Research Article

Variations in extensor carpi radialis longus and brevis – A cadaveric study

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Abstract

Objectives: The Extensor Carpi Radialis Longus (ECRL) and Extensor Carpi Radialis Brevis (ECRB) are two of the superficial muscles of extensor compartment of forearm. The extensor carpi radialis brevis is involved in tennis elbow. The surgeons performing Z shaped tenotomy on tennis elbow to lengthen the tendon of ECRB must be aware of the variation in order to avoid unwanted complications. Recently, ECRB has also gained importance for use in free functional muscle transfer. In cases of variation of extensor muscles like fusion of muscle bellies or splitting of tendon and in cases of absent ECRB, the entrapment neuropathy of Radial nerve or Posterior interosseous nerve should also be kept in mind. In this study, we have described some variations of ECRL and ECRB which were different from what has already been reported as they are clinically important.

Methods: 30 upper limbs from 15 formalin fixed adult human cadavers were dissected to study the ECRL and ECRB.

Results: Out of 15, 4 cadavers showed variations. ECRL showed a split of its tendon into two in 3 limbs belonging to 2 cadavers in which one cadaver showed bilateral split. ECRB showed a similar split of tendon in two limbs. One of the limbs showed complete absence of ECRB. Bellies of ECRL and ECRB fused to form a single mass in 3 limbs.

Conclusions: The additional tendons noted in the present study could be utilized effectively and reliably in tendon transfers and in surgical rehabilitation in patients with paralytic disorders.

Keywords: Tennis elbow, Variations, Tendon transfer.

1. Introduction

The Extensor Carpi Radialis Longus (ECRL) and Extensor Carpi Radialis Brevis (ECRB) are two of the superficial muscles of extensor compartment of forearm. ECRL arises mainly from distal third of lateral supracondylar ridge of humerus and from the front of lateral intramuscular septum but some fibres come from common tendon of origin of the forearm extensors. The tendon runs deep to Abductor Pollicis Longus (APL), Extensor Pollicis Brevis (EPB) and Extensor Pollicis Longus (EPL) and then passes under the extensor retinaculum and inserts on the radial side of dorsal surface of base of 2nd metacarpal. ECRB is shorter and is covered by ECRL. ECRB arises from lateral epicondyle of humerus, radial collateral ligament of elbow joint, aponeurosis and adjacent intramuscular septa. Its belly ends at about mid forearm in a flat tendon which passes under the extensor retinaculum to be attached to the dorsal surface of base of 3rd metacarpal on its radial side and adjoining parts of the 2nd metacarpal base.1

ECRB has a unique anatomical location that makes it’s under surface vulnerable to contact and abrasion against the lateral edge of capitulum, while ECRL compresses ECRB against underlying bone1. Extensor carpi radialis brevis is the muscle involved in tennis elbow. The surgeons performing Z shaped tenotomy on tennis elbow to lengthen the tendon of ECRB must be aware of the variation in order to avoid unwanted complications. Recently, it has also gained importance for use in free functional muscle transfer i.e. transfer of a muscle with its motor nerve and vascular pedicle from one site of body to another distant site, in order to restore motor function. The knowledge of the variation is thus important while ECRB muscle is being harvested1. ECRB is also used for autologous blood injections for treatment of tennis elbow2. Tendon transfers are frequently used in obstetrical brachial plexus injuries to restore elbow function3.

Posterior Interosseous Nerve (PIN) entrapment neuropathy may occur within these forearm extensor muscles. After the point of bifurcation of Radial Nerve, PIN traverses through the radial tunnel. The radial tunnel is described as a 5cm long furrow bounded by brachialis and biceps tendon medially and mobile extensor muscles anterolaterally4. Muscular variations of the extensor compartment of forearm are unusual and the variations in the superficial group of extensors are rarely observed4. The variations of the muscles especially those of additional bellies and tendons of existing muscles or those of additional muscles in unusual locations might misguide surgical procedures. Such muscles may simulate soft tissue tumor and can result in nerve compressions5.

In cases of variation of extensor muscles like fusion of muscle bellies or splitting of tendon and in cases of absent ECRB, the entrapment neuropathy of Radial nerve or PIN should be kept in mind. In this study, we have described some variations of ECRL and ECRB as they are clinically important.

2. Methods

Thirty upper limbs from 15 formalin fixed adult human cadavers were dissected in the Department of Anatomy, to study the Extensor Carpi Radialis Longus and Extensor Carpi Radialis Brevis. The steps of dissection were followed from Cunningham’s Manual of Practical Anatomy Volume one. The variations were noted and the photographs were taken.

3. Results

Out of 30 limbs, in seven limbs variations of ECRL and ECRB were seen. These seven limbs having different variations belonged to four cadavers. ECRL showed a split of its tendon into two in three limbs belonging to two cadavers so that one cadaver showed bilateral split. ECRB showed a similar split of tendon in two limbs. One of the limbs showed complete absence of ECRB. The bellies of ECRL and ECRB fused to form a single mass at the site of origin in three limbs belonging to three different cadavers and all these three limbs were of right side. The observations noted in these cadavers are given below.
Cadaver 1 - On the right side, the bellies of ECRL and ECRB were fused. These formed single tendon as they passed below the APL, EPB and EPL and then inserted on dorsal surface of base of 2nd metacarpal. On the left side, ECRB was absent (Figure 1) while ECRL showed no variation.

Figure 1 – Showing Absent Extensor Carpi Radialis Brevis on left side of Cadaver 1.


Cadaver 2 – On the right side, the bellies of ECRL and ECRB fused to form a single tendon at the site of origin. It followed the typical course and then inserted onto the dorsal surface of base of 2nd metacarpal. Left side showed no variation.

Cadaver 3 - On the right side, the bellies of ECRL and ECRB were fused at their origin and then separated into two. The superficial part formed the tendon of ECRL which passed below the APL, EPB and EPL and inserted in the typical manner on the 2nd metacarpal. The deeper part formed ECRB which showed a split into two tendons, then again united into one as they passed below APL, EPB and EPL after which it inserted on to the 3rd metacarpal (Figure 2). On the left side, there was fusion of the bellies of ECRL and ECRB at the origin. Then the bellies separated into ECRL and ECRB. The tendon of ECRL showed a split into two and united just before insertion. The ECRB also showed a similar split but inserted as separate tendons on the 3rd metacarpal (Figure 3). This was the only case where the split tendons did not reunite before insertion.

Figure 2 – Showing fused bellies of Extensor Carpi Radialis Longus and Brevis with splitting of Extensor Carpi Radialis Brevis tendon on right side of Cadaver 3.

ECRL – Extensor Carpi Radialis Longus, ECRB – Extensor Carpi Radialis Brevis, T1 and T2 – Split tendons of Extensor Carpi Radialis Brevis

Figure 3 – Showing fused bellies of Extensor Carpi Radialis Longus and Brevis with splitting of their tendons on left side of Cadaver 3. Extensor Carpi Radialis Brevis tendon remains split till insertion.

Cadaver 4 – On both the sides, the two muscles showed a typical origin. After origin ECRL showed a bilateral split into two tendons. The tendons united as they passed below abductor pollicis longus and extensor pollicis brevis. After which it inserted as a single tendon on the 2nd metacarpal (Figure 4). ECRB did not show any variation on both the sides.

Figure 4 – Showing typical origin of muscles but Extensor Carpi Radialis Longus having split tendons. Extensor Carpi Radialis Brevis showing no variations.

The findings of the present study have been shown in Table 1.

Table 1 – Showing the Distribution of Variations

<table>
<thead>
<tr>
<th>Variation observed</th>
<th>Number of limbs</th>
<th>Percentage of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split of ECRL tendon</td>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td>Split of ECRB tendon</td>
<td>2</td>
<td>6.6%</td>
</tr>
<tr>
<td>Absent ECRB</td>
<td>1</td>
<td>3.3%</td>
</tr>
<tr>
<td>Fused bellies of ECRL and ECRB</td>
<td>3</td>
<td>10%</td>
</tr>
</tbody>
</table>

4. Discussion

The anatomical variations of ECRB are of interest because of its possible relationship to the tennis elbow, i.e., lateral epicondylitis. The pathomechanics of tennis elbow are linked to the origin of the ECRB, and the treatment of tennis elbow targets injection or release of the ECRB. So the clinicians should be aware of variations of this muscle and must keep in mind the possibilities of absence of it or fusion of its belly with ECRL. Some research has been done on it in the past.

ECRL gave origin to an accessory head, the tendon of this accessory head passed through a separate tunnel in extensor retinaculum and inserted on the 1st metacarpal. ECRB had an accessory tendon which joined with the main tendon and then inserted. Additional belly of ECRB was seen lying on the radial side of the main belly having common origin with it. This additional belly had a long slender tendon which merged with the main tendon and then inserted. An additional belly of ECRB was found lying lateral to the main belly. The tendon of this additional belly passed deep to the main tendon of ECRB and entered the 4th compartment of extensor retinaculum after which it inserted onto to the 3rd metacarpal. Supernumerary tendons were seen in relation to ECRL in three hands and presence of accessory tendon making union between longus and brevis in four hands. ECRL and ECRB were found to be absent in one limb but in the other limb the longus did not give off any additional tendons.

Variant tendons which were large enough can be used to activate a tendon transfer and extra muscle found in this region can be useful in the surgical rehabilitation in patients with paralytic disorders. The elongation of ECRL tendon was performed using the radial half of parent tendon in 12 patients. It was suggested that splitting of ECRL tendon to use one half as a tendon graft can be considered in patients in whom ECRL transfer is planned to correct finger clawing. In such cases, if the surgeon is aware of probable variation of radial carpal extensors like additional bellies and tendons then such tendons can be used for grafting instead of splitting the parent tendon.

The relation between medial edge of ECRB and PIN was analysed and it was suggested that ECRB is a possible cause of PIN entrapment. The fusion of the bellies of ECRL and ECRB or the splitting of tendon makes it highly vulnerable to radial nerve compression and absence of ECRB might make PIN prone to entrapment neuropathy. All variations of ECRB in the form of absence or duplicate tendons should be known to the surgeons and orthopedicians.

4.1. Embryological basis

The first indication of limb musculature is observed in the seventh week of development as a condensation of mesenchyme near the base of the limb buds. The mesenchyme is derived from dorsolateral cells of the somites that migrate into the limb bud to form the muscle. Upper limb muscles are derived from abaxial precursors. The new description of muscle development characterized by primaxial and abaxial domains differs from the old concept of epimeres and hypomeres which was based on a functional definition of innervation.

At about the 9mm stage the mesenchyme condenses into premuscle masses. From them the girdle and limb muscles differentiate, the developing muscles tend to become arranged into a dorsal group of extensors and a ventral group of flexors. The extensors appear sooner than the flexors. The dorsal muscle mass forms the caudodorsal muscles of the definitive upper limb which function as extensors. The extensor muscles are divided into a superficial and a deep group. The deep fascia assists in the formation of compartments for muscles with the same function.

Anatomical variations always have underlying cause as developmental arrest in the different stages of gestation. There can be developmental defect at the time when the muscles differentiate from the single muscle mass. This can be the reason of absence of ECRB or duplication of tendon of ECRL. The fusion of bellies of ECRL and ECRB could also be explained by the fact that the muscles were not separated by the fascia at the time of development.

As anatomists it can be said that additional tendons of ECRL noted in the present study could be utilized effectively and reliably in tendon transfers. Hence the obverse observation made in the present study will supplement the knowledge of variations in this region, which should be quite useful in forearm and hand surgery.
References