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Review Article

Arthroscopic Management of Lateral Epicondylitis

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Abstract

Lateral epicondylitis is a common disorder that affects 1% to 3% of the general population. This dysvascular and degenerative condition presents with lateral elbow pain worse with wrist extension against resistance. The primary pathologic tissue is believed to be the tendinous origin of the extensor carpi radialis brevis. The condition is self-limited in 70% to 80% of patients; therefore conservative management is first line. Surgery may be considered in persistent cases of lateral epicondylitis refractory to conservative therapy and is required in 4% to 11% of patients. The three common surgical modalities for treatment are open, percutaneous, and arthroscopic, all with good results thus far. This article aims to summarize arthroscopic treatment of lateral epicondylitis and discuss its advantages, techniques, rehabilitation, outcomes, and complications.

Introduction

In 1873, Runge [1] first described the condition of lateral epicondylitis. A decade later, Morris associated the symptoms with lawn tennis, and the term 'tennis elbow' was coined [2]. Lateral epicondylitis may occur with sports, but is often the result of activities or work conditions including forceful activities, high repetitions, or awkward posture [3,4].

Incidence

Lateral epicondylitis (LE) occurs in 1% to 3% of the general population, and most commonly affects the dominant extremity [3] of adults aged 35 to 50 years old [4]. LE reportedly occurs equally in males and females, [3,5] although one study found males are four to five times more likely to develop LE compared to females [6]. The condition is usually self-limited, [7,8] although some articles report of a less favorable prognosis. Bot et al [9]. found 90% of all patients report some improvement after one year, but only one-third of patients report full recovery. Nilsson et al [10] reported in that 297 patients after two years of conservative care, 54% had continued pain, while 46% had reduced function.

Pathophysiology

The tendinous origin of extensor carpi radialis brevis (ECRB) has often been cited as the most likely cause of LE [3,11]. Lateral epicondylitis was initially thought to be an inflammatory process where partial tearing of the ECRB muscle and periosteum of lateral epicondyle caused an inflammatory response leading to pain [2]. The condition is now known to be a dysvascular and degenerative process without inflammation [12]. LE is better described as 'tendinosis' (Figure 1), rather than tendinitis [2]. Cumulative microtrauma that exceeds the tissue's capacity for repair leads to a degenerative process characterized by disruption of tendon fibers, invasion of fibroblasts, disorganized collagen, and vascular hyperplasia [2,7,8]. Additionally, the tendon of ECRB is contiguous with the tendon of extensor digitorum communis (EDC), and lesions may therefore involve both structures [12]. Although most literature focuses on ECRB, other structures that have been suggested as causative factors include annular ligament, collateral ligamentous complex, lateral capsule, radial nerve, and several bands of EDC [2,13].

Examination

Symptoms

The typical pain of lateral epicondylitis is centered over the lateral elbow and may radiate to the proximal forearm and occasionally proximal to the elbow [3,12]. Pain varies between patients and can range from intermittent ache to constant and severe pain [3]. Lateral epicondylitis is often associated with diminished grip strength which may affect sports performance, work activities, and activities of daily living [3,12]. Symptoms typically progress insidiously in older patients, but may begin abruptly in young adults with an inciting event such as lifting or trauma [3,12].

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Physical Exam

On presentation, a thorough physical exam should be performed, with particular attention paid to neck and upper extremity [12]. Shoulder exam should be performed as some patients may be compensating for a dysfunctional shoulder [3]. Lateral epicondylitis pain is reproducible with pressure over lateral epicondyle, common extensor tendon origin, and often extensor muscles distal from the epicondyle [2]. Several physical exam maneuvers may assist in the diagnosis of lateral epicondylitis, although their diagnostic accuracy has not been determined [14], these maneuvers include Cozen's test (active dorsiflexion of wrist against resistance) [15], Polk's test (lifting a 5 lb object with elbow in flexion) [16], Maudsley's test (active long finger extension against resistance) [17] and Mill's test (passive palmar wrist flexion). These tests are all performed with a pronated forearm and are positive when pain is elicited over the lateral epicondyle. A complete elbow exam should include a systematic evaluation of elbow stability, range of motion, strength testing, and neurovascular function [3]. Elbow stability may be evaluated with varus and valgus stress testing and posterolateral rotatory stability evaluation with a lateral pivot-shift maneuver. To perform the posterolateral rotatory stability test, a valgus stress and axial load are applied to a partially flexed elbow with forearm fully supinated [12]. Posterior subluxation of the radial head is a positive test, while apprehension and pain without subluxation is suggestive, but not diagnostic of rotatory instability.

Imaging

Plain radiographs may be obtained for suspected LE and help rule out other potential causes of pain such as radiocapitellar arthritis. Radiographs may demonstrate calcification in soft tissue near ECRB insertion on the lateral epicondyle, although they are typically normal [3]. Magnetic Resonance Imaging (MRI) is not required, but can confirm the diagnosis of LE with high sensitivity (90% to 100%) and specificity (83% to 100%) [18]. MRI may provide useful information about tendon defect size [12]. Abnormally high signal intensity in thickened common extensor tendon origin may be seen on T2-weighted and short T1 inversion recovery sequences [19]. If the common extensor tendon appears normal, adjacent soft-tissue edema is usually present on T2-weighted sequences [3]. MRI can also help determine the presence of osteochondral defects, intra-articular loose bodies, or ligamentous injuries [3] additionally; ultrasound is another imaging modality that may assist in diagnosis of lateral epicondylitis. A systematic review article by Dones et al [20]. evaluated 15 diagnostic studies and ultrasonographic findings of lateral epicondylitis. Hypoechogenicity of the common extensor origin was found to be moderately sensitive (64%) and highly specific (82%). Additionally, neovascularity, calcifications, and cortical irregularities were found to be highly specific at 100%, 97%, and 96%, respectively. Partial and complete tears of the common extensor tendon may also be seen as discrete cleavage planes on a background of decreased echotexture [21].

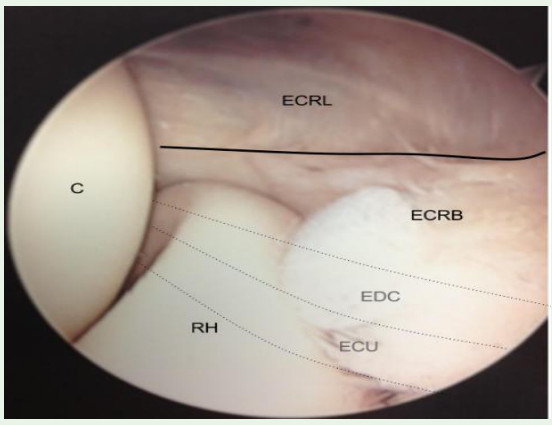

Figure 1: Intraoperative arthroscopic view demonstrating extensor carpi radialis brevis (ECRB) tendinosis. ECRL = extensor carpi radialis longus, EDC = extensor digitorum communis, ECU = extensor carpi ulnaris, RH = radial head, C = capitulum.

Differential Diagnosis

It is important to eliminate other conditions that may mimic or occur concomitantly with lateral epicondylitis. Lateral elbow pain may be caused by several other conditions including synovial plica, intra-articular body, osteochondritis dissecans of the capitulum, radiocapitellar arthrosis, cervical radiculopathy, posterolateral rotatory instability, and radial tunnel syndrome [3,21]. Before elbow strapping, radial tunnel syndrome should be ruled out as strapping may further compress the posterior interosseous nerve at site of entrapment [3]. Radial tunnel syndrome presents with pain along the dorsoradial aspect of proximal forearm and asymmetrical localized tenderness over the radial tunnel located deep to the brachioradialis muscle and approximately 3 to 5 cm distal to the lateral epicondyle [22]. Radial tunnel syndrome may also present with extensor weakness without sensory deficit from compression of the posterior interosseous nerve [22]. Radial tunnel syndrome may be confused with LE because of its proximity to site of tenderness to LE [3].

Treatment Options

Conservative therapy is considered first line for lateral epicondylitis; as the condition is typically self-limited with 70% to 80% of patients achieving relief of symptoms by one year [12]. Surgery is reserved for patients with recalcitrant elbow pain after failing nonsurgical management [12]. Surgical options include open, percutaneous, and arthroscopic techniques.

Non-operative treatment options

Conservative options for lateral epicondylitis include rest, activity modification, nonsteroidal anti-inflammatory drugs, forearm counterforce bracing, physical therapy and corticosteroid injections [2,3,12]. The importance of rest from inciting activity should be emphasized first, and in active patients activity modification should be discussed [3]. Counterforce bracing can be effective for pain and works by distributing tension from the ECRB tendon to other areas [3].

Andres and Murrell [23] performed a systematic review of oral Non steroidal Anti-Inflammatory Drugs (NSAIDs). They found NSAIDs provide short term pain relief, but no evidence to support long-term effectiveness in LE. Topical agents may also be used, particularly in patients with gastroenterological conditions or oral NSAID sensitivities [3]. Creams may be compounded with multiple ingredients including diclofenac. Hoogvliet et al. [24] published a systematic review of physical therapy and supported its use in management of LE.

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In addition to traditional conservative therapies, other novel treatment methods have become more popular including extracorporeal shockwave, autologous blood injections, and Platelet-Rich Plasma (PRP) injections [3]. Several alternative medicine options have also been described in literature including acupuncture, dry needling, prolotherapy, deep tissue massage, kinesio taping, low frequency heat, and electric stimulation [2,3,23]. The success rates of all of these alternative medicine therapies are approximately 85% [2]. It remains possible that these therapies may just allow normal healing to occur rather than improving outcomes.

Surgical treatment options

In cases of persistent LE refractory to a minimum of six to nine months of conservative therapy, surgery may be considered [12,25] and is required in 4% to 11% of patients for symptom relief [3,7,8]. Surgical options for LE exist through open, arthroscopic, and percutaneous modalities. Over 15 surgical techniques exist [26] including simple release, epicondylectomy division of common extensor origin, reconstruction of common extensor tendons, separation of deep fascia that covers common extensor tendon, denervation of lateral epicondyle, excision of intra-articular capsular folds, division of the annular ligament, distal ECRB tenotomy near wrist, and debridement of degenerative ECRB and EDC tendon tissue [12,26]. The majority of surgical procedures for LE involve release and debridement of the tendons with their attachment on the lateral epicondyle, with particular attention paid to ECRB [27]. These techniques aim to relieve stress at the tendon insertion through the release of the common extensor origin [27,28] or removal of degenerative tissue [8,27].

Open treatment

Current open treatment primarily focuses on resection of ECRB tendinosis tissue (Figure 2) with or without repair of the extensor tendon origin [3]. Nirschl and Pettrone [8] evaluated 1,213 clinical elbow cases and performed open surgery on 88 elbows of 82 patients. They achieved a 97.7% overall improvement and 85.2% of patients returning to full activity including sports. 66 elbows achieve excellent results, 9 elbows had good results, 11 elbows had fair results, and 2 elbows failed. Their technique involved open identification and excision of tendinosis tissue within ECRB and decortication or drilling of lateral epicondyle to stimulate blood flow. Anatomic repair of ECRL and EDC was then performed. The authors believed ECRB did not retract because of close fascial adherence to ECRL, therefore did not require repair.

Percutaneous release

In 1982, Baumgard and Swartz [29] performed percutaneous release on 34 elbows and found 91% had complete symptom relief at average follow-up of three years. Yerger and Turner [30] later described an in office percutaneous release. Under local anesthetic in the prone position, a 2 mm incision was made anterior to the tip of the lateral epicondyle and parallel to the long axis of the humerus (Figure 3). After releasing the ECRB, the patient was asked to flex and extend the elbow against resistance while the surgeon evaluated for a defect at the ECRB origin. Compared to open and arthroscopic techniques, a notable difference of the percutaneous method is the procedure lengthens the ECRB tendon, rather than remove the diseased tendon [31].

Arthroscopic release

Arthroscopic release Baker et al [32]. described an arthroscopic technique for lateral epicondylitis treatment outlined here. First, the joint is insufflated with 30 mL of normal saline through the soft spot of the lateral epicondyle, radial head, and olecranon. Elbow is flexed to 90° and forearm is placed in a neutral position. The proximal anteromedial portal is established (2 cm proximal and 1 cm anterior to medial epicondyle) using the nick-and-spread technique. Arthroscopic cannula is introduced aiming towards the center of the joint. Next, the proximal anterolateral portal is established (2 cm proximal and 1 cm anterior to lateral epicondyle) using an outside-in or inside-out technique. The lateral joint capsule is then released with a shaver or electrothermal device, thereby revealing the extracapsular ECRB. Beginning from the most proximal attachment, the ECRB origin is debrided from the lateral epicondyle from the anterior half of the radial head. Debridement to the posterior half may put the lateral ulnar collateral ligament at risk. Additionally, portions of the ECRL and EDC may be debrided as well, with careful attention to not advance too superficially as this puts lateral cutaneous tissue at risk.

Figure 2: Open excision of pathologic extensor carpi radialis brevis tendon. (From Pomerantz ML. Complications of Lateral epicondylar release. Orthop Clin N Am 2016; 47:445-469).

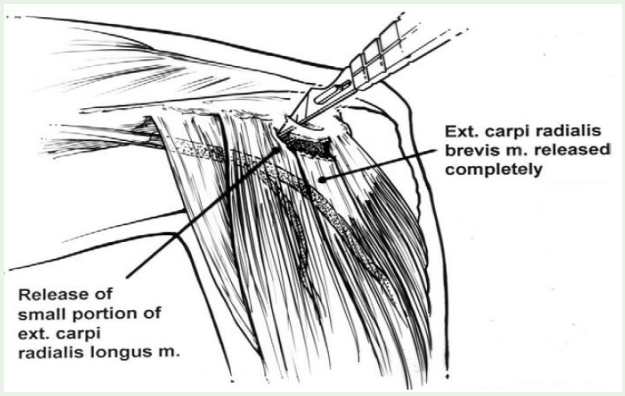

Figure 3: Percutaneous release of extensor carpi radialis brevis. (From Szabo SJ, Savoie FH III, Field LD, Ramsey JR, Hosemann CD. Tendinosis of the extensor carpi radialis brevis: An evaluation of three methods of operative treatment. J Shoulder Elbow Surg 2006; 15:721-727).

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During arthroscopy, additional intra-articular pathology may be found and addressed intraoperatively. Recent advances in arthroscopic repair and increased recognition of coexisting lesions have allowed arthroscopic technique to provide excellent results [2]. Pathology that may be discovered during arthroscopic LE surgery includes split or damage to the ligamentous structures and inflamed posterolateral synovial plica [2]. As damage to the ligamentous structures is the most important injury, a split or avulsion of the direct lateral part of the radial ulnohumeral complex should be repaired if present [2]. Lateral collateral ligament splits may be repaired using a needle-retriever technique or anchored together [2].

Radiocapitellar synovial plica

Although ECRB origin is the most commonly discussed pathologic structure in LE, other structures have also been implicated, namely radiocapitellar synovial plica. Some authors recommend excision of radiocapitellar plica, as this structure may contribute to lateral elbow pain [33]. Plica resection can be performed without jeopardizing results [2]. Mullett et al [33]. described an arthroscopic technique to resect the degenerative capsulosynovial fold of the leading edge of the annular ligament while leaving the common extensor origin undisturbed. In 30 patients, they reported a 93% complete relief of symptoms at 2 weeks. Rhyou and Kim [34] retrospectively reviewed 38 patients to evaluate whether posterior synovial plica excision was necessary in arthroscopic LE surgery. They compared 20 patients who received only ECRB origin debridement with 18 patients who received ECRB origin debridement and resection of radiocapitellar synovial plica. With a minimum follow-up of 2 years, they found no difference in Visual Analog Scale (VAS) pain or Disability of Arm Shoulder and Hand (DASH) scores at final follow-up. They concluded that debridement of posterior synovial fold did not appear to improve long term pain relief or function compared to ECRB origin debridement alone.

Techniques

In addition to the prototypical arthroscopic ECRB tendon resection, other arthroscopic techniques have been described, including debridement, decortication, plication of ECRB to ECRL, lateral epicondyle anchor placement, and extra-articular technique. Solheim et al [27] retrospectively compared arthroscopic tenotomy (n = 204) versus debridement (n = 79) with a minimum follow-up period of four years. Both groups saw significant improvement compared to baseline, but no significant difference was found between the two groups in Quick DASH, pain, function, or reoperation rate. The debridement group saw shorter mean length of sick leave by two weeks (p = 0.007) suggesting that tenotomy of ECRB may be an unnecessary step in arthroscopic treatment of LE.

Another technique, decortication of the lateral epicondyle may be performed with a shaver or burr [12]. Decortication was initially proposed to improve healing of the damaged ECRB, to parallel the drilling used in open technique [32]. Kim et al. [26] retrospectively studied patients receiving arthroscopic ECRB release with decortication (n = 19) versus simple ECRB release without decortication (n = 19). In the simple ECRB release group, the authors found patients had significantly less pain immediately postoperative, less pain on exertion at two and four weeks postoperative and faster return to work by approximately 15 days less. The study suggests that decortication of the lateral epicondyle leads to increased postoperative pain without improving clinical results.

Additionally, Savoie and O'Brien [2] described two optional repair techniques. The first technique involves plication of remaining ECRB to overlying ECRL using absorbable sutures. This is performed using a simple needle-retriever technique, where the needle is passed through ECRB while absorbable suture are then passed through the needle into the joint and retrieved through the ECRL and lateral intermuscular septum via the lateral portal. The suture ends are retrieved subcutaneously and tied together, thus repairing the ECRB to ECRL and lateral septum. The second optional technique offered by Savoie and O'Brien uses the anterolateral portal to place an anchor into the anterior aspect of the lateral epicondyle. Sutures are passed into the joint and retrieved through the capsule and ECRB. The suture ends are retrieved percutaneously through a modified lateral portal and tied deep to ECRL.

Finally, Brooks-Hill and Regan [35] described an extra-articular technique for LE release, which was successfully performed on 20 patients without complications. The technique involves placing the arthroscope extra-articularly through the middle anterolateral portal, while the shaver is placed in the proximal anterolateral portal. The reported advantages include direct visualization of diseased structures and less joint capsule loss. The small capsular hole required for the extra-articular technique could theoretically decrease swelling and the risk of compartment syndrome compared to the more extensive capsular excision required for intra-articular technique.

Rehabilitation

After arthroscopic surgery, immediate active motion exercises of the elbow and forearm are encouraged [12,27]. A sling may be worn for comfort for two to four days [27]. Washing over the portal sites can occur after two to three days [12]. Weightlifting is restricted for six weeks, with gradual return to unrestricted activities over two months [12]. Conservative measures such as stretching and forearm counterforce bracing may be continued as needed. Physical therapy may be considered in patients with persistent elbow pain or strength deficits [12].

Office workers not using a computer may return to work between two and four weeks, while manual workers may take eight weeks or more [27]. Owens [36] and Baker [32] reported return to work of six days and 2.2 weeks respectively. Particular attention must be paid to patients who desire to return to heavy work as soon as possible [25].

Outcomes

Results of arthroscopic treatment of lateral epicondylitis have been comparable to open treatment at midterm follow-up [12]. Regardless of surgical technique, time course for relief of symptoms is variable [12]. Current retrospective studies show satisfactory, good, or excellent results in approximately 70% or more of cases [12]. Despite this, early studies had rates of postoperative pain between 10% and 20% [37-39]. Successful outcomes of the studies discussed below are summarized in Table 1.

Baker and Baker [40] performed arthroscopic resection of pathologic tissue on 42 elbows, 30 of which had extensive follow-up at an average of 130 months. They found mean pain score at rest of 0, during activities of daily living of 10, and with work or sports of

19 out of 100. Mean functional score was 11.7 out of a possible 12 points. 23 patients (77%) stated they were much better, 6 patients (20%) stated better, and 1 patient (3%) had no change. The overall satisfaction was 87% with 93% (28 patients) stating they would have surgery again if needed.

Oki et al. [25] reported on a retrospective case-control study of 23 patients after arthroscopic debridement of the capsule and ECRB. They evaluated functional recovery of patients using VAS pain during rest and activity, grip strength, DASH scores, and Japanese Orthopedic Association (JOA) elbow scores. The results showed continuously improving function and scores for three months postoperatively. VAS pain score at rest improved significantly one month after surgery (26 to 8) and plateaued thereafter, while pain with activity followed a different trajectory with significant improvement in the first month (68 to 35) and continued improvement over the 24 months evaluated.

Outcome predictors

To improve surgical results, it is important to identify patient risk factors associated with worse outcomes. Young age has been identified as a weak predictor for poor outcomes from surgery [28]. Despite being associated with a worse baseline, smoking may not affect postoperative outcomes and therefore has not been identified as a contraindication to arthroscopic LE surgery [4,27]. Also, prior open ECRB release is not a contraindication, as one author reported successfully treating a number of patients with revision arthroscopic surgery [40].

Table 1: Summary of outcomes of arthroscopic lateral epicondylitis studies.

Studies evaluating arthroscopic surgeries only						
Study	**Publication Year**	**Design**	**Number of surgeries**	**Finding: preoperative --> postoperative measurements**	**Follow-up**	**Complications**
Baker and Baker [23]	2008	Case series	30	**At final follow-up**	130 months (mean)	0 reoperations, 1 continued counterforce brace with heavy activity
				VAS pain at rest: 0		
				VAS pain with activities of daily living: 10		
				Functional score: 11.7/12		
				87% satisfaction		
Oki et al [25]	2014	Case series	23	**At 3 months**	24 months	None reported
				VAS pain at rest: 26 --> 3		
				VAS pain during activity: 68 --> 19		
				DASH: 32 --> 15		
				At 1 month		
				JOA score 38 --> 61		
Studies comparing different techniques						
Pomerantz [37]	2016	Review article	660	1.1% complications in arthroscopic technique	Not reported	3 nerve complications, 1 hematoma, 3 infections
				1.9% complications in percutaneous technique		
				4.3% complications in open technique		
Solheim et al [5]	2013	Case - control study	225	QuickDASH in arthroscopic: 60.2 --> 11.6	48 months (median)	0 deep infections, permanent nerve injuries, or elbow stiffness, 16 (7%) poor outcomes (QuickDash > 60 after surgery)
				QuickDASH in open technique: 60.5 --> 17.8		
Szabo et al [31]	2006	Case - control study	44	No significant difference between arthroscopic, open, or percutaneous procedures in regards to recurrences, complications, failures, VAS scores, preoperative and postoperative Andrews-Carson scores	47.8 months (mean)	1 reoperation

VAS = Visual Analog Scale (scale out of 100 points), DASH = Disability of Arm, Shoulder, and Hand (scale out of 100 points), JOA = Japanese Orthopedic Association (scale out of 100 points).

Yoon et al [4]. retrospectively reviewed 45 patients with arthroscopic ECRB release and related outcomes with preoperative tendon status and sex. All patients had significant clinical improvement on VAS pain, Upper Extremity Functional Scale, and Mayo Elbow Scores. At final follow-up, 37 patients (82.2%) of patients were satisfied with outcomes, while eight patients (17.8%) were not. ECRB tendon status was evaluated based on classification from Walton [41] on T2-weighted fat-suppressed coronal plane MRI. Classification is as follows: homogeneous low intensity or mild focal increased tendon signal (grade I defect), tendon with 2 to 5 mm defect (grade II), or tendon with ≥ 6 mm defect (grade III). They found female sex ($p = 0.016$) and grade III tendon defect (≥ 6 mm) to be associated with dissatisfaction. The study also found that age, arm dominance, smoking status, underlying medical disease (hypertension or diabetes), duration of symptoms, treatment history, traumatic history, level of sport activity, elbow demands, and number of prior steroid injections did not affect postoperative satisfaction. Extent of calcification was also found to be not significantly affecting outcome scores. Intraoperative findings that were not correlated with postoperative results include capsular tear status, presence of plica, and degree of synovitis. The authors suggested patients without additional risk factors (female and high grade tendon defect), typically result in positive clinical outcomes, even in patients with articular pathologic conditions.

In contrast to the findings of Yoon, Wada et al. [42] performed arthroscopic release of 20 patients with LE and found lack of high signal intensity on T2-weighted images of ECRB correlated with worse outcomes. The authors found that preoperative MRI of ECRB origin and socioeconomic factors (receiving public assistance) were significantly associated with postoperative residual symptoms as evaluated by the DASH score.

Grewal et al. [43] conducted a retrospective review of 36 patients who received arthroscopic LE release. Although 30 of the 36 patients reported symptomatic improvement with surgery, patients with heavy or repetitive work and patients involved in workers' compensation claims had significantly worse outcomes on standardized outcome measures. The study had a high number of patients involved with heavy or repetitive work (25 patients) and workers' compensation claims (26 patients). Patient selection and occupational demands may therefore have an important role in determining outcomes.

Complications

Relatively few complications have been reported for arthroscopic LE surgery. Carofino et al. [44] described two cases of nerve injury in arthroscopic LE surgery: one case of posterior interosseous nerve transection and one case of partial median nerve laceration. The authors believed the injuries were most likely caused by portal placements or by the shaver. In a review article by Pomerantz, [45] 12 studies and 660 arthroscopic LE surgeries were reviewed. Seven total complications (1.1%) were found and included three cases of infection, one hematoma, and three nerve issues (one forearm paresthesias, one ulnar sensory deficit, and one complex regional pain syndrome).

Appropriate surgical technique should be employed to avoid adverse outcomes. Nick-and-spread technique should be used to avoid cutaneous nerve injuries [45]. To avoid deep nerve injury, trocars should be aimed towards the center of the joint when establishing portals [44]. It is important to avoid passing through soft tissues anterior to the joint where neurovascular structures reside [44]. The proximal lateral portal is the safest lateral portal regarding the radial nerve [45]. While placing the anteromedial portal, care should be taken to avoid the medial antebrachial cutaneous nerve and median nerve. Placing the portal posterior to the intermuscular septum puts the ulnar nerve at risk [45]. Additionally, incomplete release may result in less than ideal improvement of symptoms [40].

Open versus Arthroscopy

When compared to open methods, arthroscopic LE surgery has several advantages including limited skin incisions, quicker rehabilitation, faster return to normal activities [5,12,25]. Arthroscopic tendon release also may also result in slightly better outcomes [6] and faster return to work [35]. Preservation of wrist extensor muscles and tendon tissues overlying ECRB and EDC origins [12] may result in improved grip strength [32]. Arthroscopic surgery also allows for inspection of the interior joint and treatment of concurrent intra-articular pathology, that may be seen found intraoperatively [12,25].

Compared to other surgical options, open technique is more invasive and therefore a higher risk of complication may be expected, however recent higher quality studies demonstrate complications of open and arthroscopic techniques are essentially the same [27,31,37,45]. Despite this, Solheim et al. [5] conducted a case-control study of 305 patients and found a small, but statistically significant improved ($p = 0.004$) outcome for the arthroscopic tenotomy group (11.6 ± 15.6) compared to open tenotomy group (17.8 ± 19.4) evaluated by Quick DASH at a minimum of three year follow-up.

Szabo et al. [31] performed a comparative study of 102 patients with three different surgical modalities with mean follow-up of 47.8 months. 23 patients received percutaneous treatment, 41 received arthroscopic treatment, and 38 received open treatment. A significant improvement was noted when comparing postoperative to preoperative on the Andrews-Carson score in all three groups. No substantial difference was found between the groups in regards to complications, recurrences, failures, VAS pain scores, or preoperative and postoperative Andrews-Carson score. Failures, as defined as need for further surgical intervention, occurred in three patients who received percutaneous treatment, one who received arthroscopic treatment, and two who received open treatment. Pomerantz [45] in a review of 67 studies, found low rates of complications for open (4.3%), percutaneous (1.9%), and arthroscopic (1.1%) surgeries. He concluded that specific recommendations could not be made on the superiority of any method because all had low failure and complication rates. Grewal et al. [43] suggested that a randomized control trial is required to determine if arthroscopic LE surgery is more efficacious than percutaneous or open techniques.

Although arthroscopic LE treatment has shown good outcomes, open and percutaneous treatment may be more appropriate in certain patients. Open surgery may more effectively treat patients with concurrent diagnosis of posterolateral rotator instability of elbow or radial tunnel syndrome [9]. Using an open technique, LE with posterolateral rotator instability can be repaired with tendon debridement and ligament construction, while LE with radial tunnel syndrome can be treated with tendon debridement and decompression of the posterior interosseous nerve [46]. Prior surgery

(eg. ulnar nerve transposition) may change surgical anatomy and place the nerve at risk of injury during arthroscopic portal placement, [11] therefore open surgery is preferred in this situation. In cases where patients request a less invasive option, percutaneous surgery may be a better option [31].

Conclusion

Lateral epicondylitis is a common condition among adults. Although most cases of lateral epicondylitis resolve through conservative management, some patients require surgical treatment for their symptoms. Through the years, elbow arthroscopy for lateral epicondylitis has become a safe and effective procedure with low complication rates. There exist several arthroscopic techniques for surgeons to choose. Compared to open technique, arthroscopic surgery may lead to faster return to normal activity, with minimal incisions. Additionally, the technique has the advantage of being able to evaluate the joint intra-articularly. Currently, some studies exist that compare arthroscopic, open, and percutaneous techniques, however there is no clear consensus on the best technique in regards to complication rates, recovery time, and functional outcomes. While arthroscopic management of lateral epicondylitis has had promising results thus far, further investigations with randomized control studies are required to determine if arthroscopic management is superior to open or percutaneous techniques.

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