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Original article

# Anatomic study of the extensor carpi radialis brevis in its relation with the motor branch of the radial nerve

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A B S T R A C T

*Introduction:* The cause of the tunnel syndrome is the entrapment of the posterior interosseous nerve, and can occur due to different anatomic structures, the arcade of Frohse being the main one of them.
*Purpose:* To describe the anatomic relation between the extensor carpi radialis brevis (ECRB) muscle and the motor branch of the radial nerve at its entrance under the arcade of Frohse.
*Materials and methods:* An anatomic dissection of 21 elbows of fresh human cadavers was conducted, describing the deep aponeurosis and the superomedial tendinous arch of ECRB and its relation with the motor branch of the radial nerve.
*Results:* In 100% of the specimens, there was evidence of an aponeurosis in the undersurface of ECRB. A tendinous arch at the superomedial margin of ECRB was found in 20 cases (95.2%). In 71.5%, this arch surpassed proximally the arcade of Frohse on an average of 4.5 mm (2–10 mm); it passes in direct contact with the motor branch of the radial nerve.
*Conclusions:* The extensor carpi radialis brevis muscle courses in a close relation to the motor branch of the radial nerve at its entrance under the arcade of Frohse, and it demonstrates an aponeurosis at its undersurface and a tendinous arch at its medial edge that could play an important role in the development of the radial tunnel syndrome.
*Level of evidence:* Level IV. Anatomic research study.



## 1. Background

The cause of the radial tunnel syndrome is the entrapment of the deep motor branch of the radial nerve or posterior interosseus nerve (PIN) in its course in the radial tunnel. The cause of this entrapment could be produced by different anatomic structures, being the arcade of Frohse (AF) the main implicated, according to various studies [1–7].

In 1972, Roles and Maudsley proposed that some persisting cases of tennis elbow were the result of the radial tunnel syndrome [7]. This tunnel is defined as a potential space created by the structures that surround the radial nerve and its posterior interosseous branch in its course by the proximal third of the forearm. Different structures potentially might compress the radial nerve, such as the common tendon of the extensors, the proximal fibrous edge of the supinator (arcade of Frohse), the recurrent proximal radials vessels at the same level (Henry's leash), ganglions, and the fibrous proximal edge of the extensor carpi radialis brevis (ECRB) among others [2,8–13]. Some authors doubt the existence of the radial tunnel syndrome because essentially it is a painful syndrome without objective clinical or electrophysiologic manifestations [14].

The motor branch of the radial nerve runs within the supinator muscle mass before entering to the posterior compartment of the forearm at where innervates the wrist and fingers extensor muscles [3,8,15]. The proximal fibrous edge of the supinator forms the AF, described in 1908 by Frohse and Frankel [1].

The characteristics of the radial tunnel syndrome are pain in the proximal dorsolateral region of the forearm, in some cases with motor deficiency. The pain could radiate to the lateral region of the elbow, getting confused many times with "tennis elbow", which is the main differential diagnosis [4,6,14–16].

The ECRB muscle has been the main one implicated in the development of the lateral epicondylitis, and its tendinous or fibrous margin has been described as a possible mechanism of compression over the deep radial nerve before its entrance to the AF [10,11,14–16].

The aim of the current study is to make a detailed anatomic description of the relation of ECRB and radial nerve, and the possible role played by the ECRB as a mechanic agent involved in the

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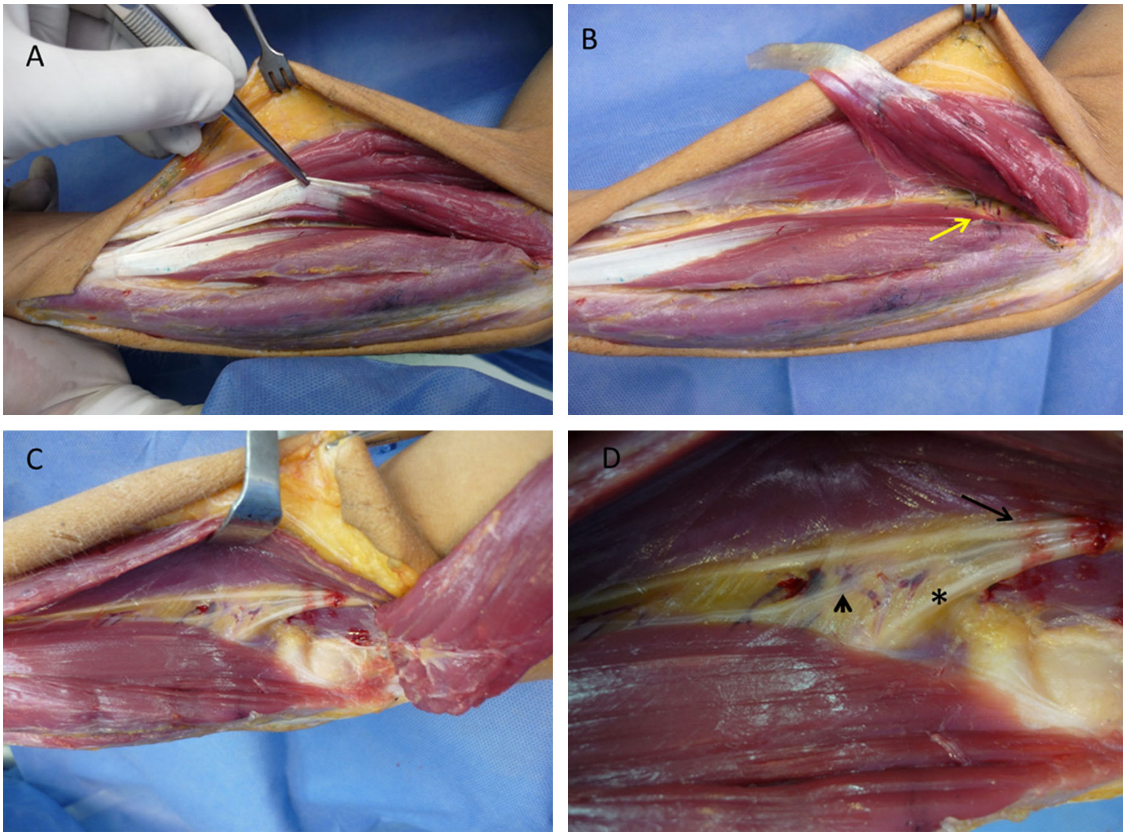


**Fig. 1.** A. With the forceps the ECRL is separated from the ECRB. B. The ECRL separated and sectioned. The NIP is detected below the ECRB (arrow). C. The 2 branches of the radial nerve are dissected. D. Close view of the sensitive branch of the radial nerve (arrow), the motor branch to the ECRB muscle (arrow head) and the NIP (asterisk).

entrapment of the radial nerve syndrome and the lateral pain in the elbow.

## 2. Methods and materials

An observational descriptive study in fresh human cadavers was performed. Twenty-one forearms and elbows were dissected, excluding specimens with signs of trauma or deformities at the upper extremity.

The variables examined were: position of the ECRB fibrous or tendinous edge in relation to the AF and PIN, the width and appearance of the ECRB aponeurosis over the Frohse arcade (which we define as severe thickness, moderate, and mild) distance epicondyle – AF, distance epicondyle – PIN exit to the posterior compartment of the forearm, distance radial head – AF, distance radial head – exit of the NIP to the posterior compartment, distance between the radial nerve division in the motor and sensitive branches in relation to the AF (Fig. 1).

All our measurement results are given as the mean (minimum–maximum) and were analyzed in Excel, and all specimens were photographed.

The research was done with the approval of the ethics committee of our university.

## 3. Results

Twenty-one elbows were dissected, 90.4% males, and 9.6% females. The measurements were made in pronation. In 100% of the specimens, there was evidence of aponeurosis on all the undersurface of the ECRB, from which 14.3% had severe thickness, 57.2% moderate, and 28.5% mild (Fig. 2). A fibrous edge or tendinous arch

**Fig. 2.** The aponeurosis under the ECRB (asterisk) and its tendinous arch (arrow). The upper image shows the only case of muscular arch not tendinous but with the aponeurosis under the ECRB. The pin indicates where was the aponeurosis edge before it was lifted, exceeded the AF (arrow head), in direct contact with the NIP. We can see some vessels (Henry's leash). Below the same description in another specimen, the edge was at the same level of the AF.

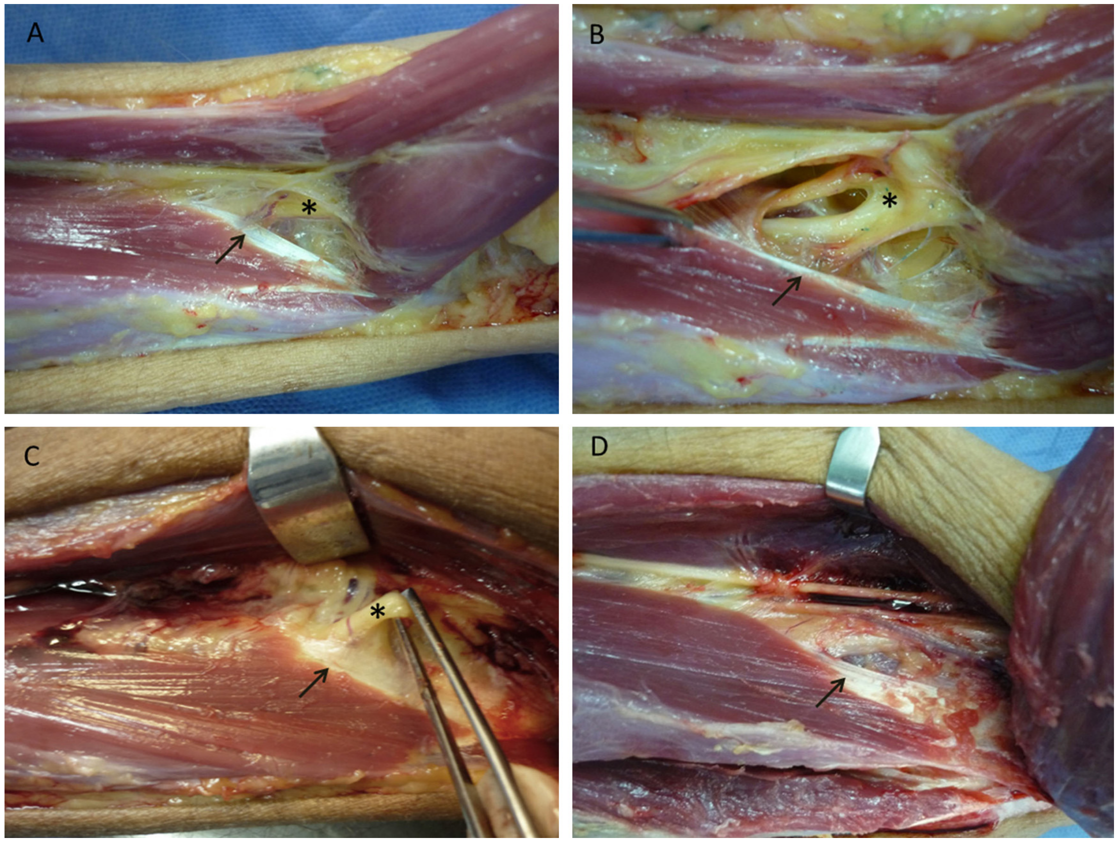


**Fig. 3.** A–B. Images of a same specimen where we can see the tendinous arch of the ECRB (arrow) in direct relation with the PIN (asterisk). C and D are two different specimens showing the same.

in the superomedially margin of the ECRB was found in 20 cases (95.2%) (Fig. 3).

In 71.5% of the specimens, this arch proximally surpassed the AF in 4.5 mm (2–10 mm), situated in direct contact with the motor branch of the radial nerve. In 9.5%, this tendinous arch was found at the same level of the AF, and in 19% it was in a distal position without direct contact with the PIN (Fig. 2). The width of the deep aponeurosis of the ECRB, measured at the height in which the nerve was located, was 14.6 mm (11–21 mm). The distance between the outlets of the motor branch of the radial nerve (PIN) to the entrance AF was 25.8 mm (18–30). The distance between the lateral epicondyle and the entrance to the AF was 47.1 mm (39–57 mm), and the exit of the nerve to the posterior compartment of the forearm was 84.2 mm (76–96 mm) (Fig. 4). The distance between the radial head and the entrance of the nerve to the AF was 24.4 mm (19–31 mm), and its exit to the posterior compartment was 63 mm (50–78 mm) (Fig. 5).

All the results are summarized in Table 1.


**Fig. 4.** Distance between lateral epicondyle (E) and the entrance of the PIN to the supinator tunnel (black arrow), and the exit of this (long arrow).

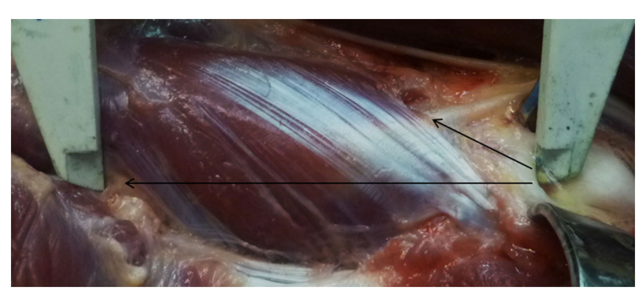

**Fig. 5.** Distance between the proximal edge of the radial head and the entrance and exit of the PIN to the supinator tunnel (arrows).

## 4. Discussion

Kopell and Thompson described the entrapment of the RN in the radial tunnel in 1963 [3]. The arcade of Frohse is the structure that most causes entrapment of the radial nerve [3,4,8,12]. This entrapment has been implicated with the production of pain in the lateral side of the elbow and forearm, and occasionally is misinterpreted as epicondylitis.

The entrapment of the motor branch of the RN or PIN could be due to different structures that potentially can compress this nerve. Highlights the proximal fibrous edge of the ECRB or tendinous arch, which some authors describe as the cause of the entrapment of the PIN [2,6,11,13–15,17,18]. Nayak et al. described the presence of this

**Table 1**
Summary of results.

| | |
|---|---|
| Presence of aponeurosis at ECRB | 100% |
| Thickness of ECRB | Severe 14.3%<br>Moderate 57.2%<br>Mild 28.5% |
| Position of the tendinous arch regarding the PIN | Direct contact 71.5%<br>To the level of AF 9.5%<br>Not contact 19% |
| Width of aponeurosis where contact PIN | 14.6 mm (11–21) |
| Distance division RN–AF | 25.8 mm (18–30) |
| Distance lateral epicondyle–entrance AF | 47.1 mm (39–57) |
| Distance lateral epicondyle–exit PIN of supinator | 84.2 mm (76–96) |
| Distance proximal edge radial head–arcade of Frohse | 24.4 mm (19–31) |
| Distance proximal edge radial head–exit PIN of supinator | 63 mm (50–78) |

edge like an arch in the aspect superomedially of the ECRB, and found it tendinous in 29.1% of its specimens, muscular in 11.1% and absent in 59.7% [15]. They did not describe the deep aponeurosis that was in contact with the radial tunnel. In our dissections, in 20 cases of 21 (95.1%) the presence of a tendinous or fibrous arch was found. This fibrous arch was located over the arcade or proximally surpassed in 81% of the cases, and in close contact with the PIN. In 19% of the specimens, this margin was distal to the AF directly over the supinator muscle in the radial tunnel.

The anatomic characteristic of this tendinous edge might eventually cause compression of the radial nerve before its entrance to the AF. Therefore, it should be considered in the surgical treatment of the neuropathic compression of the radial nerve in the radial tunnel syndrome.

On the other hand, the aponeurosis of the undersurface of the ECRB must be also considered in the analysis of causes of tunnel radial syndrome. In 100% of the specimens of our research, we found this aponeurosis, having a moderate to severe thickness in 71.5% of the cases, and always in direct relation with the radial tunnel. Also should be considered the performance of a deep aponeurotomy when a compressive neuropathy of the radial nerve is managed with surgical treatment with the purpose of achieving a complete liberation of the nerve.

In conclusion, we can say that these anatomic findings of the ECRB muscle must be considered in the physiopathology and the treatment of the lateral and anterior pain in the elbow and forearm.

## Disclosure of interest

The authors declare that they have no competing interest.

## References


[1] Frohse F, Frankel M. Die Muskeln des menschlichen Armes. Fischer Jena; 1908. p. 164–9.
[2] Henry M, Stutz C. A unified approach to radial tunnel syndrome and lateral tendinosis. Tech Hand Up Extrem Surg 2006;10(4):200–5.
[3] Ozturk A, Kutlu C, Taskara N, Kale AC, Bayraktar B, Cecen A. Anatomic and morphometric study of the arcade of Frohse in cadavers. Surg Radiol Anat 2005;27:171–5.
[4] Hazani R, Engineer N, Mowlavi A, Neumeister M, Lee A, Wilhelmi B. Anatomic landmarks for the radial tunnel. Open Acces J Plast Surg 2008;8:377–82.
[5] Clavert P, Lutz JC, Adam P, Gabel RW, Liverneaux P, Kahn JL. Frohse's arcade is not the exclusive compression site of the radial never in its tunnel. Orthop Traumatol Surg Res 2009;95:114–8.
[6] Kirici Y, Irmak MK. Investigation of two possible compression sites of the deep branch of the radial nerve and nerve supply of the extensor carpi radialis brevis muscle. Neurol Med Chir 2004;44:14–9.
[7] Ferdinand BD, Rosenberg ZS, Schweitzerl ME, Stuchin SA, Jazrawi LM, Lenzo SR, et al. MR imaging features of radial tunnel syndrome. Radiology 2006;240:161–8.
[8] Capener N. The vulnerability of the posterior interosseous nerve of the forearm. A case report and an anatomical study. J Bone Joint Surg Br 1966;48(4):770–3.
[9] Ducic I, Felder JM, Quadri HS. Common nerve decompressions of the upper extremity. Ann Plast Surg 2012;68:606–9.
[10] Tennent TD, Woodgate A. Posterior interosseous nerve dysfunction in the radial tunnel. Curr Orthop 2008;22:226–32.
[11] Tomaino MM. Radial tunnel release: true entrapment neuropathy or mainly a pain operation? Curr Opin Orthop 2000;11:246–9.
[12] Sarris IK, Papadimitriou NG, Sotereanos DG. Radial tunnel syndrome. Tech Hand Up Extrem Surg 2002;6(4):209–12.
[13] Spinner M. The arcade of Frohse and its relationship to posterior interosseous nerve paralysis. J Bone Joint Surg Br 1968;50(4):809–12.
[14] Campbell WW, Landau ME. Controversial entrapment neuropathies. Neurosurg Clin N Am 2008;19:597–608.
[15] Nayak S, Ramanathan L, Krishnamurthy A, Prabhu LV, Madhyastha S, Potu BK, et al. Extensor carpi radialis brevis origin, nerve supply and its role in lateral epicondylitis. Surg Radiol Anat 2010;32:207–11.
[16] Rinker B, Effrom CR, Beasley RW. Proximal radial compression neuropathy. Ann Plast Surg 2004;52:174–80.
[17] Wittaut J, Steffens K. Paralysis of the interosseous nerve by a tendinous margin of the extensor carpi radialis brevis. Handchir Mikrochir Plast Chir 1995;27(6):329–30.
[18] Vergara-Amador E, Ardila KA, Calixto LF. Fundamentos anatómicos de la epicondilitis lateral. Revista Cubana de Ortopedia y Traumatologia 2011;25(2):149–58.