

Danger zone of radial nerve in Indian population – A cadaveric study[☆]

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ABSTRACT

Background: Identification of the radial nerve is necessary during surgery of the humerus fracture to avoid injury to it. Iatrogenic nerve injury during humerus fracture surgery is a well-known complication. Prevention of this type of injuries would be of great value. Aim of this study is to reduce the chance of iatrogenic nerve injury by defining of a danger zone in the distal upper arm regarding the radial nerve in indian population.

Methods: Thirty six upper limbs of eighteen adult human formalin preserved cadavers (14 males & 4 females) were used in this study. The posterior aspect of the arm was dissected to expose the radial nerve from the triangular space to the point where the radial nerve pierced the lateral intermuscular septum. Systematic identification of radial nerve and multiple measurements were done for each specimen.

Results: The mean humeral length was $30.96 + 1.23$ cm. Mean Distance of medial epicondyle to entry of radial nerve into spiral groove was $18.5 + 0.79$ cm. Mean Distance of lateral epicondyle to exit of radial nerve into spiral groove was $11.34 + 0.41$ cm. The mean length of radial nerve groove/spiral groove was $4.3 + 0.75$ cm.

Conclusions: Our study has identified the point of intersection of radial nerve to humerus in Indian population. Understanding the safe zones and the zone of danger of the humerus provides more safety during the surgical interference of the humerus. To do this, the radial nerve must be identified and protected. Wide incision and blunt dissection is still recommended to minimize the risk of radial nerve damage.

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1. Introduction

One of the most common reasons for peripheral nerve palsy is an injury of the radial nerve associated with a fracture of the humeral shaft.^{1–4} Regarding the literature, the overall incidence of radial nerve palsy in patients with humeral shaft fracture is between 7 and 17%.³ One can differ between primary or traumatic nerve injury and secondary or iatrogenic nerve injury following fracture fixation or manipulation.^{3,5,6} Claessen et al. found an incidence of 7% for iatrogenic radial nerve palsy in patients with humeral shaft fractures, and data in the literature vary between 6 and 32%.^{6–8}

Now a days there is increase in surgical intervention for management of shaft humerus fracture to allow earlier mobilization and rapid return to work.

The radial nerve arises from the posterior cord of the brachial plexus. The nerve, along with accompanying vessels, crosses medial to lateral obliquely over the posterior surface of the humerus in the spiral groove. It then penetrates the lateral intramuscular septum near the junction of the middle and distal thirds of the humerus.^{9,10} The brachial portion of the nerve is commonly encountered during the posterior approach to the humerus.

The purpose of this study were to find out the points at which the radial nerve begins and ends its course in posterior shaft of humerus in relation to palpable bony landmarks. And also determine a safe zone of radial nerve in arm.

2. Materials and methods

Thirty six upper limbs of eighteen adult human formalin preserved cadavers (14 males & 4 females) were used in this study. These cadavers were obtained from The Department of anatomy and forensic medicine at our center. The cadavers with identifiable upper limb trauma were excluded from this study. The postero lateral angle of acromion & tip of coracoid processes of scapula, distal end of deltoid tuberosity and the centre of both lateral and medial epicondyles of the humerus were used as bony landmarks. The posterior aspect of the arm was dissected to expose the radial

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nerve from the triangular space to the point where the radial nerve pierced the lateral intermuscular septum. The radial (spiral) groove was determined to be the short distance where the radial nerve lay directly on the posterior surface of the humerus. A number of

measurements were made to determine the course of the radial nerve relative to the previously reported bony landmarks.

Measurements were made of the course of the radial nerve as it crossed the posterior aspect of the humerus, with the medial and



Fig. 1. Distance from lateral epicondyle to exit point of radial nerve.



Fig. 2. Distance from lateral epicondyle to exit point of radial nerve.



Fig. 3. Distance from medial epicondyle to entry point of radial nerve.

Table 1
Measurements of cadavers.

Cadaver number	sex	Humeral Length		Distance from medial epicondyle to entry point of radial nerve in spiral groove		Distance from lateral epicondyle to exit point of radial nerve in spiral groove		Length of spiral groove	
		Right	Left	Right	Left	Right	Left	Right	Left
1	Male	31.7	31.5	19.2	19.0	11.5	11.4	4.6	4.5
2	Female	28.5	28.6	16.8	16.8	10.8	10.8	2.9	2.9
3	Male	31.2	31.2	18.7	18.7	11.2	11.2	4.9	4.9
4	Male	32.2	32.2	18.5	18.4	11.4	11.3	5.2	5.2
5	Male	32.1	32.2	19.0	19.0	13.9	14.4	4.9	4.7
6	Male	31.5	31.4	19.2	19.2	12.0	12.1	4.6	4.6
7	Female	29.1	29.3	17.1	17.1	11.0	11.0	3.3	3.1
8	Male	29.8	29.8	18.9	18.9	10.8	10.6	4.5	4.5
9	Male	30.4	30.7	19.0	19.0	12.2	12.2	3.9	3.9
10	Female	29.9	29.9	17.5	17.5	10.9	10.7	3.2	3.0
11	Female	29.7	29.7	17.2	17.2	11.2	11.2	3.1	3.1
12	Male	31.9	31.7	18.7	18.7	11.8	11.6	4.5	4.2
13	Male	31.4	31.2	19.1	19.2	11.7	11.5	5.1	5.1
14	Male	32.1	32.2	18.8	18.7	11.7	11.7	4.9	4.9
15	Male	31.0	31.1	19.1	19.1	11.1	11.1	5.3	5.0
16	Male	30.8	30.7	19.0	19.1	11.2	11.3	4.7	4.3
17	Male	32.0	32.0	19.1	19.1	10.9	10.9	4.7	4.7
18	Male	32.1	32.1	18.9	18.9	11.2	11.1	4.5	4.4

lateral epicondyles used as distal reference points. The length of the humerus from the lateral epicondyle to posterior-lateral angle of acromion was also documented for each specimen. Figs. 1–3 showing measurements in cadveric specimens, Fig. 5 shows radial nerve into distal humerus dividing into superficial branch of radial nerve and posterior interosseous nerve.

3. Results

Without sex or age differentiation the results of this study (Table 1 & Fig. 4) are:

The mean humeral length was 30.96 ± 1.23 cm

Mean Distance of medial epicondyle to entry of radial nerve into spiral groove was 18.5 ± 0.79 cm

Mean Distance of lateral epicondyle to exit of radial nerve into spiral groove was 11.34 ± 0.41 cm

The mean length of radial nerve groove/spiral groove was 4.3 ± 0.75 cm.

4. Discussion

The upper limb is innervated by a plexus of nerves arising from the ventral rami of the C5–T1 nerve roots. The ventral rami of the upper, middle and lower trunks divide into anterior and posterior divisions. The posterior divisions of all three trunks form the posterior cord. In the axilla, the radial nerve is located posterior to the axillary artery from where it runs inferiorly along the medial aspect of the proximal humerus. The radial nerve then descends along the radial groove to pierce the lateral intermuscular septum proximal to the lateral epicondyle where it runs between the brachialis and brachioradialis muscles. As the radial nerve approaches the lateral epicondyle it divides into the superficial radial and posterior interosseous nerves.

In our study the radial nerve crossed the posterior aspect of the humerus from an mean of 18.5 ± 0.79 cm proximal to the medial epicondyle to 11.34 ± 0.41 cm proximal to the lateral epicondyle. The mean length of the radial nerve in the spiral groove varied from 4.3 ± 0.75 cm. In this area, the radial nerve could be injured by operative procedures.

In an anatomic study, Guse and Ostrum¹¹ reported that the proximal extent of the radial nerve in the spiral groove was 18.1 cm (± 1.1 cm) proximal to the medial epicondyle, whereas the distal

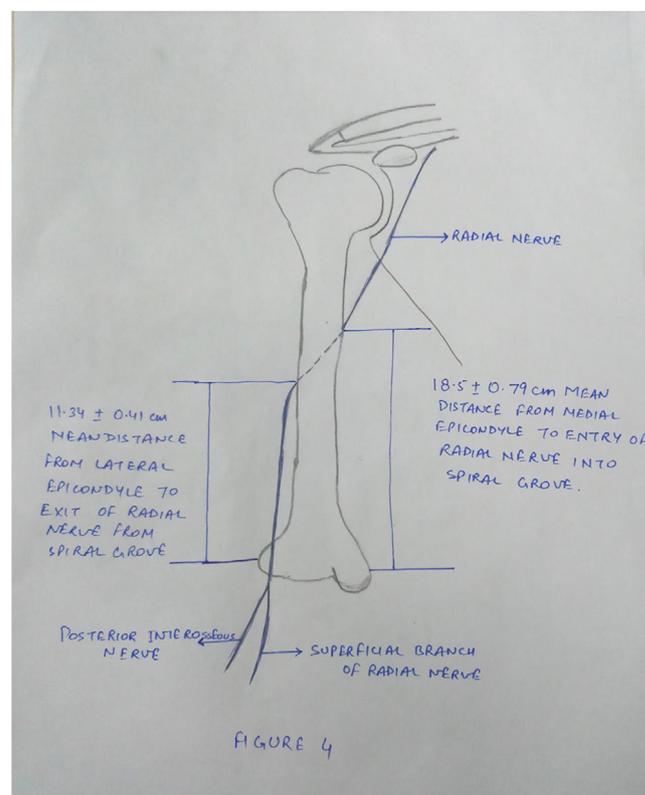


Fig. 4. Line diagram of safe zone.

extent of the radial nerve in the spiral groove was 12.6 cm (± 1.1 cm) proximal to the lateral epicondyle of the humerus.

In a similar study, Gerwin et al.¹² reported that the radial nerve ran along the posterior aspect of the humerus from 20.7 cm (± 1.2 cm) proximal to the medial epicondyle to 14.2 cm (± 0.6 cm) proximal to the lateral epicondyle of the humerus.

In another anatomic study on 55 formalin-preserved cadavers, Chaudhry et al.¹³ analyzed the radial nerve in relation to the lateral epicondyle and lateral margin of the triceps aponeurosis. In their dissections, the radial nerve was 11.1 (± 1.2) cm away from the lateral epicondyle at the inferior margin of the spiral groove, and



Fig. 5. Division of radial nerve into superficial branch and posterior interosseous nerve.

ran a course parallel and 22 mm to 27 mm (± 2 mm) lateral to the lateral margin of the triceps aponeurosis.

Understanding the safe zones and the zone of danger of the humerus provides more safety during the surgical interference of the humerus. To do this, the radial nerve must be identified and protected. The proximal and distal safe zones as defined by Guse and Ostrum,⁽¹¹⁾ are the length of humerus proximal and distal to the point at which the radial nerve respectively begins and ends its course on the posterior shaft of the humerus. We found the proximal safe zone ended at an average 18.5 ± 0.79 cm from the medial epicondyle and the distal safe zone began at 11.34 ± 0.41 cm from lateral epicondyle.

In minimally invasive plate osteosynthesis the radial nerve is not at risk as long as the forearm is kept in supination during the procedure, and no screws are inserted into that part of the humeral shaft where the radial nerve runs along the spiral groove (between 11 and 19 cm from lateral epicondyle). In this danger zone, bicortical screw placement from anterior to posterior should be avoided; if screw insertion is needed, unicortical screw placement is recommended.

The highest risk of injury to the radial nerve in external fixation is at the point where the nerve pierces the lateral intermuscular septum (approximately 11 cm from lateral epicondyle). The pin placement more than 10 cm from the lateral epicondyle should be avoided and that pins should be positioned as posterior as possible to minimize the risk of radial nerve damage.

We did not encounter any variation in the anatomy of the radial nerve.

5. Conclusion

Understanding the safe zones and the zone of danger of the humerus provides more safety during the surgical interference of the humerus particularly for junior surgeons. To do this, the radial nerve must be identified and protected. Wide incision and blunt dissection is still recommended to minimize the risk of radial nerve damage.

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Conflict of interest

None.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional ethical research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The manuscript has been read and approved by all the authors, the manuscript represents honest work.

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