Technical Note

Arthroscopic Diagnosis of Posterolateral Rotatory Instability of the Elbow

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Abstract: Posterolateral rotatory instability (PLRI) is the most common form of symptomatic acute and chronic elbow instability. Diagnosis is usually made using a combination of clinical tests and imaging modalities; however, in more subtle forms of instability, these measures may be equivocal. Arthroscopy is a valuable adjunct for diagnosis and treatment of PLRI. It allows direct appreciation of the instability process, quantification of the degree of instability, and identification of concurrent associated pathology. The aim of this technique article is to report a series of reproducible arthroscopic tests used for diagnosis of PLRI with examples of normal and pathologic arthroscopic findings.

Elbow dislocation is defined as static loss of ulnohumeral and radiocapitellar joint congruency, whereas instability is defined as a symptomatic, dynamic disturbance to joint congruency with stress.[1] This rate of acute traumatic elbow dislocation is 7 cases per 100 000 population per year.[2-4] Although only a small proportion of these injuries suffer ongoing instability, 90% of chronic instabilities are the result of nonhealing soft-tissue injuries or bony defects following acute trauma.[1] This is more common in fracture dislocations. Repetitive stress, congenital or acquired deformities, collagen disease, inflammatory arthritis, and iatrogenic injuries due to steroid injections or previous surgery account for the remaining 10% of chronic elbow instability.[1]

The most common form of chronic instability is posterolateral rotatory instability (PLRI). The ubiquitous lesion of PLRI is damage to the lateral collateral ligament (LCL) of the elbow, typically at its humeral origin.

Making the diagnosis of chronic PLRI can be challenging. Currently this is done by taking a clear history, performing a detailed clinical examination, and using advanced imaging such as magnetic resonance imaging.

History is focused on screening for risk factors for instability such as previous trauma, surgery, or corticosteroid injections. The patient's symptoms may describe pseudo locking, loss of motion, apprehension, or pain with certain activities. Clinical examination includes assessment of alignment, the presence of previous scars, and attempting to reproduce instability using a number of provocative tests.

For PLRI, these tests attempt to demonstrate ulnohumeral instability indirectly by reproducing posterolateral translation of radial head. A number of "axial-loading" tests have been described, including the table top relocation test, chair push-up test, and press-up test.[5] In the authors' experience, these tests are not of great value in the clinical setting, as they often miss subtle instability, are awkward to perform, and difficult to quantify.

The pivot shift test is a more useful test where radial head subluxation and relocation is demonstrated by taking the elbow from extension to flexion in the supine position while applying axial load, supination torque and valgus stress.[6] Although the test has high specificity, the sensitivity is low, as it requires practice and clinical expertise to perform and can be uncomfortable for the patient without anesthesia.

The posterolateral rotatory drawer test[6] is a much more sensitive and specific test that is reproducible and possible to perform in clinic. This test is analogous to the Lachman test in the knee and aims to reproduce radial head translation manually in the supine positioned patient. This is the most commonly used clinical test in our practice.

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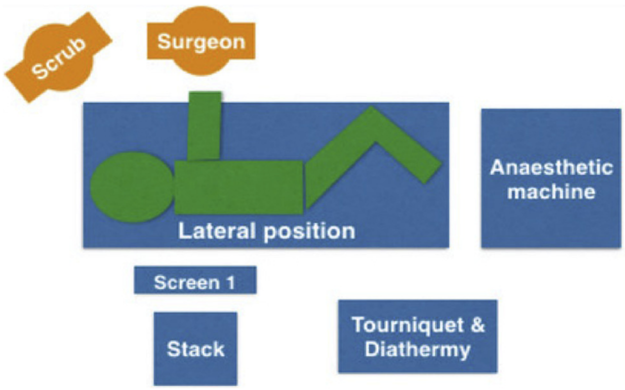

Fig 1. Positioning for elbow arthroscopy in the operating theater. Anesthesia is at foot end of bed. Patient is in lateral position. Surgeon is facing the front of patient and arm with the ability to move into varying degrees of flexion and extension. Monitors are to the posterior side of the patient.

Imaging

Static imaging modalities do not demonstrate instability, which is a dynamic phenomenon but may infer the presence of instability by revealing bony or soft-tissue abnormalities that contribute to instability. These include bony alignment deformities, coronoid dysplasia or deficiency, static subluxation or ligament deficiency. Magnetic resonance imaging is frequently used to assess the osteoligamentous structures. However, it is not dynamic and can underestimate the presence of subtle instability patterns.

Ultrasonography and fluoroscopy are dynamic modalities that can demonstrate radial head subluxation or ulnohumeral widening but are user dependent and not readily available to all clinicians.

The Role of Arthroscopy

Grossly unstable elbows are able to be diagnosed using clinical examination and imaging modalities. Nonetheless, there are a subset of patients with instability that are more difficult to diagnose clinically.

This may be because of patient factors such as co-existing pain, body habitus or guarding, or because the degree of instability is more subtle and challenging to appreciate. A typical example is a patient with lateral elbow pain with multiple prior steroid injections where subtle PLRI may coexist with tendinopathy.[7]

In these situations, arthroscopy allows a direct, dynamic appreciation of the instability and any other coexisting pathology. The degree and pattern of instability can be quantified and, depending upon surgical expertise, treatment can be performed arthroscopically at the same time. Several arthroscopic tests have been described, however, given the paucity of surgical experience and the evolving nature of these techniques, there is limited clear instruction or standardization of how to perform these tests.

The aim of this article is to outline a systematic arthroscopic method to diagnose PLRI using a series of reproducible arthroscopic tests that can be adopted by other surgeons.

Surgical Technique (With Video Illustration)

Patient Positioning and Equipment

General anesthesia with a regional nerve block is used. An examination under anesthetic is performed with the patient in the supine position. Range of motion is assessed and the pivot shift and posterolateral rotatory drawer tests are performed. The patient is then positioned in the lateral decubitus position with precautions taken to protect all bony prominences. A sterile tourniquet and arm holder (TRIMANO; Arthrex, Naples, FL) is used for the arthroscopy but also allows the arm to be easily repositioned for posterior or lateral open approaches if necessary (Fig 1). A standard 4-mm 30° arthroscope is used along with a fluid pump set at 20 mm Hg pressure.

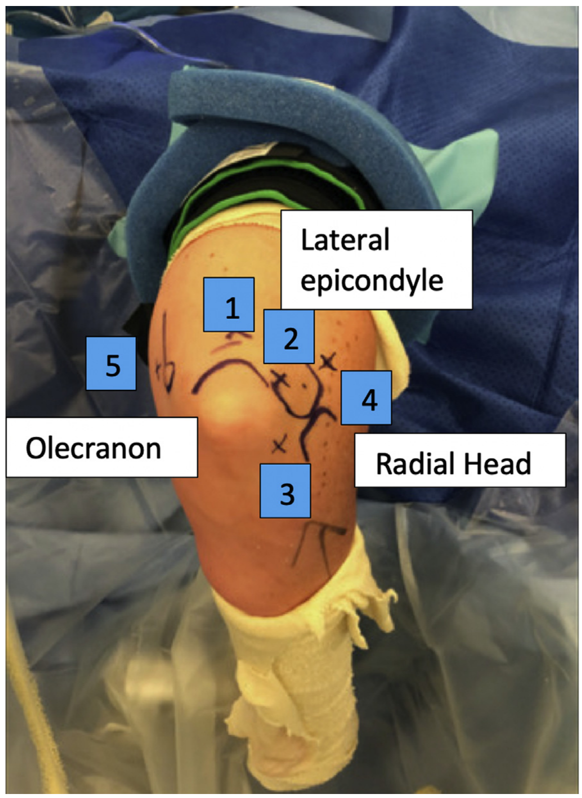

Fig 2. Five portals are used to assess all compartments of the elbow for evidence of posterolateral rotatory instability. (1) Direct posterior. (2) Posterolateral. (3) Accessory posterolateral. (4) Anterolateral. (5) Proximal anteromedial. For most arthroscopic procedures, initial viewing portal is posterolateral (2). For elbow instability, viewing from the direct posterior portal is important to compare ulnar and radial gutters (right side).

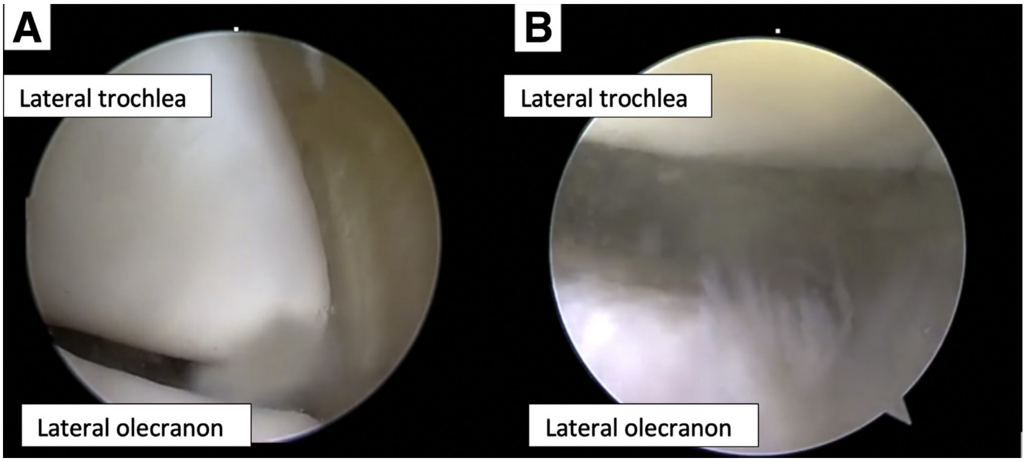

Fig 3. Posterior supination test. Viewing from the direct posterior portal, the scope is directed to lateral gutter. Some widening is observed in the lateral ulnohumeral joint space, with forearm supination in the normal elbow (A). Marked widening is seen in posterolateral rotatory instability (B). (A) Normal widening. (B) Pathologic widening (right side).

Portal Placement and Order of Approach

Five portals are used for a standard, full diagnostic arthroscopy (Fig 2). The posterior compartment is entered first, followed by the posterolateral compartment, followed by the anterior compartment. Most instability pathology is encountered in the posterior and posterolateral compartments.

The posterior compartment is initially entered using the direct posterior portal. A soft-tissue shaver is introduced through the posterolateral portal to create a clear view of the medial and lateral ulnohumeral gutters. From this position, pathologic gapping of the ulnohumeral joint can be assessed using the posterior supination test (see the section "Diagnostic Maneuvers"). The arthroscope is then switched to the posterolateral portal and driven down the lateral gutter until the posterolateral compartment and radiocapitellar joint is visualized. The soft-tissue shaver is introduced via an accessory posterolateral portal and used to attain a clear view of the radiocapitellar joint, proximal radioulnar joint and posterolateral ulnohumeral joint. In this position, the posterolateral supination test, axial pull test, and drive-through test are performed (see the section "Diagnostic Maneuvers").

Finally, the anterior compartment is entered using the proximal anteromedial portal. A proximal anterolateral portal is created using an outside in technique to allow insertion of instruments from the lateral aspect of the joint. An arthroscopic pivot shift test, can be performed and laxity of the annular ligament assessed although

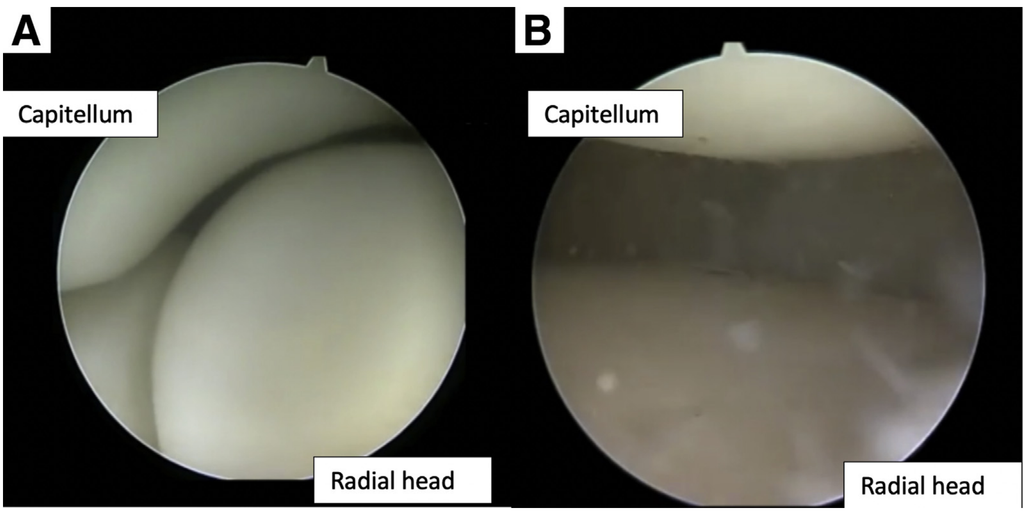

Fig 4. Axial pull test. With the scope in the posterolateral compartment through the posterolateral portal, the radiocapitellar joint is visualized. With supination and axial traction of the forearm, the normal radiocapitellar joint maintains its congruency (A). In PLRI with supination of the forearm tilting open of the radiocapitellar joint can be seen. With axial traction, pathologic gapping of the radiocapitellar joint can be demonstrated, as seen in (B). (A) Normal radiocapitellar congruency. (B) Widening of radiocapitellar joint with anterior rim of radial head visible in PLRI (right side). (PLRI, posterolateral rotatory instability.)

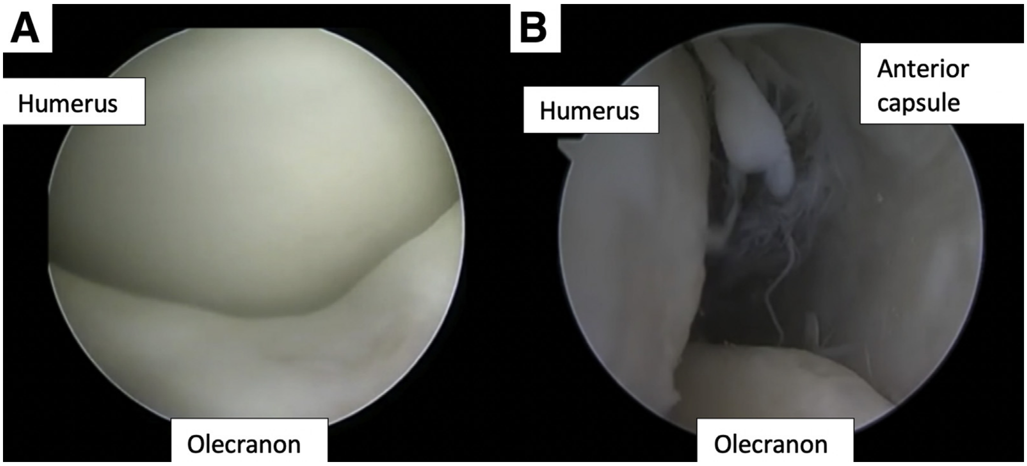

Fig 5. Drive-through sign. With the arthroscope in the posterolateral portal viewing the posterolateral compartment, the scope is directed to view the posterolateral ulnohumeral joint immediately adjacent to the radiocapitellar joint. In a normal elbow, the cartilage of the greater sigmoid notch of the ulna (olecranon) is visible distal to the bare area of the olecranon (A). In posterolateral rotatory instability, the scope can be driven into the anterior compartment or the medial ulna-humeral gutter depending on the instability. In (B) where marked instability is seen, the scope can be driven into the anterior compartment, in this case visualizing the anterior capsule (right side).

compared to the other compartments the anterior compartment provides the least information regarding PLRI.

Diagnostic Maneuvers

Posterior Supination Test (Posterior Compartment)

With the scope in the direct posterior portal, the medial ulnohumeral gutter is viewed. The patient's forearm is then pronated and supinated. With pronation (internal rotation), there is normal widening of the medial ulnohumeral joint and with supination there is closure of this space. Pathologic medial instability can be diagnosed in this region with excessive widening of the joint in pronation.

The scope is then directed into the lateral gutter to view the lateral ulnohumeral joint. Forearm rotation is performed. It is normal to see some widening of the lateral ulnohumeral joint space with supination (external rotation) and closure with pronation. In the normal state the widening is more than seen on the medial side in pronation. However, marked widening of the lateral ulnohumeral joint with forearm supination is consistent with lateral ligament insufficiency and PLRI (Fig 3) (Video 1).

Posterolateral Supination Test (Posterolateral Compartment)

With the scope in the posterolateral portal the radiocapitellar joint is visualized. The forearm is then supinated. In PLRI, there will be widening of the posterolateral ulnohumeral joint space and uncovering of the radial head from beneath the capitellum because of LCL insufficiency. The joint is seen to tilt open with supination. This can be exacerbated by extending the

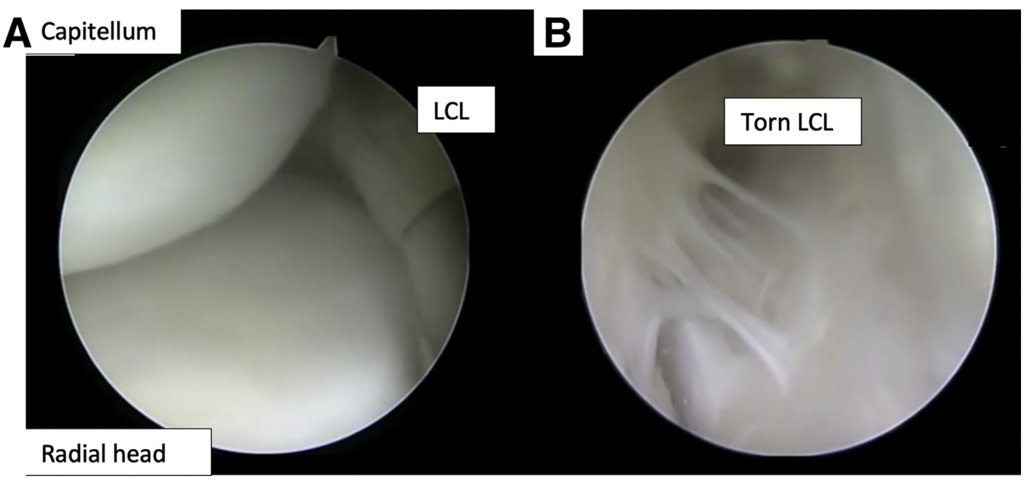

Fig 6. Visualization of LCL insertion. Posterolateral compartment. With the arthroscope in the posterolateral portal the scope is directed to view the humeral origin of the LCL at the lateral most aspect of the radio capitellar joint (A). In PLRI, remnants of torn LCL can be visualized (B). (A) Intact LCL. (B) Torn LCL in chronic PLRI (right side). (LCL, lateral collateral ligament; PLRI, posterolateral rotatory instability.)

Table 1. The 4 Diagnostic Tests With Our Anecdotal Quantification of What Is Abnormal During Testing

Diagnostic Maneuver	Location	Abnormal Finding
Posterior supination test	Posterior compartment	>5 mm gapping of lateral UHJ
Posterolateral supination test	Posterolateral compartment	>5 mm gapping of RC joint with full view of radial head articular surface including anterior rim
Axial pull test	Posterolateral compartment	>5 mm gap between capitellum and trochlea Anterior compartment visible through RC joint
Drive-through test	Posterolateral compartment	Possible to push arthroscope through into anterior compartment and/or medial UHJ gutter

These findings are based on observation in our practice, and we aim to objectively quantify these with further research.
RC, radiocapitellar; UHJ, lateral ulnohumeral joint.

elbow at the same time to fully uncover the radial head from the capitellum. Visualization of the anterior rim of the radial head moving posteriorly from underneath the capitellum is consistent with PLRI. Pronation of the forearm reverses these displacements and reduces the joint (Video 1).

Axial Pull Test (Posterolateral Compartment)

With the arthroscope in the posterolateral portal viewing the posterolateral compartment, axial traction is applied to the forearm. In the normal setting there should be minimal gapping of the radio capitellar joint space. In PLRI, there will be obvious gapping and divergence of the radio capitellar joint space as well as varus tilting of the forearm relative to the humerus. In extreme cases the anterior compartment can be visualized through the widened radio capitellar joint space (Fig 4) (Video 1).

Drive-Through Sign (Posterolateral Compartment)

With the arthroscope in the posterolateral portal viewing the posterolateral compartment, the scope is directed to view the posterolateral ulnohumeral joint immediately adjacent to the radiocapitellar joint. In a normal elbow, the cartilage of the greater sigmoid notch of the ulna (olecranon) is visible distal to the bare area of the olecranon. In an unstable elbow, the scope can be driven through the ulnohumeral joint to a varying degree, depending on the degree of instability. In marked PLRI, the scope can be driven fully into the anterior compartment and/or the medial ulnohumeral gutter such that the coronoid and anterior capsule are visualized (Fig 5) (Video 1).

Visualization of the LCL Insertion (Posterolateral Compartment)

With the arthroscope in the posterolateral portal the scope is directed to view the humeral origin of the LCL at the lateral most aspect of the radio capitellar joint. In acute cases the LCL can be seen to be torn from the lateral epicondyle. In chronic cases this may be less apparent although pathologic changes to the insertion are frequently seen (Fig 6) (Video 1).

Axial Pull Test (Anterior Compartment)

With the arthroscope in the proximal anteromedial portal, the anterior compartment is visualized. The pull test may be repeated and positive and the radial head may "disappear" posteriorly with supination and extension in PLRI, however these findings are less obvious and reproducible when viewing from the anterior compartment than those described for the posterior and posterolateral compartments.

Discussion

In this article, we describe the arthroscopic tests used in our practice to confirm or diagnose PLRI of the elbow. The diagnostic maneuvers outlined are

Table 2. Pearls and Pitfalls of the Arthroscopic Technique for Diagnosis of PLRI

Pearls	Pitfalls
Perform these tests in every elbow arthroscopy to allow an appreciation of the normal findings	There is some degree of physiologic ulnohumeral joint widening with forearm supination therefore be careful not to over diagnose and over treat PLRI
Use standardized portals and camera positions to get consistent comparable findings	In hyperlax patients, there will be more evidence of PLRI, which is not abnormal for them—the arthroscopic findings may not be pathological
Have an assistant to perform maneuvers on the arm while the surgeon maintains the view	Surgeons should be familiar with elbow arthroscopy to avoid complications such as nerve injury
Start in the posterior compartment where the findings tend to be in the posterior and posterolateral compartment	If subtle PLRI is noted in a patient having an arthroscopic tennis elbow release, the release may exacerbate the condition; therefore, either an open repair with ligament reefing or formal reconstruction should be considered and discussed with the patient

PLRI, posterolateral rotatory instability.

Table 3. Advantages and Disadvantages of Using Arthroscopy for Diagnosis of Posterolateral Rotatory Instability

Advantages	Disadvantages
Offers a clear and thorough understanding of the patient's pathoanatomy	Requires expertise and training in elbow arthroscopy
Allows diagnosis of subtle forms of instability not appreciated with clinical examination and imaging	Requires anesthesia for diagnosis so should only be performed in cases where the diagnosis is suspected but not made by conventional techniques
Allows for concurrent treatment of pathology as its appreciated	Adds to health care costs compared with clinical examination therefore should be reserved for subtle instability which is not diagnosed through other means

mentioned sporadically in the literature but are not clearly described in one article with a focus on diagnosis of PLRI. If surgeons are to use arthroscopy to diagnose and treat PLRI, there should be a more systematic and prescriptive technical approach which is what we have provided in this article.

Other authors have pioneered arthroscopy in the management of elbow instability. Savoie et al.[2] have developed arthroscopic techniques for fixation of the LCL but their emphasis has been on treatment rather than diagnosis. For diagnosis, they view the anterolateral compartment and observe posterior rotatory translation of the radial head with supination and extension. In our experience, the primary diagnostic findings are best appreciated in the posterior and posterolateral compartments where direct subluxation and gapping of the radiocapitellar and ulnohumeral joint can be observed and quantified. van Riet et al.[8] also place more emphasis on diagnosis of PLRI in the posterolateral compartment and have developed a ligament plication technique to address LCL laxity, which we have adopted with some success. What remains unclear is how to interpret the signs seen on arthroscopic examination and for each test, what the normal variation is, i.e., what is normal and what is pathologic. To our knowledge, this has not been reported in the literature and any current recommendations are based on opinion and experience rather than objective data. Our aim is to investigate this in cadaveric and in vivo studies. This is important as we have observed certain patient groups with greater but normal degrees of laxity. Younger, female patients fall into this group, largely because of increased global hyperlaxity and elbow hyperextension. In these patients, it is important to preoperatively examine their opposite elbow using the posterolateral rotatory drawer test, document the degree of hyperextension and perform a Beighton score to understand what their normal degree of elbow laxity is in order to avoid over diagnosis of PLRI. Conversely, patients who have little laxity in the opposite elbow and positive clinical and arthroscopic findings are likely to have pathologic PLRI present. Our current anecdotal experience for positive quantification of the diagnostic maneuvers outlined in this article is shown in Table 1 but remains subject to further objective research. Pearls and pitfalls and advantages and disadvantages are summarized in Tables 2 and 3, respectively.

Conclusions

To our knowledge, this is the first article with accompanying instructional videos that clearly documents the arthroscopic tests used in clinical practice to diagnose PLRI.

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