

Anatomy of Posterior Antebrachial Cutaneous Nerve Related to the Lateral Epicondyle and Interepicondylar Line

Anatomía del Nervio Cutáneo Posterior del Antebrazo Relacionado con el Epicóndilo Lateral y la Línea Interepicondilar

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SUMMARY: Posterior antebrachial cutaneous nerve (PACN) is a branch of radial nerve supplying the skin of posterior forearm. Data regarding its anatomy remain insufficient especially the origin and number of branches. We dissected 101 upper extremities from 32 male and 20 female cadavers to expose the PACN. In all specimens, the nerve emerged from the deep fascia at the hiatus proximal to the interepicondylar line (IEL) with mean distances of 7.24 and 7.44 cm in males and females, respectively. Percentage of this distance to the arm length was 23.2 % and 26.1 % in males and females, respectively. After penetrating the deep fascia, the PACN coursed in the subcutaneous layer and crossed the IEL anterior to the lateral epicondyle (LE) in all cases. The mean distances from the crossing point to the LE along the IEL were 1.52 cm in males and 1.34 cm in females. Regarding the branches of PACN, at least 50 % of the specimens had up to 3 or 4 branches originating either proximal or distal to the hiatus. In two arms, one of these branches passed posterior to the LE. Moreover, there were communicating branches between the PACN and the lateral antebrachial cutaneous nerve in 9 specimens. Gender and side differences were found in some measurement parameters. These data are crucial for avoiding the PACN injury during surgical procedures around the elbow.

KEY WORDS: Posterior antebrachial cutaneous nerve; Lateral epicondyle; Interepicondylar line; Anatomy.

INTRODUCTION

Posterior antebrachial cutaneous nerve (PACN) is a branch of radial nerve providing sensory innervation to the skin of posterior forearm. In the spiral groove, after separation from the radial nerve, the PACN emerged from the lateral intermuscular septum (LIMS) (MacAvoy *et al.*, 2006; Matzi *et al.*, 2015). MacAvoy *et al.* reported that the nerve immediately pierced the deep fascia at the hiatus after emerging from the LIMS. More distally, its main trunk and branches course in the subcutaneous layer to the posterior forearm as far as the wrist.

The course of PACN is clinically important due to its close proximity to the lateral epicondyle (LE) of the humerus. Therefore, it can be injured during surgical procedures around the LE. The PACN injury was diagnosed after the surgical treatment of lateral epicondylitis (Dellon *et al.*, 2004; Iyer, 2014). Regarding the elbow arthroscopy, the PACN was also at risk since its position was close to the portals (Adolfsson, 1994; Chaware *et al.*, 2016).

Knowledge in the anatomy of PACN remains incomplete. Previous studies used the LE as the only reference point to localize the nerve (MacAvoy *et al.*; Matzi *et al.*). Our previous studies have shown that the interepicondylar line (IEL) linking the two epicondyles of humerus was useful for locating the medial and lateral antebrachial cutaneous nerves (Wongkerdsook *et al.*, 2011; Damwan *et al.*, 2014). Therefore, this study employed the IEL including the LE as the landmarks to improve the localization of the PACN. Moreover, since the data regarding its ramification are lacking, we also investigated this issue.

MATERIAL AND METHOD

One hundred and one upper extremities from 32 male and 20 female cadavers were included with an approval from the institutional ethics committee. Three upper extremities

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from 2 males and one female were excluded due to poor fixation.

The posterior aspects of arm and proximal forearm were dissected to expose the PACN with the anatomical course carefully preserved. The most prominent points of the medial epicondyle (ME) and the LE were identified and the IEL located with silk thread passing these two landmarks. The course of PACN from the piercing point through the deep fascia, designated hiatus according to MacAvoy *et al.*, until the nerve crossed the IEL was followed. The ramification and number of branches along the course were noted. Furthermore, due to the close proximity of the PACN to the lateral antebrachial cutaneous nerve (LACN), the possible communication between these nerves was explored.

To obtain quantitative data, a digital caliper was used to measure the distances from the midline of PACN at the hiatus to the IEL in a perpendicular plane and from the point where the PACN crossed the IEL to the LE along the IEL (Fig. 1). The vertical distance to the IEL was compared with the arm length (the distance from the inferior border of acromion process to the LE). Student's *t* test was employed to detect any significant differences in the measurement data between genders and sides. $p < 0.05$ was considered significant. When the nerve gave branches above the IEL, the measurement was done only to the main trunk of PACN.

RESULTS

In all specimens, the PACN emerged from the deep fascia at the hiatus proximal to the LE and IEL (Fig. 2). The hiatus was 7.24 ± 1.73 cm proximal to the IEL in males and 7.44 ± 1.36 cm in females (Table I). The average percentage to the arm length was 23.2 % and 26.1 % in males and females, respectively, with significant difference between genders ($p < 0.01$).

Distal to the hiatus, the PACN coursed in the subcutaneous layer and crossed the IEL anterior to the LE in all specimens. The distances between this crossing point and the LE along the IEL were 1.52 ± 0.58 cm and 1.34 ± 0.70 cm in males and females, respectively (Table I). The significant difference was observed between sides of males in this measurement ($p < 0.05$).

As for the branching, 1–3 branches of the PACN could be found beneath the deep fascia in 56 specimens (55.4 %). In two left male extremities, one of these branches coursed posterior to the LE. Distal to the hiatus but proximal to the IEL, up to 4 branches were found in 50 specimens (49.5 %). Distal to the IEL, the PACN gave 1–3 branches in 63 specimens (62.4 %). There were communicating branches between the PACN and the LACN in 9 specimens (8.9 %, 5 males and 4 females). These branches could be found either proximal or distal to the IEL (Fig. 3).

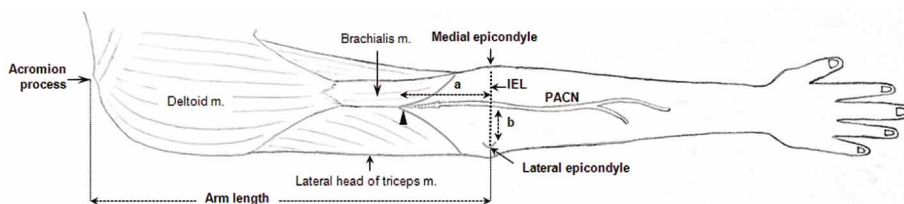


Fig. 1. Measurements regarding the anatomy of posterior antebrachial cutaneous nerve (PACN). The right upper extremity with pronated forearm is shown. Distances were measured from the PACN at the hiatus (arrowhead) to the interepicondylar line (IEL) (a) and from the crossing point of the PACN on the IEL to the lateral epicondyle (b). The arm length was designated as the distance between the inferior border of acromion process and the lateral epicondyle.

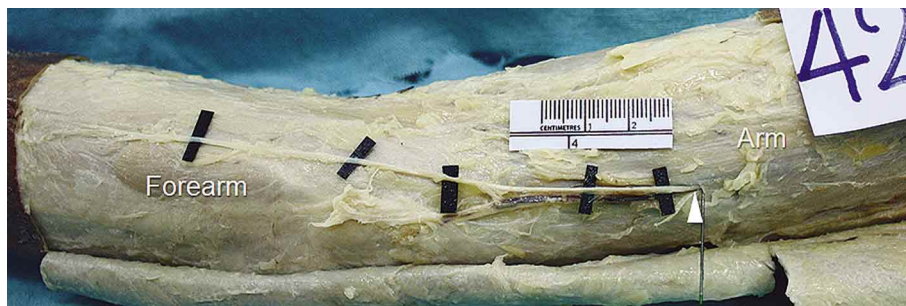


Fig. 2. Course of the posterior antebrachial cutaneous nerve (PACN). The nerve penetrated the deep fascia at the hiatus (arrowhead).

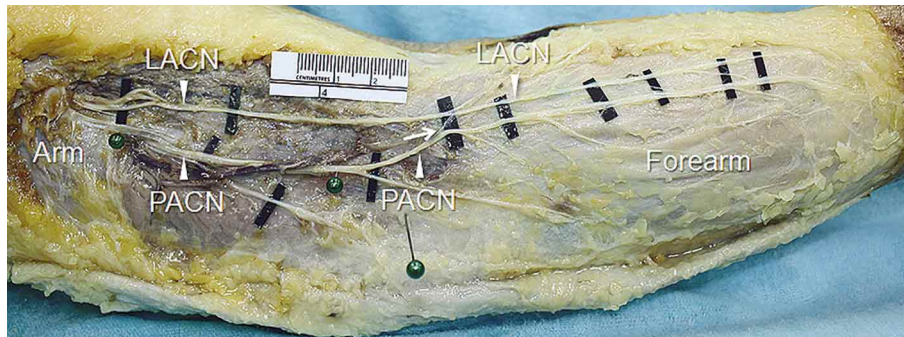


Fig. 3. Communication between the posterior antebrachial cutaneous nerve (PACN) and the lateral antebrachial cutaneous nerve (LACN). Arrow indicates the communicating branch.

Table I. Measurement data regarding the course of posterior antebrachial cutaneous nerve (PACN).

Sex	Side	Distance (cm)		% of arm length
		(Range)		(Range)
		H-IEL	CP-LE	H-IEL
Male	Right	7.11±1.44	1.68±0.61 ^b	22.8±4.7
	Left	7.36±1.98	1.37±0.50	23.6±6.3
	Bilateral	7.24±1.73 (3.19–12.66)	1.52±0.58 (0.16–3.01)	23.2±5.6 ^a (10.2–40.8)
Female	Right	7.53±1.38	1.34±0.68	26.4±5.2
	Left	7.34±1.36	1.33±0.74	25.7±4.6
	Bilateral	7.44±1.36 (4.54–10.39)	1.34±0.70 (0.18–3.04)	26.1±4.8 (16.1–37.2)

Data are means ± SD. H= hiatus, IEL= interepicondylar line, LE= lateral epicondyle, CP= crossing point of the PACN on the IEL. a= p < 0,01 vs. female, b= p < 0.05 vs. left male

DISCUSSION

In this study, the PACN emerged from the hiatus slightly longer than 7 cm proximal to the IEL. MacAvoy *et al.* and co-workers found that this point was 6.6 cm proximal to the LE. The different reference points in this and the above study might be responsible for the slight discrepancy. Nevertheless, the consistent finding was that the PACN emerged from the deep fascia and LIMS approximately 7 cm proximal to the level of LE. It should be noted that Matzi *et al.* reported the distances from the LE to the PACN at the LIMS in the range of 10–15 cm. The reason for this much longer distance compared to those of our study and MacAvoy *et al.* is unknown.

When taking the arm length into account, the distances between the hiatus and the LE were 23 % and 26 % of the arm length in males and females, respectively. Despite significant difference between genders, they were approximately one-fourth of the arm length.

At the level of IEL, the PACN was approximately 1.3–1.5 cm anterior to the LE along the IEL in both genders. MacAvoy *et al.*, reported the mean distance of 2.1 cm. The discrepancy might be derived from the different measurement method used since we measured the distance along the IEL. This was likely more accurate in localizing the nerve as the ME and the LE are palpable. However, these data suggest that the PACN was approximately 1–2 cm anterior to the LE supporting the recognition that the nerve is close to the LE. Another inconsistent finding was, in all of our specimens, the PACN crossed the IEL anterior to the LE. In contrast, MacAvoy *et al.* observed that in one of 30 specimens, the nerve was posterior to the LE.

It is worth noting that the above details were referred to the main trunk of PACN. Existing data regarding the origin and number of branches of the PACN are scarce. One study described the branches posterior to the main trunk of PACN

which likely supplied the LE as posterior branches (Rose *et al.*, 2013). However, more details were not provided. In this study, we found that in at least 50 % of the specimens, there were up to 3 or 4 branches originating from the PACN either proximal or distal to the hiatus. In 2 specimens, one of these branches passed posterior to the LE. Besides these branches, additional branches communicating between the PACN and the LACN were observed in approximately 9 % of our specimens. This communication has not been reported previously. Taken together, these data indicate that up to 4 branches of the PACN could be found anterior and/or posterior to the LE in about 50 % of cases. The communicating branches between the PACN and the LACN are of clinical importance, for example, causing variations in the innervated areas of these nerves and affecting the electrophysiologic study.

There were significant differences in some parameters between genders and between sides. Gender and side differences were similarly observed in the previous study (Matzi *et al.*). This was also found with other cutaneous nerves (Wongkerdsook *et al.*; Damwan *et al.*). These findings emphasize that gender and side should be considered in the localization of PACN.

The above data are useful for avoiding the iatrogenic PACN injury during surgical procedures at the elbow. Portal placement in the elbow arthroscopy could injure the nerve (Adolfsson; Chaware *et al.*). The PACN injury was diagnosed after the surgical treatment of lateral epicondylitis (Dellon *et al.*; Iyer). Furthermore, preservation of the PACN during harvest of the lateral arm free flap for soft tissue reconstruction was associated with less sensory disturbances (Fogdestam *et al.*, 1996; Ki, 2016).

In conclusion, this study provided the anatomy of the PACN in relation to the LE and the IEL including the number of branches along its course. The ratio of vertical distance to the arm length was also obtained. Comparison between sides and genders revealed significant differences in some measurement parameters. These data are crucial for avoiding the PACN injury during various surgical procedures at the elbow. We also found the communicating branches between the PACN and the LACN. This should be aware when conducting clinical and electrophysiological evaluations of these nerves.

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CHODEWARATHAM, P.; CHENTANEZ, V.; AGTHONG, A. & HUANMANOP, T. Anatomía del nervio cutáneo posterior del antebrazo relacionado con el epicóndilo lateral y la línea interepicondilar. *Int. J. Morphol.*, 34(3):953-957, 2016.

RESUMEN: El nervio cutáneo posterior del antebrazo (NCPA) es un ramo del nervio radial que inerva la piel del antebrazo. Los datos acerca de su anatomía siguen siendo insuficientes en especial en cuanto a su origen y el número de ramos. Disecamos 101 miembros superiores de cadáveres pertenecientes a 32 hombres y 20 mujeres para exponer el NCPA. En todas las muestras, el nervio surgió de la fascia profunda en el hiato proximal a la línea interepicondilar (LIE) con distancias medias de 7,24 y 7,44 cm en hombres y mujeres, respectivamente. El porcentaje de esta distancia a la longitud del brazo fue 23,2 % y 26,1 % en hombres y mujeres, respectivamente. Después de penetrar la fascia profunda, el NCPA continuaba en el tejido subcutáneo y cruzaba la LIE anterior al epicóndilo lateral (EL) en todos los casos. Las distancias medias desde el punto de cruce del EL a lo largo de la LIE fueron 1,52 cm en hombres y 1,34 cm en mujeres. Con respecto a las ramos del NCPA, al menos 50 % de las muestras tenían hasta 3 o 4 ramos, ya fuesen proximales o distales al hiato. En dos de los brazos, uno de estos ramos pasó posterior al EL. Por otra parte, en 9 de las muestras se observó comunicación entre los ramos del NCPA y el nervio cutáneo antebrachial lateral. No se encontraron diferencias secundarias o de sexo en algunos parámetros de medición. Estos datos son esenciales para evitar las lesiones durante los procedimientos quirúrgicos alrededor del codo que involucren el NCPA.

PALABRAS CLAVE: Nervio cutáneo posterior del antebrazo; Epicóndilo lateral; Línea interepicondilar; Anatomía.

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