

Study of Median Nerve Between the Two Heads of Pronator Teres to Determine Its Accessibility with Positional Reference to Inter-Epicondylar Line

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Abstract

Background: The median nerve (MN), originating from the brachial plexus (C5–T1), traverses between the two heads of the pronator teres (PT) muscle in the forearm in the majority of individuals. This anatomical passage can be a site of entrapment, known as Pronator Teres Syndrome (PTS), especially in individuals with repetitive pronation activity. Surgical decompression is often warranted in persistent cases, but standard incisions may result in unsightly scarring. This study aims to provide anatomical data to support an alternative surgical approach based on the positional relationship of the MN to the inter-epicondylar line. **Material and Methods:** The study was conducted on 30 formalin-fixed cadavers (50 upper limbs) at Bowring and Lady Curzon Medical College and Research Institute, Bangalore. Standard dissection techniques were used to expose the MN and PT muscle heads. Measurements taken included the inter-epicondylar distance (AB), vertical distance from the inter-epicondylar line to the point of MN insertion between PT heads (CD), and the horizontal distance from the medial epicondyle to the vertical line (AC). Data were compared with previous anatomical studies. **Results:** The MN passed between the two heads of PT in 81% of specimens. It passed under both heads in 19%; no case had a single humeral head. Mean inter-epicondylar distance (AB): 10.42cm. Mean vertical distance (CD): 4.41 cm Mean horizontal distance (AC): 4.42 cm. Comparative analysis with previous literature confirmed the variability in MN passage and supports the observed pattern. **Conclusion:** The present study suggests that a precise incision may be planned along the vertical path (CD) from approximately 4.42 cm lateral to the medial epicondyle and 4.41 cm below the inter-epicondylar line to access the MN at its point of passage between the PT heads. This approach may facilitate safer, targeted surgical decompression while minimizing cosmetic concerns.

Keywords: Median Nerve, Pronator Teres Syndrome, Forearm Anatomy, Inter-Epicondylar Line, Nerve Entrapment, Surgical Access, Cadaveric Study.

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INTRODUCTION

The median nerve (MN) arises from the medial and lateral cords of the brachial plexus, with root values C5–T1, and supplies motor and sensory innervation to the forearm and hand.^[1] It enters the forearm by passing between the two heads of the pronator teres (PT) muscle, which usually consists of a humeral head originating from the medial epicondyle of the humerus and a ulnar head from the coronoid process of the ulna.^[2]

These two heads usually unite distally, but before that, the median nerve typically passes between them in 74–82% of cases, while the ulnar head may be absent in about 14%, resulting in altered nerve path and clinical relevance.^[2,3] Compression of the median nerve at this site leads to Pronator Teres Syndrome (PTS), a form of proximal median nerve entrapment. The syndrome is often due to fibrous bands or hypertrophied muscle, especially involving the superficial humeral head.^[4] Patients typically present with pain in the proximal forearm, paresthesia in the median nerve distribution (thumb, index, middle fingers), and weakness in grip strength. A distinguishing feature is the

absence of nocturnal symptoms, which helps differentiate PTS from Carpal Tunnel Syndrome (CTS).^[4,5]

PTS is more prevalent among individuals involved in repetitive pronation and gripping activities, such as carpenters, mechanics, athletes, and weightlifters, with higher incidence in the dominant arm.^[4] While physiotherapy is the first-line treatment, surgical decompression may be necessary in chronic or resistant cases.

Conventional surgery typically involves a long S-shaped incision (~10 cm) made approximately 3 cm distal to the medial epicondyle, allowing full access to the nerve but often resulting

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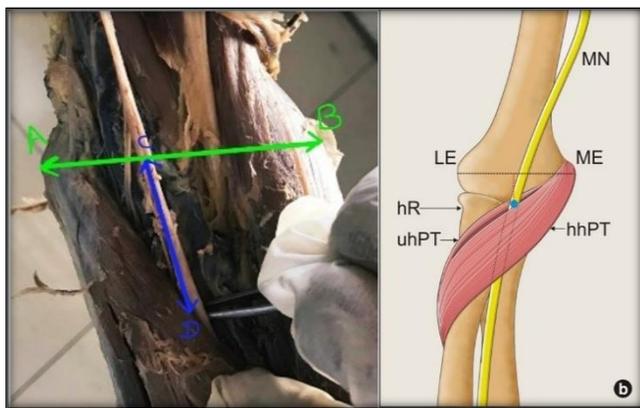
in unfavorable scarring.^[6] More recently, minimally invasive techniques have been developed, including a 3.5 cm oblique skin incision placed 6 cm distal to the medial epicondyle over the flexor/pronator mass, which provide effective nerve access with better cosmetic outcomes.^[7-9]

In light of these anatomical and clinical challenges, the present study aims to evaluate the median nerve's accessibility between the two heads of the pronator teres, using positional reference to the inter-epicondylar line, and to explore the feasibility of an alternative incision site that is surgically effective and cosmetically favourable.

Aims and Objectives

The primary aim of this study is to determine the positional relationship of the median nerve as it passes between the two heads of the pronator teres muscle, using the inter-epicondylar line as a reference point. The objective is to identify an anatomically consistent and minimally invasive site for surgical access to the nerve, potentially offering an improved approach for decompression procedures in Pronator Teres Syndrome.

MATERIALS AND METHODS



The study was carried out on 30 formalin-fixed cadaveric specimens of adult upper arm at Shri Atal Bihari Vajpayee Medical College and Research Institute, Bangalore. Theme Dissector (Volume I): Upper Limb and Thorax was followed to carry out the dissection. In 50 isolated, formalin-fixed upper limbs, the cubital region and the forearm were dissected. The following measurements were taken: origin of the PT muscle heads, the length of these heads, the length of the forearm, diameter of the MN and

the number of its muscular branches to the pronator teres muscle. Lengths were measured using thread and scale. The following measurements were taken: AB, CD and AC.

Study Design: This was a descriptive, cross-sectional, cadaveric anatomical study conducted at the Department of Anatomy, Shri Atal Bihari Vajpayee Medical College and Research Institute, Bangalore. A total of 30 formalin-fixed adult human cadavers (60 upper limbs) were used for the study. Standard dissection protocols were followed as outlined in Theme Dissector (Volume I): Upper Limb and Thorax. Each specimen was meticulously dissected to expose the median nerve (MN) and pronator teres (PT) muscle in the cubital region and proximal forearm. The study aimed to analyze the course of the median nerve in relation to the two heads of the PT muscle, and its positional reference to the inter-epicondylar line, to explore safer and more effective surgical access points.

Inclusion and Exclusion Criteria

All formalin-fixed cadavers of adult individuals (regardless of sex) with intact upper limbs and no visible deformities, surgical scars, or traumatic injuries in the arm, elbow, or forearm regions were included in the study. Cadavers with gross anatomical abnormalities, congenital deformities, amputated upper limbs, damaged or dissected PT or MN structures, or evidence of prior surgical procedures in the cubital or forearm region were excluded to ensure anatomical consistency and accuracy of measurements.

Data Collection Procedure: Dissections were carried out following the steps in Theme Dissector Volume I under standardized laboratory conditions. The cubital fossa and proximal forearm were exposed to identify the median nerve and its relation to the two heads of the pronator teres. Measurements were taken using non-elastic thread and a calibrated measuring scale. The following anatomical points were identified and measured:

- AB: Inter-epicondylar distance (distance between medial and lateral epicondyles),
- CD: Perpendicular distance from the inter-epicondylar line to the point of entry of the median nerve between the two PT heads,
- AC: Horizontal distance from the medial epicondyle to the vertical line dropped to the point of nerve insertion.

Additional data collected included: the origin and length of PT heads, length of forearm, diameter of the median nerve, and the number of muscular branches supplying the PT muscle. All measurements were recorded systematically for statistical analysis.

RESULTS

Table 1: Measurements of Median Nerve Insertion Relative to Inter-Epicondylar Line

| Specimen no. | Inter-epicondylar distance (cm) i.e. Ab | Distance of the point of insertion from the inter-epicondylar line along the median nerve i.e. Cd (cm) | Distance between the medial epicondyle and the point above the point of insertion on the inter-epicondylar line i.e ac (cm) |
|--------------|---|--|---|
| 1 | 11.5 | 4.5 | 4.5 |
| 2 | 12 | 5.8 | 4.5 |
| 3 | 9.9 | 5 | 4 |
| 4 | 10.3 | 4.9 | 4.8 |
| 5 | 9.9 | 5.6 | 5.5 |
| 6 | 10.5 | 3 | 4 |

| | | | |
|----|------|-----|-----|
| 7 | 8.5 | 3.4 | 3.6 |
| 8 | 9.1 | 4.1 | 4.3 |
| 9 | 10.8 | 4.2 | 4.9 |
| 10 | 11.7 | 3.6 | 4.1 |

- Mean distance between A and B = 10.42 cm
- Mean distance between A and C = 4.42 cm
- Mean distance between C and D = 4.41 cm

Table 2: Showing the relation of median nerve with PT muscle

| Sl. No. | Type of Course | Percentage |
|---------|--|------------|
| 1 | The MN passed between the two heads of the PT muscle | 81% |
| 2 | The MN passed under two heads of the PT | 19% |
| 3 | The PT possessed only a humeral head, and the MN passed deep to it | 0 |

DISCUSSION

In the present study, the relation of the median nerve (MN) to the pronator teres (PT) muscle was analysed in 10 specimens.

- Mean inter-epicondylar distance (A–B) = 10.42 cm
- Mean distance from medial epicondyle to AC = 4.42 cm
- Mean distance from AC to CD along the MN = 4.41 cm
- Course of MN in relation to PT: MN passed between the two heads of PT in 81% of specimens; MN passed under both heads in 19%; no cases where PT had only a humeral head with MN passing deep to it.

1. Course of MN through/under PT

- According to Marine Dididze, in the majority of cases (74–82%), MN passes between the humeral and ulnar heads of PT.^[10]
- Sharma et al. (Nepal) found that in 92.6% of 54 specimens, MN passed between the two heads; in 7.4% it passed below the ulnar head.^[11]
- In a Central European study (Vymazalová et al.), the types were: MN between both heads ~74%; beneath both heads ~12%; beneath the humeral head alone ~14%.^[12]

Our findings (81% between heads, 19% under both heads, 0% only humeral head variant) are broadly in agreement with published ranges. The percentage of “between two heads” is slightly lower than some high values (e.g. ~92.6% in Sharma et al.^[11]), and your “under both heads” (19%) is somewhat higher than in many reports where beneath both heads is less frequent (often ~5–12%).^[12] The absence of any cases of the humeral-head only variant is consistent with many studies but differs from some (e.g., ~14% in Central European sample had ulnar head absent / only humeral head deep route).^[12]

2. Distances from inter-epicondylar / epicondylar lines

- In a study of muscular branch of median nerve to the pronator teres (India, cadaveric), the origin of the branch to PT was at mean 1.31 ± 0.58 cm proximal to the inter-epicondylar line, and 1.2 ± 1.27 cm distal in some.^[14]
- In Morphology and morphometry of the ulnar head of PT (112 forearms), the median nerve passed anterior to the ulnar head at a distance of $\approx 50.4 \pm 10.7$ mm from the inter-epicondylar line.^[13]

Our “mean distance between A and C” (which I interpret to be from medial epicondyle to a point above the insertion onto the inter-epicondylar line) = 4.42 cm → i.e. ~44.2 mm.

This lies somewhat below the ~50.4 mm in the ulnar head study,^[15] but close enough given differences in sample size, measurement landmarks, and specimens. The mean distance of ~4.41 cm (C to D) also shows similar magnitude of distance from some reference lines as in published work.

3. Variability and absence of certain types

- In Vymazalová et al., the “absent ulnar head” variant, leading MN to pass deep to humeral head, was ~14%.^[12]
- Some literature also notes rare paths: e.g., MN piercing the humeral head of PT.^[16]

In our sample none of these rare variants (only humeral head, or MN piercing) were observed. That could be due to small sample size (10 limbs), or population differences.

Possible Explanations for Differences

- Sample size: our study has only 10 specimens, which increases variability, and rare variants may simply not appear.
- Population / ethnic differences: Anatomical morphometry can vary with population (height, limb length, muscularity etc.). Many of the comparative studies are in Caucasian or mixed Asian cadaveric sources; yours may represent a different population.
- Measurement landmarks: Differences in how “inter-epicondylar line,” “point of insertion,” and “point of MN passage” are defined can shift measured distances by a few millimetres or centimetres.
- Preservation and dissection technique: embalmed vs fresh cadavers, whether tissues have contracted, whether measurements are taken in situ vs after dissection etc.

Clinical Implications

- The fact that in approx. 19% of our sample, MN passes under both heads suggests a non-negligible risk of compression there in those individuals.
- The distances you measured can aid surgeons/local anaesthetists to predict the likely location of MN in surgeries around the elbow or in decompression procedures. For example, incisions or surgical exposures aiming at the MN should consider that in many (~80%) specimens MN will run between PT heads about 4.4 cm from the medial epicondyle (or inter-epicondylar line), but in others might be deeper or under both heads.

Limitations

- Small sample size (n = 10) limits generalizability and ability to capture rare anatomical variants.
- If specimens were all from one region/age group, there may

be bias.

- Measurement error: landmarks may not coincide exactly with those used in other studies.

CONCLUSION

Overall, your findings are largely consistent with prior studies: majority of median nerves pass between the heads of pronator teres, with a sizeable minority passing beneath both heads. The distances you measured from the inter-epicondylar or epicondylar lines are also in line with reported values, though somewhat lower than some reports (≈ 50 mm etc.). These anatomical data may help in planning surgical, anesthetic, or rehabilitative interventions around the elbow to avoid nerve injury.

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Conflicts of interest

There are no conflicts of interest.

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