

RESEARCH ARTICLE

Ultrasound Measurements of the ECRB Tendon Shows Remarkable Variations in Patients with Lateral Epicondylitis

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Abstract

Background: Lateral epicondylitis (LE) most commonly affects the Extensor Carpi Radialis Brevis (ECRB) tendon and patients are generally treated with injection therapy. For optimal positioning of the injection, as well as an estimation of the surface area and content of the ECRB tendon to determine the volume of the injectable needed, it is important to know the exact location of the ECRB in relation to the skin as well as the variation in tendon length and location. The aim of this study was to determine the variation in location and size of the ECRB tendon in patients with LE.

Methods: An observational sonographic evaluation of the ECRB tendon was performed in 40 patients with LE. The length of the ECRB tendon, distance from the cutis to the center of the ECRB tendon, the length of the osteotendinous junction at the epicondyle and the distance from cutis to middle of the osteotendinous junction were measured.

Results: The average tendon length was 1.68cm (range 1.27-1.98; SD 0.177). Compared to women, the ECRB tendon of men was on average 0.12cm longer. Overall, the average distance from cutis to the center of the ECRB was 0.75cm (range 0.50-1.46cm; SD 0.210), the average length of the junction was 0.55cm (range 0.35-0.87; SD 0.130), and the distance from cutis to middle of the osteotendinous junction was 0.73cm (range 0.40-1.25cm; SD 0.210).

Conclusion: The size and depth of the ECRB tendon in patients with LE is largely variable. While there are no studies yet suggesting sono-guided injection to be superior to that of blind injection, the anatomic variability of this study suggests that the accuracy of injection therapy for LE might be compromised when based solely on bony landmarks and therefore not fully reliable. As a result, there is value in further studies exploring the accuracy of the ultrasound guided injection techniques.

Level of evidence: IV

Keywords: Anatomy, Extensor carpi radialis brevis, Lateral epicondylitis, Tennis elbow, Ultrasound

Introduction

Lateral epicondylitis (LE), widely known as Tennis Elbow, is a common condition affecting many individuals and has a major socio-economic impact (1). It has an estimated prevalence of 1-3% with an

estimated incidence of 4-7 per 1000 patients per year (2-4). Lateral epicondylitis is often easy to diagnose based on clinical presentation and physical examination. Ultrasound is sometimes used to confirm the diagnosis;

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however sonographic abnormalities, such as focal hypoechoic defects and anechoic defects in the Extensor Carpi Radialis Brevis (ECRB) tendon are also found in asymptomatic healthy study participants (5). While the exact etiology of LE is not completely understood, the common extensor tendinopathy is traditionally thought to result from repetitive microtrauma, degenerative characteristics of the tendon, and an inadequate healing response. Microscopic and histological studies show hypercellularity, angiofibroblastic hyperplasia, neovascularization and disorganized and immature collagen (6-8). Of the common extensor tendons, the ECRB tendon is most often affected with more than 95% of patients with LE showing pathologic changes in the ECRB tendon (6, 7, 9). In most cases LE is a self-limiting condition; complaints are resolved in 80% of the cases after six months and up to 90% recovers within a year after a wait-and-see policy with avoidance of aggravating activities (10-12). Treatment is generally limited to patients with worsening or sustained complaints, with injection therapy being the most common method of treatment.

At present, there is no consensus on the preferred method of injection therapy in patients with LE. Both the injection substance, the amount of substance to be injected, and the injection technique itself are still subject of discussion. This makes a comparison of current studies on the effectiveness of injectables impractical because of the heterogeneity in injection techniques (13).

Another debate is how to inject patients with LE. Injection therapy is frequently performed without ultrasound (US) guidance (14-19). A recent cadaveric study showed that injections for LE aiming at the ECRB insertion by relying solely on (bony) landmarks are not accurate; in only 30% of the cadaveric arms the injected dye was actually found to be located in the ECRB. Consequently, the majority of the injections end up (at least partly) in the surrounding soft tissue (20). This could potentially lead to collateral damage of important structures such as the lateral collateral ligament, possibly leading to posterolateral instability, since the radial band of the lateral collateral ligament partially covers a portion of the ECRB (21-23).

One could question whether this would primarily be a risk when using multiple perforations as in a peppering technique or when using corticosteroids (24). It is conceivable that injection therapy in live patients is more accurate than in cadaver specimens because of the better tissue feeling in the living, and experienced practitioners might have better results than juniors.

It is generally accepted today that the pathophysiology of LE is located at the insertion of the ECRB tendon. Therefore, it might be assumed that the injection for adequate treatment should be aimed at the insertion and cover the entire ECRB insertion. To avoid damage to the surrounding tissue, while covering the whole insertion, it is important to know the variation in length of the tendon, as well as the exact location of the ECRB tendon in relation to the bony landmarks and skin (for depth of the injection).

To improve the accuracy of injecting the ECRB tendon, the aim of this study was to determine the variation in location and size of the ECRB tendon in patients with LE using ultrasound.

Materials and Methods

Patients

An observational ultrasound study of the ECRB tendon was performed in 40 patients with LE. Informed consent was obtained from all study participants. Patients enrolled in the study if symptoms of LE persisted and not responded to conservative treatment for at least three months. Clinical criteria to diagnose LE are pain at the region of the lateral epicondyle with tenderness over the common extensor tendon and a positive provocation test for irritation of the ECRB. The provocation test was considered positive when dorsiflexion of the wrist (from a neutral position) against resistance with a straight elbow was painful at the lateral elbow region. To exclude radiocapitellar disease, a provocation test of the radiocapitellar joint was performed with axial compression on the joint in both flexion and extension supplemented by an X-ray of the affected elbow. Patients with lateral sided elbow surgery or documented elbow trauma as radial head fracture, or dislocation of the elbow in the past, were excluded from the study. Demographic data on gender and arm dominance were collected.

Experimental setup

Participants were routinely examined in a sitting position. For sonographic evaluation the shoulder was abducted 90 degrees with the arm resting on a table and the affected elbow flexed at 90 degrees, the forearm in pronation and the wrist in a neutral resting position. The ultrasound was performed by an orthopedic surgeon, highly experienced in elbow pathology and with adequate training in musculoskeletal ultrasound of the elbow, using the Mindray digital ultrasonic diagnostic imaging system dp-50 (Shenzhen Mindray Bio-Medical Electronics Co. China). The linear ultrasound probe used in this study was five centimeters long and one centimeter in width. An ultrasound image of the ECRB tendon was captured and all measurements were performed on this image by the same orthopedic surgeon [Figure 1].

The following measurements were made: see Figure 1.

The length of the ECRB tendon (M1), the distance from cutis to the center of the ECRB tendon (M2), the length of the osteotendinous junction on the epicondyle (M3) and the distance from cutis to the middle of the osteotendinous junction (M4) were measured [Figure 1]. The distance between the lateral epicondyle and the radial head at the center of the ECRB tendon was defined as M1, since hypervascularization in LE is generally seen in this area with ultrasound (25).

Statistical analysis was done using IBM SPSS Statistics version 22. Means, standard deviations and ranges of the measurements were calculated. Independent T tests were used to determine differences in outcome parameters between gender and arm dominance.

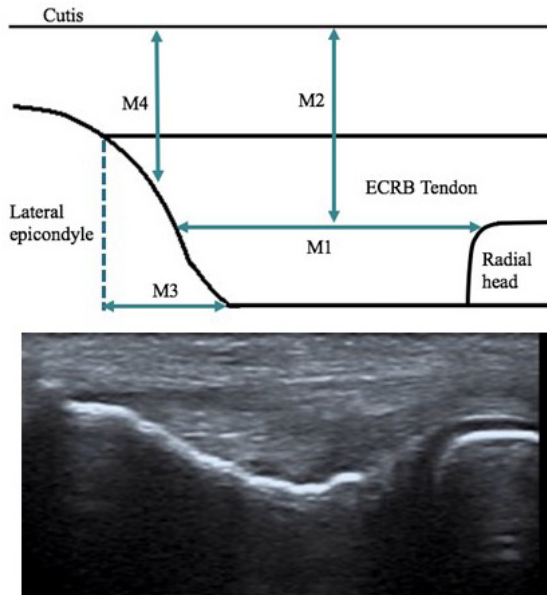


Figure 1. Measurements of the ECRB tendon. Schematic (non-anatomical) view and ultrasound view.

Results

A sonographic evaluation of 40 elbows was performed in 20 men and 20 women. In 25 patients, the dominant arm was affected. Prior to the sonographic evaluation an X-ray of the elbow was made in all patients; none of the X-rays showed radiocapitellar disease or other abnormalities at the lateral side of the elbow.

The average tendon length (M1) was 1.68cm (range 1.27-1.98; SD 0.177). Compared to women ($P=0.03$), the ECRB tendon of men was on average 0.12cm longer. Overall, the average depth of the tendon from cutis to the center of the ECRB (M2) was 0.75cm with a wide range from 0.50 to 1.46cm (SD 0.210). The average length of the junction (M3) was 0.55cm (range 0.35-0.87; SD 0.130). The depth from cutis to the center of the osteotendinous junction (M4) was 0.73cm with a wide range from 0.40 to 1.25cm (SD 0.210). There was no difference between men and woman in M2, M3 and M4 [Table 1]. There was also no difference between the dominant and non-dominant arm in all parameters.

Discussion

The ECRB tendon is about 1.7 cm long and located at a distance of 0.8 cm from the cutis. The variation in size and location of the ECRB tendon is substantial. The length of the tendon is larger in men than in women.

A cadaveric study has shown that achieving accuracy in injection without ultrasound of the ECRB is difficult, with 70% of the blindly performed injections not located in the intended ECRB tendon (20). One might assume, therefore, that blindly performed manual injections of the ECRB for the treatment of LE will not be accurate in reaching the intended place. Hence, this 'freehand' technique might not be the most suitable injection technique in the treatment of LE. However, a caveat must be made as the injection study was conducted on 'unresponsive' cadaveric arms with injections placed using directions based on bony landmarks only. One might argue that tissue feeling, namely the 'feel' of the tissue one injects in and the layers one punctures through, could support the proper positioning of the needle in the tendon. Freehand injections in patients that localize the painful area could further increase more accuracy, assuming the pain is located at the same place as the tendinopathy area most of the time (5). The tendinopathy zone in LE is typically found at the insertion of the ECRB tendon, while the location of reported pain varies and is often more diffuse, centered around the lateral epicondyle, or radiating into the forearm or the upper arm and neck (26). Using ultrasound, the accuracy of positioning the needle in the tendinopathy zone could increase enormously.

Given the current concepts that the tendinosis in LE is located at the insertion of the ECRB tendon, for adequate treatment the injection should preferably be aimed at the entire insertion of the tendon (25). In order to position injections accurately, a sonographic localization of the ECRB tendon before injection, or an ultrasound guided injection, can be useful. For adequate positioning in injection therapy it might further be useful to take the slope of the lateral epicondyle into account. The variation in measurements of depth (M2 and M4) are both depending on the thickness of the subcutaneous fat layer. It is therefore not surprising that these measurements vary widely, but since injection into the ECRB tendon next to the osteotendinous junction based on anatomical landmarks only was shown not

Table 1. Results of the measurements in cm

	Total		Male (M)		Female (F)		Difference M/F
	Mean (range)	SD	Mean (range)	SD	Mean (range)	SD	P
M1	1.68 (1.27-1.98)	0.18	1.75 (1.49-1.98)	0.17	1.62 (1.27-1.87)	0.16	$P=0.03$
M2	0.75 (0.50-1.46)	0.21	0.73 (0.50-1.21)	0.18	0.78 (0.51-1.46)	0.24	$P=0.47$
M3	0.55 (0.35-0.87)	0.13	0.56 (0.41-0.87)	0.14	0.55 (0.35-0.78)	0.13	$P=0.69$
M4	0.73 (0.40-1.25)	0.21	0.74 (0.50-1.25)	0.20	0.71 (0.40-1.21)	0.23	$P=0.63$

M1 = Length of the ECRB tendon. M2 = Distance from cutis to the center of the ECRB tendon. M3= Length of the osteotendinous junction on the epicondyle. M4= Distance from cutis to middle of the osteotendinous junction.

to be accurate, it is an important variable to take into account.

Determining the surface area and depth of the ECRB tendon might bring useful knowledge to decide on the number of injections and the volume of the injection fluid needed to infiltrate the whole insertion.

Despite an increasing availability of imaging modalities, the diagnosis of LE is in general clinically based. Although varying results are reported regarding the specificity, the sensitivity in the detection of symptomatic LE by ultrasound has increased (27-29). In diagnosing LE focal hypoechoic regions with loss of the normal fibrillar pattern, calcifications, tendon thickening, irregularity of the adjacent bone and decreased echogenicity are reported (28-31). It has been reported that the size of the focal hypoechoic areas ranges from 3 to 15mm (mean 8.7). Since the average tendon length found in this study was 1.68cm, this indicates that these affected areas can almost cover the entire insertion (30). The locations of these sonographic lesions were found to be located at three different sites of the ECRB tendon in patients with LE, namely at the insertion site on the lateral epicondyle, between the insertion site of the ECRB and the radiohumeral joint, and at the radio-humeral joint level. These locations of the sonographic lesions correspond with painful areas of the elbow mentioned by patients with clinically determined LE (5). However, given the small size of the ECRB tendon and the larger and diffuse pattern of pain mentioned in LE it is unclear to what extent it can be stated that pain complaints correspond with the localization of sonographic abnormalities (26). In addition, sonographic abnormalities are also found in asymptomatic healthy study participants. Therefore, the clinical relevance of these abnormalities in symptomatic patients still remains doubtful.

No previous reports have been published on the size of the ECRB and the depth of the ECRB in relation to the skin. One study measured the thickness of the ECRB tendon with ultrasound and reported a good intra- and interobserver reliability of the sonographic measurements. Although this study did not assess intra- or interobserver reliability, results are assumed to be comparable (32).

The high variation in size and location of the ECRB tendon implies that this should be taken into account when injecting for LE.

The size and depth of the ECRB tendon in patients with

lateral epicondylitis is variable.

The average tendon length was 1.68cm (range 1.27-1.98; SD 0.177) and the average depth of the ECRB was 0.75cm (range 0.50 to 1.46cm; SD 0.210). Assuming that injections for LE should reach and cover the entire insertion of the ECRB tendon, but not the surrounding tissue, it is important to take these variations into account while injecting freehand. This variation in surface area and size might also be important in determining the optimal number of injections given at a specific time and the volume of the injection fluid needed for proper infiltration of the entire ECRB insertion.

Although there are no studies available showing that results of sono-guided injection are superior to those without ultrasound, the anatomic variability of the ECRB found in this study suggests that the accuracy of positioning in injection therapy for LE based on bony landmarks only might not be reliable. Further studies into the added value of ultrasound in the detection and treatment of LE is necessary.

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