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Posterolateral rotatory instability of the elbow

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Abstract Posterolateral rotatory instability of the elbow is often caused by a complex injury to the lateral ulnar collateral ligament complex. This often leads to chronic mechanical symptoms of instability and pain. Surgical repair or reconstruction of the ligament is often required to stabilize the radiocapitellar joint. Multiple techniques have been described in the literature for repair or reconstruction of the lateral ligamentous complex with overall good clinical outcomes.

Keywords Posterolateral rotatory instability · Lateral ulnar collateral ligament · Elbow · Reconstruction · Repair

Introduction

Posterolateral rotatory instability (PLRI) of the elbow was first described in 1991 by O'Driscoll et al. [1•] as an injury to the lateral ulnar collateral ligament (LUCL) leading to posterolateral subluxation or dislocation of the radius on the capitellum without disruption of the proximal radioulnar joint. It is most often caused by a traumatic event such as an elbow dislocation or a significant valgus stress combined with an axial load [2].

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PLRI can also be the result of an iatrogenic complication of previous procedures including corticosteroid injections and debridement for lateral epicondylitis, as well as from ligamentous attenuation from chronic cubitus varus [3–6]. Although O'Driscoll et al [1•] initially described injury to the LUCL as the primary cause of PLRI, this has since become controversial in the literature with many authors showing that additional injury to the remaining lateral elbow soft tissue structures is required to develop PLRI [7–9]. Most patients present with pain and mechanical symptoms as a result of their instability. The management of PLRI usually requires operative treatment with either ligamentous repair or reconstruction.

Pathoanatomy of posterolateral rotatory instability

The elbow joint has three bony articulations: ulnohumeral, radiocapitellar, and proximal radioulnar. Stability of the elbow relies on these bony articulations, as well as capsuloligamentous and musculotendinous structures. The bony stabilizers are most important at extremes of motion, specifically at less than 20° and greater than 120° of elbow flexion while the lateral and medial ligamentous complexes are the primary stabilizers throughout the remainder of the motion arc [10].

The lateral ligament complex is Y-shaped and is comprised of four ligaments: the radial collateral ligament (RCL), lateral ulnar collateral ligament (LUCL), accessory ligament, and annular ligament [11]. The lateral ulnar collateral ligament was first described by Morrey and An [12•] in 1985 as a thickening of the capsule that extends from its origin on the lateral humeral epicondyle to its tubercle on the supinator crest of the ulna. The LUCL is a restraint to varus stress and also acts to stabilize the radial head from posterior subluxation/dislocation [1•, 12•].

O'Driscoll et al. [1•] were the first to describe posterolateral rotatory instability of the elbow in 1991. They believed the essential lesion was insufficiency or injury of the lateral ulnar collateral ligament while the annular ligament remains intact, stabilizing the proximal radioulnar joint. This leads to a rotatory instability of the radius on the capitellum. The concept of the LUCL being the primary stabilizer to PLRI has been debated in the literature of late, with multiple anatomic studies demonstrating that additional lateral elbow structures must also be injured, such as the radial collateral ligament, parts of the annular ligament, and/or the common extensor mechanism [4, 7, 13, 14]. In many cases, the entire lateral collateral ligament complex and the lateral joint capsule may be avulsed off of the humeral epicondyle as one sheet of tissue. This tissue is often pulled distally and rests on the articular surface of the capitellum which does not allow healing of the ligamentous complex, leading to chronic posterolateral rotatory instability [15].

Mechanism of injury

The most common cause of posterolateral rotatory instability is trauma. In a recent systematic review, Anakwenze et al. found that 67 of 71 patients described a traumatic event as the inciting event causing their instability and pain [2]. Most patients either had a frank elbow dislocation or they had a fall on an outstretched hand with a forceful valgus moment while the forearm was in supination [16, 17]. The source of damage to the LUCL may also be iatrogenic in nature such as multiple corticosteroid injections for lateral epicondylitis or lateral elbow procedures with inadequate repair of the LUCL or common extensor tendons [14]. Radial head resection and/or chronic cubitus varus from prior distal humeral fracture may also lead to PLRI [3–6, 18].

Clinical presentation

Patients often present with lateral elbow pain, especially with activities that place the elbow into extension and supination, such as pushing up on arm rests to get up from a chair and/or a prone push-up motion. Lateral elbow pain may be accompanied by mechanical symptoms such as clicking, locking, or snapping that is most prominent at 40° of flexion as the arm is being extended [19•].

On examination, most patients with non-acute injuries tend to have a "normal" appearing elbow. In chronic PLRI cases, it is often difficult to elicit any tenderness to palpation, and patients usually have full, painless range of motion [15]. Provocative testing are the most useful in the office setting to help confirm the diagnosis of PLRI. Stability of the lateral and medial ulnar collateral ligaments should be tested with varus and valgus stress at 30° of elbow flexion to unlock the bony articulations. Valgus stress should be administered with the forearm both in full supination and then in full pronation to distinguish medial ulnar collateral ligament (MUCL) tear from PLRI. Placing the arm in full pronation stabilizes the LUCL and the radial capitellar joint, allowing one to test only the anterior bundle of the MUCL. When the arm is in supination, both the LUCL and anterior bundle of the MUCL contribute to stability [3]. Many patients with PLRI do not have pain or apprehension with these tests [15].

An important provocative test to confirm the diagnosis of PLRI is the posterolateral rotatory instability test which was described by O'Driscoll et al. [1•]. It is also known as the lateral pivot shift test, and is similar to the pivot shift test of the knee that is used to test for anterior cruciate ligament instability. The patient is positioned supine on the examination table with the arm overhead, the shoulder in full external rotation to stabilize the shoulder joint, and the forearm in full supination. The lateral pivot shift maneuver is performed starting from the extended and supinated position of the elbow. In the extended and supinated position, the radial head is in the unstable, sublimated position. As the examiner brings the arm from extension to flexion, a valgus stress is placed on the elbow and the forearm is allowed to be less supinated. This allows the forearm to pivot around the anterior bundle of the MUCL, and results in reduction of the elbow joint as the triceps becomes taught at around 40° of elbow flexion, often causing an audible or palpable clunk. In the awake patient, it is unusual to be able to elicit a positive lateral pivot shift due to guarding by the patient. Therefore, apprehension during the lateral pivot shift maneuver is often considered to be a positive test even without frank instability [1•]. If the patient is guarding too much to perform the test, three alternatives are possible to aid the examiner: (1) local anesthetic may be injected into the joint to reduce pain, (2) the test may be performed under fluoroscopy to evaluate for subtle instability, or (3) the test may be performed with the patient under anesthesia [15].

Finally, Regan and Lapner [20] described the chair push-up test to test the LUCL. The patient pushes up from a chair with the hands on the arm rest. If apprehension or dislocation occurs as the patient pushes the arm from flexion to extension, that is a positive test for PLRI [20].

Radiographic examination

The diagnosis of PLRI is often a clinical one but patients should still have plain radiographs of the elbow to evaluate for any evidence of fracture, subluxation, or dislocation. Many patients with PLRI have normal or subtly abnormal radiographs [19•]. It is imperative to obtain a true lateral radiograph in order to assess the congruity of the radial head on the capitellum. A classic lateral radiograph of a PLRI case shows the radial head posterior to the capitellum. The use of advanced imaging such as magnetic resonance imaging (MRI) is controversial as damage to the lateral ulnar collateral ligament is not always easily identifiable in chronic PLRI cases [21]. Nevertheless, in our practice, we frequently use an MRI or MR arthrogram to aid in our diagnosis.

Treatment

Nonoperative management

Nonoperative management is often unsuccessful in chronic cases of posterolateral instability. For mildly symptomatic or asymptomatic patients, a trial at avoidance of instability producing positions can be attempted. However, it should be noted that it is difficult for patients to avoid gravity varus positions with the shoulder abducted or a combined extension and supination motion of the elbow since so many activities of daily living require these combinations of motion in the upper extremity. Physical therapy and pain control with anti-inflammatories can also be utilized. Elbow bracing to limit supination and valgus moments can be trialed, but most patients do not tolerate brace wear for any extended period of time [19•]. There are some patients where surgical interventions are contraindicated and the above nonoperative measures should be used. This includes patients with open physes, significant elbow arthritis, generalized ligamentous laxity, and habitual recurrent dislocators [6, 15].

Operative treatment

The majority of patients with chronic posterolateral rotatory instability will require operative treatment. Patients with acute injuries and/or good quality ligamentous tissue are best treated with a repair of the LUCL. Different from the acutely ruptured LUCL patients, many patients with chronic instability do not have adequate tissue to repair and typically require an open ligamentous reconstruction using auto or allograft tissues. Prior to any ligamentous repair or reconstruction, one must correct all osseous deformities that may be contributing to lateral instability to protect the repair [22].

Operative repair or reconstruction can be performed with the patient in either the lateral decubitus position for a posterior approach or supine with an arm board or hand table for the modified Kocher approach. A midline posterior incision is felt by some authors to encounter fewer cutaneous nerves compared to a standard lateral incision [23]. The modified Kocher approach [24] is then used to expose the lateral ulnar collateral ligament regardless of which skin incision is used. The interval between the extensor carpi ulnaris (ECU) and the anconeus muscle is identified, usually by a thin stripe of fascia. This interval is sharply incised and extended along the supracondylar ridge. The ECU is reflected anteriorly and the anconeus posteriorly with care to lift the extensor tendon off of the remnants of the lateral ulnar collateral ligament and the joint capsule [15].

Ligamentous repair

Patients with an acute injury or who have adequate ligamentous and capsular tissue remaining may be amenable to direct ligamentous repair of the lateral ulnar collateral ligament with or without plication either through an open or arthroscopic technique.

Open ligamentous repair of the lateral ulnar collateral ligament is often performed through a standard Kocher approach to the lateral elbow as described earlier. Once the interval is developed, the ligament is inspected. Often, an avulsion of the ligament off the lateral epicondyle is identified. The ligament is then repaired by reattaching it to the humeral attachment site though either suture anchors or transosseous sutures. If transosseous sutures are used, historically, a Bunnell suture was placed in the humeral end of the LUCL and the joint capsule which are then passed through transosseous tunnels drilled in the lateral epicondyle [15, 25]. Suture anchors can also be placed at the lateral epicondyle and the sutures advanced and tied in a horizontal mattress pattern in the non injured portion of the ligament [26]. The anatomic attachment site and isometric point in the lateral epicondyle is slightly posterior to the tip of the lateral epicondyle.

Reconstruction

Ligamentous reconstruction with auto or allograft is often required in the setting of chronic posterolateral rotatory instability. With chronic injuries, the tissue is often of poor quality and repair is not feasible. The literature has discussed the use of multiple different autografts including palmaris longus, gracilis, and triceps fascia [4, 6]. Two different techniques have been described in the literature for securing the graft which will be described in the following sections [27•, 28•].

Overlay technique

Nestor et al. [27•] described a transosseous tunnel and overlay technique through a modified Kocher approach. Once the interval is developed, a posterolateral rotatory instability test is performed to confirm laxity of the ligamentous complex. The autograft of the surgeon's choice is then harvested. The authors' preferred graft is the ipsilateral palmaris longus tendon. Plication sutures are then passed through the anterior and posterior capsule that will be tied after the ligament is repaired. Attention is then turned to creating tunnels in the ulna and humerus. A small burr is used to create two holes just posterior to the supinator crest in the ulna. Care is taken to make sure the entry holes are greater than 7 mm apart to lessen the risk of fracture. An awl or curette can be used to create a connection between the two holes [27•].

The point of isometry on the humerus is then identified with a temporary suture threaded through the ulnar tunnel. A snap is placed on the sutures to identify the point where even tension is maintained throughout flexion and extension of the elbow and this isometric point is then marked for later drilling of the humeral tunnels [27•]. This location is typically slightly posterior to the tip of the lateral epicondyle.

The tendon is then passed through the ulnar tunnel. A docking hole is then drilled with a 4.5-mm drill just posterior and proximal to the isometric point on the lateral epicondyle. A 3.5-mm drill is then used to create proximal tunnels anterior and posterior in order to create a Y-shaped bone tunnel configuration in the lateral epicondyle. The tendon is then passed through those tunnels, reflected back onto and sewn to itself as it crosses the joint with non-absorbable number-1 sutures [15, 27•]. The plication sutures are then tied down to tighten the patulous capsule.

Docking technique

An alternative method for securing the sutures was described by Jones et al. [28•], often referred to as the docking technique. This group also prefers the palmaris tendon autograft but one of the benefits of this procedure is that it does not need as long of a graft as the overlay technique [15]. A modified Kocher approach is again used as described earlier. After the avulsed or attenuated ligament is identified, a Number-1 non-absorbable braided suture is then placed using a Krackow or running stitch of the surgeon's choice through one end of the tendon. The capsule and common extensor tendon are then incised longitudinally, immediately anterior to the posterior border of the extensor tendon to expose the supinator crest and the lateral epicondyle. Two drill holes are made with a 4-mm burr into the ulna with a 1 to 2-cm bridge between them to prevent fracture. The first hole is near the supinator crest and the second is approximately 2 cm proximal near the base of the annular ligament. A curved awl is used to connect the two drill holes to create the tunnel for the graft. The point of isometry on the humerus is identified as described by Nestor [27•]. The 4-mm burr is used to drill a hole at the isometric point on the humerus to a depth of approximately 15 mm. A dental drill is then used to drill two small 15-mm exit holes slightly superior-anterior and supero-posterior to the isometric point. Curettes are used to connect the tunnels. Non-absorbable sutures are then placed in the anterior and posterior capsules to also dock later with the graft for capsular plication if deemed necessary. The graft is placed through the ulnar tunnel. The stitched limb of the graft is placed first into the humeral tunnel with the sutures exiting through the posterior suture hole using a suture passer. The elbow is flexed to 30–40° and the graft is cycled to avoid creep. Final length is eyeballed by placing the free limb of the graft next to the humeral tunnel to visualize the correct length. Mark the graft with a marker and run a No. 1 braded non-absorbable suture using the stitch of the surgeon's choice at the appropriate length. A suture passer is then used to pull the graft and the capsular sutures into the anterior humeral tunnel. The sutures are tied over the boney bridge with the arm in 40° of flexion and full pronation [28•].

Clinical results

O'Driscoll et al. [1•] were the first to publish a series of clinical outcomes of patients undergoing operative treatment for posterolateral rotatory instability of the elbow in 1991. They reviewed five patients, two of whom underwent ligamentous repair while three patients required a reconstruction. The reconstructions were performed with two palmaris autografts and one triceps fascia autograft. One patient was lost to follow-up, and the remaining patients were followed for 15–30 months. They had no apprehension or recurrent episodes of instability, and had full range of motion [1•].

In continued follow-up of this group, two more series were subsequently published with larger patient cohorts and longer follow-up [27•, 29•]. Nestor et al. first reviewed 11 patients (5 from the previous O'Driscoll [1•] study) who underwent operative treatment between 1985 and 1989 for PLRI. Three patients were treated with repair and eight with reconstruction. The average follow-up was 42 months with seven excellent, three fair, and one poor result. Excellent results were defined as patients with no objective or subjective instability, no pain, and less than a 10° limitation of range of motion. A good result had no instability, pain, and/or loss of motion. A fair result had no objective instability but could have subjective instability, mild pain, and some loss of motion. Finally, a poor result had instability or apprehension on the pivot shift test. All of the patients who underwent a repair had an excellent result, but this was felt to be secondary to the fact they had less severe injuries. This patient cohort was also included in the subsequent follow-up study by Sanchez-Sotelo et al. [29•] who published one of the larger studies to date with 44 patients with PLRI. Twelve patients underwent ligamentous repair while 32 underwent reconstruction between 1986 and 1999. Thirty-two patients had a traumatic injury to the elbow while nine patients developed instability after a surgical procedure. The remaining five patients were unable to identify an inciting event. At an average follow-up of 6 years, four of the patients who underwent repair had residual instability compared with three reconstruction patients. Three patients required revision for their instability and four other patients required revision, one for heterotopic ossification while the other three had an interposition arthroplasty for arthritis. The mean Mayo elbow performance score (MEPS) at 6 years was 85 with 17 excellent, 17 good, and 10 fair results. Using the criteria of Nestor et al. [27•], the results were excellent in 19, good in 13, fair in 7, and poor in 5. Thirty-eight patients (86 %) were subjectively satisfied with their repairs. Overall, their reconstruction patients did better than their repairs [29•].

Lee and Teo [30] also reviewed ten PLRI patients; four with previous dislocations, three with a varus stress injury, and three unknown causes. Two patients had cubitus varus from supracondylar humerus fractures as children with minor varus injuries felt to have caused the PLRI. Four patients had previous surgery to their elbows. They used the technique described by Nestor et al. [27•] for reconstruction. Four patients underwent repair while six required reconstruction. At an average follow-up of 24 months, six patients were pain free while four had mild pain over the elbow. No patient had residual instability and all had a negative pivot shift test. Using the same criteria as Nestor et al. [27•], the outcome was excellent in three, good in five, and fair in two. All three patients who were considered to have an excellent outcome had tendon reconstructions which is contradictory to the results of Nestor et al. [27•], as their repairs fared worse than their reconstructions. All ten patients were satisfied [30].

Olsen and Søjbjerg [31] studied 18 patients who underwent a LUCL reconstruction using a triceps fascia graft. Fourteen patients had a stable elbow at final follow-up while four had continued apprehension with a pivot shift test, but only one complained of subjective instability. One failure required revision surgery for instability. Thirteen patients had no or only occasional pain while the remaining five had moderate pain. Mean Mayo elbow performance score at final follow-up was 92. Of note, several patients did have decreased elbow extension strength after this procedure likely related to the triceps fascia harvest [31].

In the largest study to date, Savoie et al. [32•] reviewed 54 patients who underwent arthroscopic versus open repair of the lateral ulnar collateral ligament for PLRI. Twenty-four patients underwent arthroscopic repair while 30 patients underwent an open procedure, with 27 repairs and 3 reconstructions. At 41 months of follow-up, overall clinical outcomes scores improved subjectively and objectively. They found no statistical difference between arthroscopic and open procedures with regards to outcome [32•]. It should be noted that the arthroscopic approach requires a high level of skill, due to the requirement of independent skills needed to perform arthroscopy of the elbow.

Jones et al. [28•] also performed a retrospective review of eight patients undergoing a lateral ulnar ligament reconstruction using a docking technique they described in this study. At an average follow-up of 7.1 years, six of eight patients had complete resolution of their instability. The remaining two patients had occasional subjective instability but all eight had a negative pivot shift test at final follow-up. The average postoperative MEPS was 87.5 with an excellent outcome in four patients and a good outcome in four. All eight patients were satisfied with their surgery. There was an overall 11 % complication rate with an 8 % rate of recurrent instability [28•].

Finally, Anakwenze et al. [2] recently performed a systematic review of eight of the previous articles [1•, 26, 28•, 29•, 30, 31, 33, 34] to try to better understand the results of these small studies when they were looked at together as a larger cohort. Combined, the studies reviewed 130 patients who underwent LUCL repair or reconstruction between 1991 and 2012. All of the patients had soft tissue injuries only and were 17 years of age or older with at least 12 months follow-up. The mean age of the patients was 38.1 years and the average follow-up was 44.5 months (21–85). Of the articles that discussed a preoperative exam, 95 % of the patients had a positive pivot shift with apprehension or frank subluxation/dislocation. Surgery occurred on average of 55.7 weeks from symptom onset. Of the 58 patients that underwent reconstruction for which the choice of graft was recorded, 30 had a triceps fascia graft, 19 palmaris tendon, 6 gracilis tendons, and 1 semitendinosis tendon were used. The average MEPS score was 91 with 29 excellent, 14 good, 4 fair, and no poor outcomes. The postoperative pivot shift test was reported in five studies and was negative in 92 % (72/78) of patients. Five studies included patient satisfaction at final follow-up with 50 of 51 patients satisfied with their final outcome. There were seven overall complications. Six patients had recurrent episodes of elbow instability, one patient had a postoperative hematoma, and there was one superficial infection. The overall reoperation rate for instability was only 2.6 % (2 of 76 patients) [2].

In all, the literature to date has shown mostly satisfactory outcomes for operative treatment of PLRI. Patients whose injuries are acute and their tissue are of appropriate quality, a direct repair can give good outcomes. For the majority of patients with chronic PLRI, however, reconstruction using allograft is required to prevent recurrent instability.

Conclusion

Posterolateral rotatory instability of the elbow is an injury to the lateral ligamentous complex that usually results from a traumatic event. Although there are patients who present soon after an acute traumatic injury, many patient present with chronic PLRI in delayed fashion with pain and mechanical symptoms such as locking, catching, or clicking. The diagnosis is usually a clinical one, using provocative tests such as the posterolateral rotatory instability test, the posterolateral drawer test, and the chair push-up test. Apprehension tends to be seen rather than frank subluxation or dislocation with these tests due to pain and guarding by the patient. Chronic PLRI often fails conservative measures and operative treatment with either lateral ulnar collateral ligament repair or reconstruction is required. Published studies on the clinical outcome after surgical treatment of chronic PLRI demonstrate mostly good and excellent outcomes. Isolated injury without arthritic joint damage allows the best chance at a good outcome. A repair should be performed when the ligamentous tissue is amenable, otherwise a reconstruction with autograft should be performed.

Compliance with ethical standards

Conflict of interest Catherine J. Fedorka and Luke S. Oh declare that they have no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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