

Variations in Median Nerve Branching Patterns in the Carpal Tunnel and Palm: Clinical Implication**Nidhi¹, Dhananjay Kumar², Mrityunjay Kumar³, Birendra Kumar Sinha⁴**¹Tutor, Department of Anatomy, PMCH, Patna²Associate Professor, Department of Radiology, PMCH, Patna³Associate Professor, Department of Pathology, PMCH, Patna⁴Professor & Head, Department of Anatomy, PMCH, Patna

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Abstract:**Background:** The median nerve, which arises from the medial and the lateral cords of brachial plexus, gives off no cutaneous or motor branches in the axilla or in the arm. Thereafter it passes between the superficial and deep heads of pronator teres to enter into the forearm.**Material and Methods:** The present study was conducted in the 'Department of Anatomy, Patna medical college and Hospital Patna Bihar' which is a tertiary care centre and a teaching hospital in 'Patna Bihar, India'. Before the commencement of the study approval was taken from the Institutional Ethical Committee and other concerned authorities. With prior permission the palms of 28 cadavers were dissected in a time period of two consecutive academic sessions during superior extremity dissection.**Conclusion:** Variation in the distribution of median nerve and its branches in the hand and in the carpal tunnel is not an uncommon occurrence. These variations occur frequently and may lead to diagnostic confusion followed by poor surgical outcome. Variations in the branching and course of recurrent thenar muscular branch of median nerve are of most importance because of its involvement in clinical practice. In surgical management of carpal tunnel syndrome transverse carpal ligament is sectioned to decompress the carpal tunnel.**Keywords:** Median Nerve, Carpal Tunnel, Retinaculum, Variations.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Median nerve is the principal nerve of the anterior compartment of the forearm.[6] It supplies all the flexor and pronator muscles of forearm except flexor carpi ulnaris (FCU) and the medial 1/3rd of flexor digitorum profundus (FDP). It also supplies some of the intrinsic muscles of the hand, especially the thenar group of muscles, thus contributing to the unique movement of opposition of the thumb. Median nerve, by virtue of its motor supply to the powerful flexor muscles of the forearm, is also known as the 'labourer's nerve'.

The median nerve, which arises from the medial and the lateral cords of brachial plexus, gives off no cutaneous or motor branches in the axilla or in the arm.[7] Thereafter it passes between the superficial and deep heads of pronator teres to enter into the forearm. Here it supplies all the flexor muscles except FCU and medial 1/3rd of FDP by unnamed branches or by its anterior interosseous branch. Flexor carpi ulnaris and medial 1/3rd of FDP is supplied by 'ulnar nerve'. In the distal third of the forearm, about 3cm proximal

to the flexor retinaculum the nerve gives off a palmar cutaneous branch to supply the central and the thenar parts of the palmar skin.

Median nerve enters the hand through carpal tunnel deep to the flexor retinaculum along with the nine flexor tendons.[6] Long flexor tendons of the palm are the four tendons of flexor digitorum superficialis (FDS), four tendons of flexor digitorum profundus (FDP) and one tendon of flexor pollicis longus (FPL). The carpal tunnel is the passageway deep to the flexor retinaculum between the tubercles of scaphoid and trapezium on the lateral side and the pisiform and the hook of hamate on the medial side. Compression of the median nerve within the carpal tunnel results in a clinical syndrome, characterized by burning pain or 'pins and needles' sensation over the distribution of the nerve distal to the site of compression. This is known as the 'carpal tunnel syndrome'. Distal to the retinaculum the nerve enlarges and divides, usually dividing into five or six branches, but the mode and the levels of division are variable.[8] The muscular branches supply the thenar group

of muscles and the 1st and 2nd lumbricals. It also gives palmar digital nerves to provide sensory supply to the palmar surface of lateral three and half digits.

Thus the 'carpal tunnel syndrome' can also manifest as the weakness and wasting of the thenar group of muscles and loss of cutaneous sensations along the palmar surfaces of lateral three and half digits. But there would not be any paresthesia on the thenar skin, as it is supplied by the palmar cutaneous branch of median nerve which passes superficial to the flexor retinaculum.

As median nerve is relatively superficial at wrist, it is vulnerable to division by lacerations in this region. In attempted suicides, median nerve is commonly injured just proximal to the flexor retinaculum.[6] Here the thenar muscles and the 1st and 2nd lumbricals being paralysed, the movement of opposition is greatly hampered. In injury at the level of the wrist, the muscular paralysis may go unnoticed, but the sensory loss will reveal the sensory nature of the lesion.[9] Loss of cutaneous sensations over the palmar aspects of lateral three and half digits renders the hand virtually useless in fine movements, e.g. buttoning and unbuttoning a coat. Hence the median nerve is also known as the 'eye of the hand'.

Material and Methods

The present study was conducted in the 'Department of Anatomy, Patna medical college and Hospital Patna Bihar' which is a tertiary care centre and a teaching hospital in 'Patna Bihar, India'. Before the commencement of the study approval was taken from the Institutional Ethical Committee and other concerned authorities.

With prior permission the palms of 28 cadavers were dissected in a time period of two consecutive

academic sessions during superior extremity dissection.

Inclusion Criteria

for the study was, Adult cadaveric hands preserved well in formalin.

Exclusion Criteria

included,

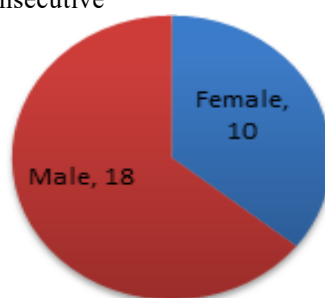
- 1) Cadavers in pediatric age group
- 2) Damaged and putrefied hands.
- 3) Hands with deformities and other congenital anomalies.

Thus, after considering the predetermined inclusion and exclusion criteria we could include 56 embalmed cadaveric hands (from 28 cadavers) in our study.

In our institution cadavers are embalmed with intra-arterial injection method. Instruments required for that are the high- pressure injector machine and the injection cannula apart from the instruments used for routine anatomical dissection. The fresh cadaver is dissected in the 'femoral triangle' region to expose the femoral artery of one side and then it is opened up to insert the injection cannula. Embalming fluid is then injected into the body via this route. The following materials are used for the preparation of the embalming fluid.

Results

After considering preset inclusion and exclusion criteria, a total number of 56 cadaveric hands could be dissected and observed for the variations in branching pattern of median nerve, within the prescribed time span. These hands belonged to 28 cadavers; out of which 18 were male cadavers and 10 were female.



Sex Distribution
among the Cadavers
under Study

Pie chart showing sex distribution of the study population

Among all those hands 25 hands (44.64%) showed usual pattern of branching and distribution of median nerve. In these hands

median nerve was passing deep to the transverse carpal ligament (TCL) through the carpal tunnel. Subsequently they showed bifurcation or

trifurcation and gave off a single extraligamentous (distal to the TCL) thenar branch with lateral three and half digital distribution. Rest of the hands, i.e. 31 hands in total (55.36%) showed a number of variations. Left hand showed more variations (19 out of 31, i.e. 61.29%) compared to the right hands (12 out of 31, i.e. 38.71%). In context of communicating branches between median and ulnar nerves, only multiple communications in the hand were considered as variations.

Thenar branch of median nerve was the first branch to arise from the main trunk of median nerve in all the 56 hands. However, they varied in number, exact sites of origin and course (according to Lanz group '0' to '4'), and modes of origin (anteriorly, antero-laterally or antero-medially from the median nerve). Single thenar branch was found in 43 cases (76.79%) while in 13 cases (23.21%) multiple thenar branches were noted. Out of these 13 hands, twelve hands contained 2 thenar branches each and a single hand contained 3 thenar branches altogether. All the hands containing multiple thenar branches showed their thenar branches to arise separately from the median nerve (without forming any common trunk).

Discussion

Results obtained from the present study show that the usual course of median nerve in the hand and in the carpal tunnel, accounted for 44.64% of the dissected cadaveric hands. Thirty one hands in total (55.36%) were found to show a number of anatomical variations. Stancic et al in his study on 100 hands, observed 48 cases (48%) following the standard anatomy. Olave in his study documented 48.3% of the specimens to follow the usual pattern. Beris et al in their study on 110 carpal tunnel release procedures, reported variations in only 10% of the cases. Alizadeh et al on the contrary reported median nerve variations in 78% of cases among 60 cadaveric hands in their study. Lanz U in his study in 1977 observed 29 variations in the course of median nerve in 246 hands explored at operation. Based on his findings he pioneered a classification system for the variations in the course of median nerve. According to Lanz classification, the findings of the present study were tabulated into Lanz groups '0' to '5'. Group '0' demarcates standard anatomy in the course of median nerve, and 26 specimens (46.43%) of the present study could be placed in this group. Group '1A' defines subligamentous thenar branch. This group included 17 hands of our study with single thenar branch and 3 hands with double thenar branches (20 hands in total). Lanz groups '1B', '1C' and '1D' include transligamentous thenar branch, thenar branch from the ulnar side and supraligamentous thenar branch respectively. No specimen in the present study could be considered to be placed in

these groups. Lanz group 2 defines an accessory thenar branch distal to the flexor retinaculum. Two examples of this group could be found in the present study. Lanz group '3' (high division of median nerve) and group '4' (proximal accessory thenar branch) remained void, not including any of the dissected hands. Vashishtha K in his study of 50 cadaveric hands, found variations in 35 (70%). He also noted that the variations were more frequent in the left hands (20 of 35) as compared to the right hands. This finding corroborates with the findings in the present study. In the present study also, variations were more frequent in the left hands (16 out of 30) as compared to the right hands. In the present study single recurrent thenar branches were observed in 43 cadaveric hands (76.79%). Twelve hands (21.43%) showed two thenar branches each. Three thenar branches could be observed in a single case (1.8%). Hurwitz et al observed multiple motor branches in 10 hands out of 80 hands in his study (12.5%). Among the 43 hands with single thenar branches, extraligamentous thenar branches (Lanz group '0') were found in 26 hands (60.47%) and subligamentous (Lanz group '1A') in 17 hands (39.53%). No transligamentous (Lanz group '1B') branch could be found in these hands. The findings for the single thenar branches were also classified according to Poisel's classification. Extraligamentous type of thenar branches (26 hands in our study) were designated as Poisel type 1. Poisel type 2 includes subligamentous thenar branch (17 hands in the present study). No case could be designated as Poisel type 3 (transligamentous thenar branch) or Poisel type 4. Poisel type 4 indicates preligamentous variety of thenar branch. Stancic et al in their study found 48% cases in Lanz group '0', seventeen percent cases in Lanz Group '1A', sixteen percent cases in Lanz group '1B', five percent cases in Lanz group '1C' and two percent cases in Lanz group '1D'. Seven percent of the hands were designated as Lanz group '2'. Group '3' included only 1% case and group '4' had 4% hands in total. Olave in his study of 60 cases documented 18.3% cases to follow Lanz Group '1A' type of variation. Group '1B' included 15% and group '1C' contained 16.7% of the hands.[37] Imamura K observed 129 carpal tunnel release procedures and reported extraligamentous variety (Poisel type 1) in 122 hands (94.6%), subligamentous type (Poisel type 2) in 2 hands (1.6%) and transligamentous thenar branch (Poisel type 3) in 5 hands (3.9%). Falconer et al in their series of observations evaluated 10 preserved cadaveric hands and found 3 hands to arise extraligamentously (Poisel group 1). He had only 1 case in Poisel group 2 (subligamentous thenar branch), whereas he found 6 thenar branches to follow a transligamentous course (Poisel type 3).[10] Vashishtha K in his study found subligamentous

thenar branch in 39.39% of cases, extraligamentous in 51.51% of cases and transligamentous in 9.09% of cases, in hands with single thenar branch.

Conclusion

Variation in the distribution of median nerve and its branches in the hand and in the carpal tunnel is not an uncommon occurrence. These variations occur frequently and may lead to diagnostic confusion followed by poor surgical outcome. variations in the branching and course of recurrent thenar muscular branch of median nerve are of most importance because of its involvement in clinical practice. In surgical management of carpal tunnel syndrome transverse carpal ligament is sectioned to decompress the carpal tunnel.

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