

Research Article

Formation of the Median Nerve and its Relation to the Axillary Artery: A Cadaveric Study from A Central Indian Population

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ABSTRACT

Background: The median nerve's mode of formation – the number and origin of its contributing roots and its relation to the axillary artery – shows well-documented but population-variable anatomical variation, with direct relevance to axillary brachial plexus block and to plexus exploration after trauma. Combined, statistically compared cadaveric data addressing this variability remain scarce for Central India.

Methods: Thirty embalmed cadavers (60 upper limbs) were bilaterally dissected at a single institution. The number and origin of the roots forming the median nerve, its relation to the axillary artery, and the length and diameter of any supernumerary root were recorded using a standardised proforma. Findings were compared between right and left sides and between sexes using the chi-square test.

Results: The classical two-root pattern was present in 66.7% of limbs (40/60), with a supernumerary root in the remaining 33.3% (20/60) – three roots in 30.0% and four roots in 3.3%. Where present, the supernumerary root arose most often from the musculocutaneous nerve (50.0%), followed by the lateral cord (40.0%) and posterior cord (10.0%), with a mean length of 20.31 ± 5.30 mm and diameter of 1.36 ± 0.31 mm. The nerve's formation lay lateral to the axillary artery in 68.3% of limbs, anterior in 21.7%, and medial in 10.0%. No statistically significant difference in supernumerary root frequency was found between sides (30.0% vs. 36.7%; $p = 0.784$) or sexes (31.8% vs. 37.5%; $p = 0.918$).

Conclusion: One in three limbs in this Central Indian cadaveric sample showed a supernumerary root to the median nerve, most often from the musculocutaneous nerve, with no significant side or sex difference – findings with direct relevance to regional anaesthesia and brachial plexus surgery in this population.

Keywords: Median Nerve, Brachial Plexus, Anatomical Variation, Axillary Artery, Cadaver, Supernumerary Root.

INTRODUCTION

The median nerve, a principal terminal branch of the brachial plexus, is classically described as arising from the union of a lateral root from the lateral cord and a medial root from the medial cord, anterior or lateral to the third part of the axillary artery [1]. This description, however, obscures a well-documented, clinically important degree of variability in the nerve's mode of formation. Supernumerary roots, additional contributions from adjacent plexus elements, and variable relations to the axillary artery have each been reported in cadaveric series worldwide, with prevalence estimates differing substantially between populations [2,3,4]. Within India alone, reported frequencies of a supernumerary root range from approximately 15% in a North Indian

series [2] to over 30% in Central Indian and Bihar-based series [3,4], a two-fold difference relevant to axillary brachial plexus block, plexus exploration after trauma, and intraoperative interpretation. Despite this recognised variability, combined, single-sample data addressing formation together with its relation to the axillary artery, and formally compared between sides and sexes, remain scarce for Central India specifically. A small, recent literature has begun applying such formal comparison to cadaveric median nerve data [5], but no equivalent dataset has previously been reported for this population. This study was therefore undertaken to document the mode of formation of the median nerve, including the number and origin of its contributing roots and its relation to the axillary artery, in a bilaterally

dissected cadaveric sample from a Central Indian institution, and to compare these findings formally between sides and sexes.

MATERIALS AND METHODS

This cross-sectional, descriptive cadaveric study was conducted on 30 embalmed cadavers (60 upper limbs; 30 right, 30 left) dissected bilaterally at the Department of Anatomy of a Central Indian medical institution. Cadavers with both upper limbs available for dissection and free of documented deformity, prior surgery, or fracture in the axilla, arm, forearm, or hand were included; cadavers with a history of trauma, prior surgical intervention, congenital anomaly, gross pathology, or poor preservation in the region under study were excluded. A total enumeration sampling strategy was used, and all eligible cadavers available during the study period were dissected until the pre-specified target of 30 cadavers was reached.

The axilla was dissected to expose the roots of the brachial plexus contributing to the median nerve. For each limb, the number of roots forming the nerve was recorded, together with the origin of any additional (supernumerary) root — classified as arising from the lateral

cord, the posterior cord, or the musculocutaneous nerve — and the site of the nerve's formation relative to the third part of the axillary artery (anterior, lateral, or medial). Where a supernumerary root was present, its length and diameter were measured using a calibrated digital vernier caliper, with the limb positioned in standardised full extension and supination. Each variation was photographed in situ with a scale reference. Data were recorded on a pre-specified, dropdown-validated proforma and audited for completeness and internal consistency before analysis.

Categorical variables are expressed as frequencies and percentages. The chi-square test (or Fisher's exact test where any expected cell frequency was below five) was used to compare the frequency of a supernumerary root between sides and between sexes, following standard guidance on statistical test selection [6]. A p-value < 0.05 was considered statistically significant.

RESULTS

Thirty cadavers (22 male, 8 female; mean age 54.17 ± 13.04 years, range 36–77 years) yielded 60 upper limbs for dissection (Table 1).

Table 1. Sample characteristics

Characteristic	Value
Cadavers dissected	30
Upper limbs studied	60 (30 Right, 30 Left)
Sex — Male	22 (73.3%)
Sex — Female	8 (26.7%)
Age, years (mean $\pm$ SD)	54.17 ± 13.04
Age, years (range)	36 – 77

The classical two-root pattern of median nerve formation (one root each from the lateral and medial cords) was observed in 40 of 60 limbs (66.7%) (Figure 1). The remaining 20 limbs (33.3%) showed a supernumerary root — three roots in 18 limbs (30.0%) and four roots in 2 limbs (3.3%). Among the 20 limbs with a supernumerary root, its origin was the musculocutaneous nerve in 10 (50.0%), the lateral cord in 8 (40.0%), and the posterior cord

in 2 (10.0%). The supernumerary root had a mean length of 20.31 ± 5.30 mm (range 11.2–27.9 mm) and a mean diameter of 1.36 ± 0.31 mm (range 0.9–1.8 mm). The median nerve's formation lay lateral to the axillary artery in 41 limbs (68.3%), anterior to it in 13 limbs (21.7%), and medial to it in 6 limbs (10.0%) (Figure 2). These findings are summarised in Table 2.

Table 2. Formation of the median nerve (n = 60 limbs)

Parameter	Category	n (%) / Mean $\pm$ SD
No. of roots forming the nerve	2 roots (classical)	40 (66.7%)
	3 roots	18 (30.0%)
	4 roots	2 (3.3%)
Supernumerary root present	Yes	20 (33.3%)

	No	40 (66.7%)
Origin of supernumerary root (n = 20)	Musculocutaneous nerve	10 (50.0%)
	Lateral cord	8 (40.0%)
	Posterior cord	2 (10.0%)
Supernumerary root length, mm (n = 20)	Mean $\pm$ SD (range)	20.31 $\pm$ 5.30 (11.2–27.9)
Supernumerary root diameter, mm (n = 20)	Mean $\pm$ SD (range)	1.36 $\pm$ 0.31 (0.9–1.8)
Relation to axillary artery	Lateral	41 (68.3%)
	Anterior	13 (21.7%)
	Medial	6 (10.0%)

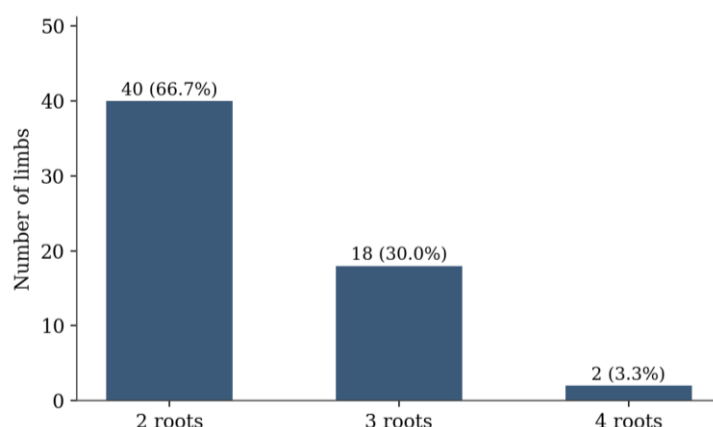


Figure 1. Number of roots forming the median nerve (n = 60 limbs)

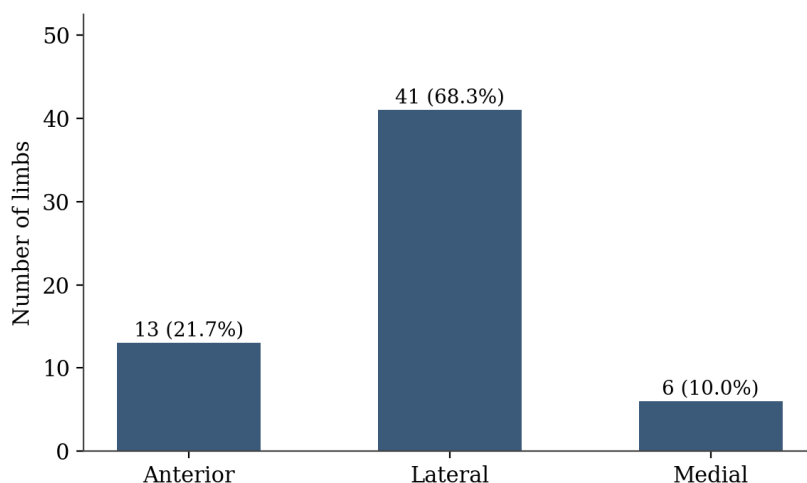


Figure 2. Relation of median nerve formation to the axillary artery (n = 60 limbs)

A supernumerary root was present in 9 of 30 right limbs (30.0%) and 11 of 30 left limbs (36.7%); this difference was not statistically significant ($\chi^2 = 0.075$, $df = 1$, $p = 0.784$). By sex, a supernumerary root was present in 14 of

44 male limbs (31.8%) and 6 of 16 female limbs (37.5%); this difference was likewise not statistically significant ($\chi^2 = 0.011$, $df = 1$, $p = 0.918$) (Table 3).

Table 3. Comparison of supernumerary root frequency between sides and between sexes

Comparison	Group 1	Group 2	Test statistic	p-value
By side	Right: 9/30 (30.0%)	Left: 11/30 (36.7%)	$\chi^2 = 0.075$, $df = 1$	0.784

By sex	Male: 14/44 (31.8%)	Female: 6/16 (37.5%)	$\chi^2 = 0.011$, df = 1	0.918
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Categorical comparison by χ^2 test (all expected cell frequencies ≥ 5).

DISCUSSION

This study found a supernumerary root contributing to median nerve formation in one-third of limbs (33.3%), most often from the musculocutaneous nerve. This figure sits toward the upper end of the range reported in the Indian cadaveric literature, closer to Central Indian and Bihar-based series (26.0–35.3%) [3,4,7] than to the North Indian series reported by Passey et al. (15.0%) [2], and is consistent with a recent Nepalese series reporting a comparable order of combined third/fourth-root frequency [8]. This pattern reinforces that reported frequencies for this parameter are genuinely population-variable rather than reflecting a single "true" national figure, and supports the value of continued region-specific documentation.

The musculocutaneous-nerve predominance among supernumerary roots observed here is consistent with the substantial overlap between the literature on median nerve formation and the separate literature on median–musculocutaneous nerve communication, in which comparable Central Indian cadaveric data have reported communication between these two nerves in around one-fifth of limbs [9]. This overlap plausibly reflects a shared developmental origin — variable axonal distribution between adjacent elements of the lateral cord group — rather than two independent phenomena.

No statistically significant difference in supernumerary root frequency was found between sides or sexes. This null finding is consistent with the small, recent cadaveric literature that has begun to apply formal statistical comparison to this parameter [5], and with a recent multi-institutional morphometric analysis in which an apparent sex difference in one formation measurement did not persist after normalisation for limb size [10], suggesting that true sex-based differences in median nerve formation, where they exist, are likely to be small and not reliably detectable at the sample size available to single-institution cadaveric studies such as this one.

Clinically, the one-in-three frequency of a supernumerary root, and the predominantly lateral relation of the nerve's formation to the axillary artery, are directly relevant to axillary brachial plexus block and to surgical exploration of the plexus after trauma, where an

unanticipated additional root may be encountered.

This study's principal limitations are its single-institution cadaveric design, which may limit generalisability; the absence of electrophysiological or imaging correlation; and a sample size that, while comparable to similar published series, provides limited power to detect small side or sex differences.

CONCLUSION

In this Central Indian cadaveric sample, the classical two-root pattern of median nerve formation was present in two-thirds of limbs, with a supernumerary root — most often from the musculocutaneous nerve — in the remainder, and no significant difference between sides or sexes. These findings extend the regional evidence base on median nerve variation and are relevant to the safe conduct of axillary block and brachial plexus surgery in this population.

Declarations

Ethical Approval: This study was carried out on cadavers already procured and donated for anatomical dissection and teaching, and did not involve living human participants. The protocol was submitted for approval to the Institutional Ethics Committee of [institution — to be confirmed] prior to commencement. [Ethics Committee reference number and date of approval to be inserted once available.]

Conflict of Interest: The authors declare no conflict of interest.

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Author Contributions: G.S.: dissection, data acquisition, data analysis, manuscript drafting. A.B.: study conception and design, supervision, manuscript review and editing. Both authors read and approved the final manuscript.

Data Availability: The dataset analysed in this study is available from the corresponding author on reasonable request.

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