Article 2

# Posterolateral rotatory instability of the elbow

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## Abstract

**Posterolateral rotatory instability (PLRI) of the elbow is the most common chronic instability pattern identified. It is the resultant ulno-humeral instability secondary to compromised lateral ligament complex. The characteristic injury is the avulsion of the lateral ulnar collateral ligament (LUCL) from its humeral attachment. Acute PLRI can present following simple or complex elbow dislocations. Chronic PLRI mostly follows trauma but also can be the result of iatrogenic injury.**

Common presentations include pain, locking, pseudo locking, loss of motion and apprehension for certain movements. Stress testing that demonstrates the posterior dislocation or subluxation of the radial head plays a vital role in the diagnosis of PLRI. Diagnosis is supported by static and dynamic imaging. Examination under anaesthesia and arthroscopy enables objective diagnosis of PLRI.

Surgical repair of PLRI is often successful following acute presentations and less symptomatic chronic presentations where there is a healthy ligament remnant is available. Many surgical reconstruction techniques for chronic PLRI have been described, with good clinical and patient reported outcomes. Most common complication following PLRI reconstruction is recurrent instability which mostly occur in revision procedures.

## Introduction

Elbow instability clinically presents as inadequate joint congruity or tendency to dislocate on examination. Acute dislocations occur most commonly during athletic activities1. After an acute dislocation ongoing instability persists in 0-8% of the patients2,3. Chronic elbow instability, 90% of the time, is the result of non-healing soft tissue injuries or bony defects following acute trauma4. Repetitive stress, congenital or acquired deformities, collagen disease, inflammatory arthritis and iatrogenic injuries due to steroid injections or prior surgery account for the remaining 10%5.

Posterolateral rotatory instability (PLRI) is the most common form of chronic instability.

Initially described by O'Driscoll et al, PLRI refers to a syndrome of ulno-humeral instability secondary to injury to lateral collateral ligament complex (LCLC)6. The resultant posterior subluxation or dislocation of the radial head relative to the capitellum gives rise to the clinical symptoms of PLRI. While PLRI can occur following simple elbow dislocations, the most common complex dislocation pattern that results in PLRI is the terrible triad injury. In terrible triad the elbow is dislocated with coexisting

radial head and coronoid fractures5. When the ulnar humeral joint externally rotates the lateral ligament complex fails in tension7.

Most common cause of PLRI, in systematic review of 168 cases , was trauma accounting for 87%. Two thirds of this of this were elbow dislocations8. Interestingly 7% patients had PLRI following iatrogenic causes like surgical release and repeated steroid injections for lateral epicondylitis. Injury to the lateral collateral ligament (LCL) of the elbow is identified as ubiquitous lesion of PLRI3. It is typically avulsed at its humeral origin. Untreated PLRI can lead to ongoing symptoms and finally degenerative arthritis of the elbow joint.

## Surgical anatomy

Elbow is stabilised by is both static (osseous and soft tissue) and dynamic mechanisms9.

Static mechanism includes the osseous congruity of the ulna-humeral joint and the medial and lateral ligament complexes. The elbow flexion angle affects the stability provided by these osseous and soft tissue structures9. Bony stability is maximum at $<20^{o}$ and $>120^{o}$ of flexion10. Soft tissue structures like static medial and lateral collateral ligament complexes are dynamically supported by muscular stabilizers; common flexor and extensor origins, the biceps brachii and triceps brachii. The anterior bundle of the medial collateral ligament (aMCL) is the primary stabiliser against valgus strain in at $30^{o}$-$110^{o}$ of flexion. Anterior bundle is mainly active during extension and early flexion whereas the posterior bundle becomes the principal stabilizer from $60^{o}$ to full flexion9.

The lateral ligament complex resists excessive varus and external rotation forces on the elbow11. The lateral ligament complex consists of, annular ligament, lateral/ radial collateral ligament and lateral ulnar collateral ligament (LUCL). LUCL origins at the lateral humeral epicondyle, partly blends with the annular ligament and inserts at the supinator crest of the ulnar. About 30% of the population has an accessory lateral collateral ligament extending from the annular ligament to the supinator crest of the ulna11.

## Applied biomechanics

The common injury pattern leading to PLRI is fall onto outstretched hand with weight of the body transmitting through an axis lateral to the elbow joint12. This creates a valgus strain on the elbow with concomitant axial load. Then a supination (internal rotation) moment is applied to the elbow, as the body rotates externally pivoting around the hand. This leads to avulsion of the LCLC off its proximal attachment at the lateral humeral epicondyle.

O'Driscoll et al demonstrated simple elbow dislocations can be produced by sequential ligament failure from lateral to medial side, a concept termed "Horii circle"13. Schreiber reviewing 62 youtube.com video footages of elbow dislocation concluded that, the elbow dislocates in a position of relative extension14. He stated that sequence of disruption occurs from medial to lateral, disrupting the anterior bundle of medial collateral ligament (aMCL) first. Evidence of MRI from further studies by Schreiber et al and Rhyou et al confirms this concept, the first study showing significant partial or complete medial ligament tears in all MRI scans following simple dislocations15,16. Therefore, it is important to identify PLRI as a stage in the spectrum of elbow instability and hence look for co-existing other instability patterns.

Classification of elbow instability remains complex. Understanding a mechanistic classification of instability is important as diagnosis of instability relies upon direct appreciation of dynamic joint incongruity on stress testing. The common mechanistic patterns of elbow instability can be rotatory (PLRI and Posteromedial rotatory instability-PMRI), Axial (Monteggia and olecranon fracture dislocations), Longitudinal (Essex-Lopresti lesion) and combined patterns. While PLRI is the most common pattern, valgus instability is the second commonest. PLRI is a consequence of trauma

in 90%, however, valgus instability results from chronic repetitive valgus strains as in pitching and overhead racket sports.

## Diagnosis

Diagnosing PLRI is often challenging, mostly in chronic presentations. A clear history, a detailed clinical examination and utilising advanced imaging such as MRI is important in making a diagnosis. Acute PLRI can present with simple or complex elbow dislocation. Chronic patients commonly present with pseudo locking, loss of motion, apprehension, or pain with certain activities. History should aim to elicit risk factors for instability such as previous trauma, surgery or corticosteroid injections most often administered for tennis elbow.

While it is important to look for signs of generalised ligamentous laxity, focussed elbow examination for PLRI is essential. Assessment of the joint alignment, the presence of previous scars is important. Stress testing or provocative manoeuvres to reproduce instability are useful.

During stress testing the direction to which the elbow has the propensity to dislocate, during physiological range of motion, is identified. The direction of instability will guide to the classification and the structures that needs to be repaired. Direction of elbow instability determines the basis of mechanistic classification.

The objective of the clinical tests for PLRI are to demonstrate ulno-humeral instability indirectly by observing the posterolateral translation of radial head, while applying axial force with valgus strain with forearm in supination, taking it through the range of motion from flexion tor extension. Observing features of instability like subluxation of radial head, apprehension and a palpable clunk while recreating the forces that disturb joint congruity enable diagnosis. The stress tests include, table-top relocation test, chair push up test and press up test17,18. Subluxation, apprehension frank dislocation or pain leading to inability to fully extend is described as positive tests.

Pivot shift test as described by O Driscoll is positive when the radial head subluxates when the elbow is taken through range of motion from extension to flexion while applying an axial load, a supination torque, and a valgus strain. During 20°-40°-degree flexion arc, the supination torque reaches a maximum and the valgus strain is the only lateral strain remaining when the elbow shows maximum instability. The subluxated radial head causes a skin dimple at this point. With further flexion the elbow reduces with a clunk. Pain and apprehension are also considered a positive test. This needs clinical experience to demonstrate, while can be uncomfortable in an awake patient. Also, the sensitivity of the test is less but the specificity is good.

Posterolateral drawers test is considered a better clinical test to diagnose PLRI due to its increased sensitivity and specificity19. Antero posterior translation of the forearm on a stable humerus is done while observing for skin dimpling over the radial head as it dislocates and reduces. Pain and apprehension are also considered positive signs. Eliciting subtle forms of instability clinically can be challenging and findings can be equivocal in milder forms where ligament reconstruction in helpful. Performing these tests in an acute painful elbow is often uncomfortable and can lead to misinterpretation of findings. Examination under anaesthesia should be considered in cases where there is strong clinical and radiological suspicion.

Examinations is not complete unless both collateral ligaments are tested. Under valgus strain 15°-30° flexion is used to check the MCL. It is important understand that PLRI is one presentation of elbow instability which may well co-exist with the other forms. Examination for the integrity of the nerves, specifically the ulnar nerve is mandatory.

Standard static X ray imaging gives minimal details on instability which is a dynamic phenomenon. Standard anteroposterior and lateral X rays may reveal presence of loose bodies, arthritis, coronoid dysplasia, and malalignments occurred because of a paediatric fracture. Also following an acute dislocation, this may reveal, angulations in the radial neck, rim defects in

the radial head and impaction fractures of the capitellum. 3D CT scans enable diagnosis of osseous factors of elbow in stability like coronoid fractures, radial head fractures and associated bone loss of the capitellum as in a 'Hill-Sach's lesion5. MRI Can be helpful in assessing the extent chondral injuries, ligament tears, chondral injuries, and joint subluxations. Dynamic imaging like ultra-sonography and fluoroscopy can demonstrate radial head subluxation or ulno-humeral widening. Ulno-humeral laxity more than 4 mm is indicative of PLRI.

However, intra operative arthroscopic diagnosis is considered the most sensitive and current gold standard with regard to pathologies in other joints like wrist20. This is due to direct appreciation of disrupted structure by the operating surgeon and objective demonstration of the instability pattern21. Also, dynamic nature of diagnostic arthroscopy allows the surgeons to assess in real time, the surgical need for repair or reconstruction, assessing the disrupted anatomy and gauging the degree of instability. Arthroscopic diagnosis and classification also help to diminish the effects of confounding factors of clinical and imaging-based diagnosis like discomfort felt by the patient and having no visual impact as in pivot shift test, where the examiner feels a clunk. Arthroscopy enables intra operative decision making and guides the treatment22, 21.

## Management

Management of lateral instability can be challenging. A management algorithm is often helpful in complex situations23.

Simple acute elbow dislocation rarely needs surgery, the two indications being, irreducible dislocations and the inability to maintain reduction. These occur less than 10% in cases of acute simple elbow dislocations. Over 90% of the simple dislocations are managed with reduction and splinting. Pronation increases stability of the elbow if lateral instability is the aetiology24. In isolated medial instability the patient should be splinted in supination25. However, if both lateral and medial ligament complexes are compromised immobilization in the neutral position is recommended. At least for 4 weeks unprotected shoulder abduction is not recommended. This is to prevent varus strain on the healing lateral ligament complex.

Some authors recommend examination under anaesthesia for simple dislocations if the mechanism of injury is of high energy, severe swelling and bruising all around the elbow, and if the patients are reluctant for active mobilisation after 1-2 weeks of non-operative management5. This is due to the extent of soft tissue injury being more dramatic where the whole distal humerus can be stripped off the soft tissue.

Ligament repair is recommended in acute stage for elbows that are instable <30°. Repair can also be attempted for early, less symptomatic chronic PLRI if soft tissues are favourable. For open surgery patient is positioned supine with the affected arm on a hand table. Use of sterile tourniquet is helpful for adequate access during the procedure. Kocher approach is used for isolated lateral access, but posterior incision is an option in the presence of co-existing medial instability. In acute elbow dislocations it is common to find a haematoma with a torn anterior capsule and brachialis muscle. Once the hematoma is cleared laxity of the lateral ligament complex and annular ligament can be observed. It is not uncommon to find the entire lateral ligament complex avulsed from the humeral origin and flipped into the radio-capitellar joint.

Once the avulsed proximal end is freed up, the footprint on the posterior aspect of the lateral humeral epicondyle can be identified. This is seen as a bare area directly lateral and slightly inferior to the centre of the olecranon fossa. After debriding the footprint, a trans osseous repair can be done with No 1 or 2 non-absorbable braided sutures. Sutures are tied at elbow flexion of 30°. Suture anchor repair is another option. Cast or brace is applied for initial post operative period which can be replaced by a removal splint/ brace at 10-14 days. The elbow is splinted at rest for 4 weeks, strictly avoiding shoulder abduction.

Symptomatic chronic PLRI rarely responds to non-operative management. Therefore, non-operative management is limited to very low demand patients. Lateral ligament complex reconstruction is considered in this situation26,27. Palmaris longus, semitendinosus, allograft or synthetic graft options can be used. Open surgery is performed through the Kocher's approach. A variety of bone tunnel configurations have been described which includes direct pass-through tunnels at the humeral or ulnar ends, convergent tunnels, or half tunnels to dock the ligaments. Most commonly reported technique is the docking technique27. Trans osseous repair with graft sutured onto itself, suture anchors or interference screws can be used for fixation.

Important technical points are identifying the isometric point on the humeral epicondyle for better stability. Graft tensioning during fixation is another crucial step with the final graft tensioning performed with the elbow positioned in 30° to 40°of flexion and pronation. Capsular closure is important to retain the graft at an extra-articular location.

Rehabilitation protocol is similar to acute repair.

## Outcome

There is no difference reported between the described techniques or choice of graft regarding surgical outcome8. Most common complication was recurrent instability and 15% patients do have recurrent instability and majority of them were following revision procedures. Over 93% of the patients would achieve normal or near normal functional range post operatively. With a mean follow up of 34 months, nearly half the patients did have ongoing pain, however 87% was satisfied following PLRI reconstruction.

## Summary

PLRI commonly follows trauma, but it can be the result of iatrogenic causes like previous lateral epicondylitis release or multiple steroid injections. Diagnosis is by a detailed history, examination using stress tests and a combination of imaging including 3D CT and MRI. It is important to look for other instability patterns as PLRI is one stage in the spectrum of elbow instability. Arthroscopy is a useful adjunct in the diagnosis of PLRI and is also effectively used for surgical repair. In chronic symptomatic PLRI surgical repair results in good clinical and patient reported outcomes.

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