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Original Research Article

The anatomical relationship of the superficial branches of radial nerve: a cadaveric study

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ABSTRACT

Background: The major superficial branches of the radial nerve like inferior lateral cutaneous nerve of arm (ILCNA) and posterior cutaneous nerve of forearm (PCNF) are susceptible to get injured during surgical procedure done in distal half of humerus.
Methods: In this study 25 voluntary donated cadavers were dissected to define the course and position ILCNA and PCNF of the radial nerve and their ramifications in relation to anatomical landmarks such as the lateral inter muscular septum or bony landmarks such as lateral epicondyle.
Results: The inferior lateral cutaneous nerve of the arm arose from the radial nerve at the lower part of the spiral groove, at a mean of 14.8 cm proximal to the lateral epicondyle and 4.2 cm proximal to the uppermost fibres of the brachioradialis muscle. The posterior cutaneous nerve of the forearm arose from the inferior lateral cutaneous nerve at a mean of 6.7 cm proximal to the lateral epicondyle.
Conclusions: The described lateral approach permits assessment of any part of the radial nerve and reduces the risk of iatrogenic injury.

Keywords: Inferior lateral cutaneous nerve of arm, Lateral epicondyle, Lateral intermuscular septum, Posterior cutaneous nerve of forearm

INTRODUCTION

The radial nerve, stemming from the posterior cord of the brachial plexus with root value C5, C6, C7, C8, T1, is a crucial contributor to upper limb innervation. As it courses through the axilla, it gives rise to branches serving the triceps brachii and posterior cutaneous nerve of the arm. Passing posteriorly through the triangular space, it supplies the lateral and medial heads of the triceps brachii at the spiral groove. Notably, it also gives rise to two cutaneous branches, namely the inferior lateral cutaneous nerve of the arm (ILCNA) and the posterior cutaneous nerve of the forearm (PCNF). Upon piercing the lateral intermuscular septum at the lower lateral aspect of the humerus, it enters the anterior compartment of the arm, where it divides into its terminal branches, including the superficial and deep branches anterior to the lateral epicondyle of the humerus.[1]

Plating the distal shaft of the humerus typically utilizes a lateral approach, which, however, poses challenges due to the need for extensive distal exposure to delineate the radial nerve's course. Consequently, there's an increased risk of injury to the radial nerve and its superficial branches at the point of piercing the lateral intermuscular septum.[2-4]

Research indicates that 17.4% of traumatic nerve damages stem from iatrogenic causes.[5] Furthermore, Dellon et al. highlighted the development of neuromas in

the PCNF following surgery for lateral humeral epicondylitis, which could lead to post-operative pain.[6] Given these considerations, there's a significant probability of iatrogenic injury to the PCNF during procedures such as injections to the common extensor tendon for treating lateral epicondylitis.

This study aims to delineate the course and position of major superficial branches like ILCNA and PCNF of the radial nerve and their ramifications concerning anatomical landmarks such as the lateral intermuscular septum and bony landmarks like the lateral epicondyle. Additionally, it seeks to identify a 'danger zone' during lateral and anteroposterior fixation of humeral injuries.

METHODS

A cross-sectional study involving 25 voluntarily donated cadavers was conducted at the Department of Anatomy of AIIMS Jodhpur from June 2020 to April 2022, following ethical approval from institutional ethical committee. Cadavers were positioned supine with the arm slightly abducted and internally rotated. An incision was made along the anterior border of the deltoid muscle, extending to the lateral aspect of the arm, approximately 1 cm anterior to the lateral intermuscular septum. The radial nerve was visible on the lateral surface of the humerus before it pierced the lateral intermuscular septum. It was then dissected proximally upto the spiral groove of the humerus. The shaft of the humerus was then approached on either side of the radial nerve, anterior and posterior to the lateral intermuscular septum. Subsequently, the ramifications of the cutaneous branches of the radial nerve, including ILCNA and PCNF, were defined. Dissection and analysis included proximal tracing of these branches to their origin from the radial nerve, their relationships with the lateral intermuscular septum, and measurements of distances between branch origins and the lateral epicondyle.

Inclusion criteria

All adult voluntary donated cadaver were taken.

Exclusion criteria

Comprised cadavers with any macroscopic deformity of their elbow joint were excluded.

Statistical analysis

Descriptive statistics, including range, mean, and standard deviation, were computed using SPSS software (IBM, version 20.0).

RESULTS

The study included ten female and 15 male cadavers, totalling 25 cadavers and fifty radial nerves (Table 1).

Table 1: Demographic profile of study population.

Sex group	Number	Age (years)
Male	15	49.3±5.2
Female	10	45.1±4.8

Anatomy of the inferior lateral cutaneous nerve of the arm

The radial nerve gives inferior lateral cutaneous nerve of the arm (ILCNA) at lower part of spiral groove at a mean distance of 14.8 cm (14.1 to 15.5) proximal to lateral epicondyle and 4.2 cm (3.7 to 5.1) proximal to the highest fibres of the brachioradialis muscle (Table 2). It then run distally along the outer margin of the humerus and stayed posterior to the lateral intermuscular septum till it emerged from the posterior compartment of the arm. In five cases the nerve penetrated the lateral intermuscular septum and enter the anterior compartment at a mean distance of 9.8 cm (7.2 to 12.4) proximal to the lateral epicondyle, which paralleled to a mean distance of 3.2 cm (2.5 to 4.3) inferior to the route of the radial nerve into the anterior compartment of the arm. Around a mean distance of 4.8 cm (3.8 to 6.5) (SD 1.2) proximal to the lateral epicondyle, it pierced the anterior brachial fascia to travel superficially in the subcutaneous tissue. The ILCNA appeared directly from the posterior compartment into the subcutaneous tissue in 20 cases (80%) and pierced the posterior brachial fascia without piercing the intermuscular septum (Figure 1a). The ILCNA ran superficially in relation to the brachioradialis muscle, slightly anterior to its origin in all cases, directing twigs to the lateral surface of the distal part of the arm. The nerve was accompanied by the posterior branch of the deep brachial artery in its proximal course.

Table 2: The mean distance of emergence of ILCNA.

	Mean distance (cm)
Proximal to lateral epicondyle	14.8
Proximal to the highest fibres of the brachioradialis muscle	4.2

Anatomy of the posterior cutaneous nerve of the forearm

The posterior cutaneous nerve of the forearm (PCNF) arose from the ILCNA in all cases. The ILCNA provided a single posterior sensory branch in 43 arms (86%); in six arms (12%) it divided into two anterior rami of the equivalent size and a posterior ramus. This separation took place at a mean of 6.7 cm (5.8 to 7.9) from the lateral epicondyle. The PCNF arose from the anterior compartment of the arm in eight cases (16%) distal to the lateral intermuscular septum, at a mean of 3.5 cm after the ILCNA had pierced the septum (Figure 1b). The PCNF arose in the posterior compartment of the arm in the other 42 arms (84%), and pierced the posterior brachial fascia. It descended marginally anterior to the

lateral intermuscular septum in the subcutaneous tissue and passed anterior to the lateral epicondyle. The PCNF ran backwards giving twigs to the upper part of the posterolateral surface of the forearm.

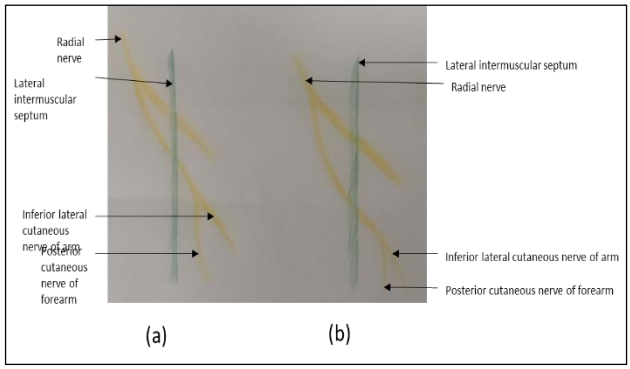

Figure 1: (a) The ILCNA pierced the lateral intermuscular septum to enter the anterior compartment and the PCNF arose in the anterior compartment; (b) The ILCNA continued in the posterior compartment and emerged directly into the subcutaneous tissue after piercing the posterior brachial fascia.

DISCUSSION

The most commonly performed approach to the shaft is the anterolateral of the humerus but proximal extension to the spiral groove may cause injury to the ILCN.[7] Other approaches may be the medial and the posterior or posterolateral approaches.[8-11] When fractures associated with vascular injuries or complex nonunions of the shaft occurred the medial approach is more often recommended.[12] In treatment of fractures of the distal third of the humerus where centrally located posterior plate is required the posterolateral exposures are useful.[10]

Mills et al proposed a lateral approach similar to that described in present study, but through an incision 1 cm posterior to the septum and without dissection of the sensory branches of the radial nerve.[13]

The strictly lateral exposure which is described in present study grounded on the preliminary identification of the ILCNA and the PCNF in the subcutaneous tissue and their proximal dissection to the radial nerve. The results obtained were comparable to previous study.[14] The ILCNA is also known as the nerve of the lateral brachial flap provides the sensory innervation of the lateral surface of the distal third of the arm. It is easily detectable and positioned along the lateral column of the humerus and at the uppermost of the fibres of the origin of the brachioradialis muscle.[15] The PCNF is persistent in its course. It arises from the ILCNA, travels subcutaneously along the lateral column of the humerus and run down vertically along the dorsal aspect of the forearm.[16] Intraoperatively to identify, locate and protect radial nerve, soft tissue landmark confluence of triceps aponeurosis is most consistent and reliable.[17] Proximal dissections of these branches allows the search of the perfect course of the radial nerve and acquaintance of the humeral shaft, both anteriorly and posteriorly to the lateral intermuscular septum.[18] This approach permits assessment of any part of the radial nerve and reduces the risk of iatrogenic injury.

Various approaches to humeral shaft fractures exist, each with its associated risks. The lateral approach, commonly utilized, may lead to ILCN injury upon proximal extension to the spiral groove. Other approaches include the medial and posterior approaches, recommended for specific fracture types.

CONCLUSION

The present study's lateral exposure approach, grounded on preliminary identification of ILCNA and PCNF, aims to minimize iatrogenic injuries by facilitating optimal radial nerve localization through proximal dissection of these branches.

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