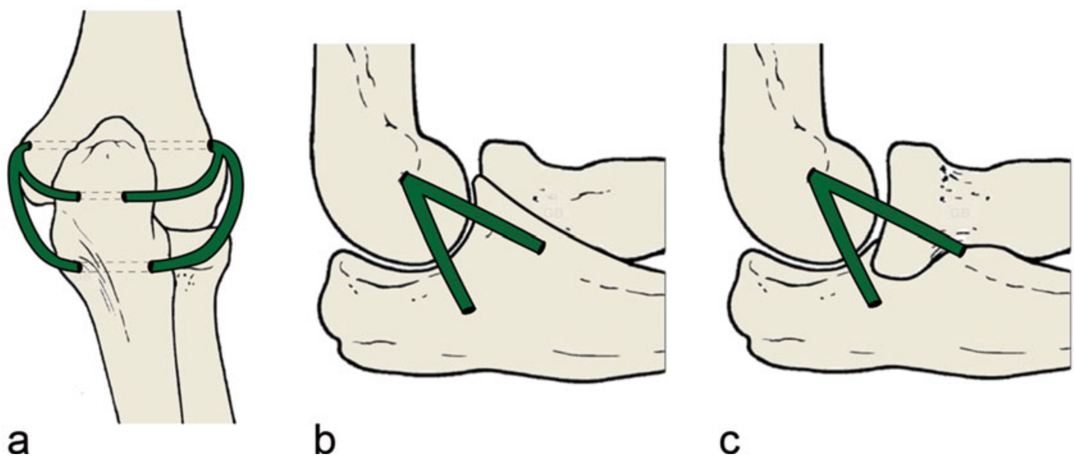

Fig. 13.3 AP (**a**), medial (**b**), and lateral view (**c**) of the elbow demonstrating the double-loop circumferential graft reconstruction. © Gregory I. Bain

plished by creating a second ulnar drill hole from the posterior supinator crest laterally to the posteromedial olecranon facet at the attachment of the posterior band of the MCL. The humeral side is the same as the single loop technique.

Tendon passage and fixation: The free ends of the graft, exiting the humerus, are then split longitudinally to create two free tails of equal size. One tail from each side is passed through the posterior ulnar drill hole, and the other tails through the anterior drill hole. The graft is tensioned and secured with interference screws (Fig. 13.3).

External Fixation

We have previously used many external fixators, but now only use them in very selected cases. Some surgeons will manage a terrible triad injury with stabilization of the radial head and an external fixator. Our preference would be to surgically stabilize the radial head, coronoid process and the associated ligmentous injuries.

We reserve the use of external fixation in complex cases where we can't obtain stability with a repair or reconstruction. Therefore we use them as a primary stabilizer most commonly in open elbow dislocations with bone and or soft tissue loss. However even in these cases, we would prefer to primarily reconstruct the tissues and if required apply a flap to the elbow. The other indication for an external fixator is with distraction arthroplasty, which we use only for chronic elbow conditions where an arthroplasty is contraindicated (e.g., infection or higher demand younger patient such as a 45 year old farmer with post-traumatic arthritis).

Internal Fixation

Although we rarely use external fixators, we are now using internal fixators. There are two types. The plate fixation method as proposed by Jorge Orbay and manufactured by Skeletal Dynamics [41]. The other option is to create an internal fixator, with sutures. The method the authors use involves placing a suture anchor with multiple strands into the isometric point on the lateral epicondyle. Any ligament tears are repaired. The free suture limb is then advanced through another anchor, which is secures to the supinator crest.

Post-operative Protocol

At the completion of the procedure the stability is assessed. If good stability has been obtained we often apply a plaster slab for 1 week at 90° of flexion. The arm is positioned in pronation or supination to protect the stabilization. A hinged brace is then worn for 2–4 weeks depending upon complexity of the case. An extension block at 30° is used for complex cases, and reduced every few weeks, aiming for full extension by 3–6 weeks The patient can return to light work activities at 6 weeks and heavy work activities at 3–6 months postoperatively.

Conclusions

Elbow instability includes a wide variety of disorders ranging from simple acute dislocations to complex dislocation with additional injuries. The diagnosis can be accurately made with a combination of history, physical examination, imaging, and arthroscopic surgery. The key to a good result is knowledge of the normal anatomy and recognizing the pathoanatomy of the injury. In acute cases, the principles of surgery are to repair the soft tissue and bony fragments to yield stability. In chronic recurrent instability, reconstruction of the collateral ligament complexes is mandatory.

References

1. McKee MD, Bowden SH, King GJ, Patterson SD, Jupiter JB, Bamberger HB, et al. Management of recurrent, complex instability of the elbow with a hinged external fixator. J Bone Joint Surg Br. 1998;80(6):1031–6.
2. Ring D, Jupiter JB, Zilberfarb J. Posterior dislocation of the elbow with fractures of the radial head and coronoid. J Bone Joint Surg Am. 2002;84-A(4):547–51.
3. O'Driscoll S, Bell D, Morrey B. Posterolateral rotatory instability of the elbow. J Bone Joint Surg Am. 1991;73(3):440–6.
4. Dunning CE, Zarzour ZD, Patterson SD, Johnson JA, King GJ. Ligamentous stabilizers against posterolateral rotatory instability of the elbow. J Bone Joint Surg Am. 2001;83-A(12):1823–8.
5. Seki A, Olsen BS, Jensen SL, Eygendaal D, Sojbjerg JO. Functional anatomy of the lateral collateral ligament complex of the elbow: configuration of Y and its role. J Shoulder Elbow Surg. 2002;11(1):53–9.
6. O'Driscoll SW. Classification and evaluation of recurrent instability of the elbow. Clin Orthop Relat Res 2000;(370):34–43.
7. McKee MD, Schemitsch EH, Sala MJ, O'driscoll SW. The pathoanatomy of lateral ligamentous disruption in complex elbow instability. J Shoulder Elbow Surg. 2003;12(4):391–6.
8. Charalambous CP, Stanley JK. Posterolateral rotatory instability of the elbow. J Bone Joint Surg Br. 2008;90(3):272–9.
9. Cheung EV, Sperling JW. Management of proximal humeral nonunions and malunions. Orthop Clin North Am. 2008;39(4):475–82.

10. Kalainov DM, Cohen MS. Posterolateral rotatory instability of the elbow in association with lateral epicondylitis. A report of three cases. J Bone Joint Surg Am. 2005;87(5):1120–5.
11. Cohen MS, Hastings 2nd H. Rotatory instability of the elbow. The anatomy and role of the lateral stabilizers. J Bone Joint Surg Am. 1997;79(2):225–33.
12. Hall JA, McKee MD. Posterolateral rotatory instability of the elbow following radial head resection. J Bone Joint Surg Am. 2005;87(7):1571–9.
13. Mehta JA, Bain GI. Elbow dislocations in adults and children. Clin Sports Med. 2004;23(4):609–27.
14. Field LD, Altchek DW. Evaluation of the arthroscopic valgus instability test of the elbow. Am J Sports Med. 1996;24(2):177–81.
15. Watts A, Bain G. New techniques in elbow arthroscopy. In: Savoie FH, Field LD, editors. AANA advanced arthroscopy: the elbow and wrist. Philadelphia, PA: Saunders-Elsevier; 2010. p. 124–31.
16. Carrino JA, Morrison WB, Zou KH, Steffen RT, Snearly WN, Murray PM. Lateral ulnar collateral ligament of the elbow: optimization of evaluation with two-dimensional MR imaging. Radiology. 2001;218(1):118–25.
17. Grafe MW, McAdams TR, Beaulieu CF, Ladd AL. Magnetic resonance imaging in diagnosis of chronic posterolateral rotatory instability of the elbow. Am J Orthop (Belle Mead NJ). 2003;32(10):501–3.
18. Potter HG, Weiland AJ, Schatz JA, Paletta GA, Hotchkiss RN. Posterolateral rotatory instability of the elbow: usefulness of MR imaging in diagnosis. Radiology. 1997;204(1):185–9.
19. Mehta JA, Bain GI. Posterolateral rotatory instability of the elbow. J Am Acad Orthop Surg. 2004;12(6):405–15.
20. Thompson WH, Jobe FW, Yocum LA, Pink MM. Ulnar collateral ligament reconstruction in athletes: muscle-splitting approach without transposition of the ulnar nerve. J Shoulder Elbow Surg. 2001;10(2):152–7.
21. Timmerman LA, Schwartz ML, Andrews JR. Preoperative evaluation of the ulnar collateral ligament by magnetic resonance imaging and computed tomography arthrography. Evaluation in 25 baseball players with surgical confirmation. Am J Sports Med. 1994;22(1):26–31.
22. Safran MR. Ulnar collateral ligament injury in the overhead athlete: diagnosis and treatment. Clin Sports Med. 2004;23(4):643–63.
23. O'Driscoll SW, Lawton RL, Smith AM. The "moving valgus stress test" for medial collateral ligament tears of the elbow. Am J Sports Med. 2005;33(2):231–9.
24. Modi CS, Lawrence E, Lawrence TM. (iv) Elbow instability. Orthop Trauma. 2012;26(5):316–27.
25. Kuhn MA, Ross G. Acute elbow dislocations. Orthop Clin North Am. 2008;39(2):155–61. v.
26. Bell S. Elbow instability, mechanism and management. Curr Orthop. 2008;22(2):90–103.
27. Kent M, Brown D, Brownson P. Posterolateral rotatory instability of the elbow: a new use for the sugar tong cast. Injury Extra. 2006;37:264–6.
28. Smith GR, Altchek DW, Pagnani MJ, Keeley JR. A muscle-splitting approach to the ulnar collateral ligament of the elbow. Neuroanatomy and operative technique. Am J Sports Med. 1996;24(5):575–80.
29. Lee YC, Eng K, Keogh A, McLean JM, Bain GI. Repair of the acutely unstable elbow: use of tensionable anchors. Tech Hand Up Extrem Surg. 2012; 16(4):225–9.
30. Nestor BJ, O'Driscoll SW, Morrey BF. Ligamentous reconstruction for posterolateral rotatory instability of the elbow. J Bone Joint Surg Am. 1992;74(8): 1235–41.
31. Sanchez-Sotelo J, Morrey BF, O'Driscoll SW. Ligamentous repair and reconstruction for posterolateral rotatory instability of the elbow. J Bone Joint Surg Br. 2005;87(1):54–61.
32. Eygendaal D. Ligamentous reconstruction around the elbow using triceps tendon. Acta Orthop Scand. 2004;75(5):516–23.
33. Jobe FW, Stark H, Lombardo SJ. Reconstruction of the ulnar collateral ligament in athletes. J Bone Joint Surg Am. 1986;68(8):1158–63.
34. Vitale MA, Ahmad CS. The outcome of elbow ulnar collateral ligament reconstruction in overhead athletes. A systematic review. Am J Sport Med. 2008;36:1193–205.
35. Micic I, Kim S, Park I, Kim P, Jeon I. Surgical management of unstable elbow dislocation without intra-articular fracture. Int Orthop. 2009;33(4):1141–7.
36. Heo YM, Yi JW, Lee JB, Lee DH, Park WK, Kim SJ. Unstable simple elbow dislocation treated with the repair of lateral collateral ligament complex. Clin Orthop Surg. 2015;7(2):241–7.
37. Jeon I, Kim S, Kim P. Primary ligament repair for elbow dislocation. Keio J Med. 2008;57(2): 99–104.
38. van Riet RP, Bain GI, Baird R, Lim YW. Simultaneous reconstruction of medial and lateral elbow ligaments for instability using a circumferential graft. Tech Hand Up Extrem Surg. 2006;10(4):239–44.
39. Finkbone PR, O'Driscoll SW. Box-loop ligament reconstruction of the elbow for medial and lateral instability. J Shoulder Elbow Surg. 2015;24: 647–54.
40. Patterson SD, Bain GI, Mehta JA. Surgical approaches to the elbow. Clin Orthop Relat Res 2000;(370): 19–33.
41. Orbay JL, Mijares MR. The management of elbow instability using an internal joint stabilizer: preliminary results. Clin Orthop Relat Res 2014;(472): 2049–60.