

# Median Nerve Variations at the Carpal Tunnel, an Anatomical Study

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## ABSTRACT

### Background:

Awareness of anatomical variations of median nerve at wrist is essential in the treatment of carpal tunnel syndrome to avoid any unfavourable outcomes. To study anatomical variation of median nerve in patients undergoing carpal tunnel release surgery in Khyber Teaching Hospital Peshawar, Khyber Pakhtunkhwa.

### Methodology:

This cross-sectional study was conducted on 200 out-door patients with moderate and severe carpal tunnel syndrome visiting outpatient department of Khyber Teaching Hospital. The duration of study was 10 months. The median nerve was carefully observed during each surgery under local anaesthesia. Any variation in the morphology of median nerve and its branches within and around carpal tunnel was noted and Lanz classification of the median nerve anatomical variations at the wrist was applied. Data was recorded and presented as percentages.

### Results:

Out of 200 patients, normal anatomy of median nerve was found in 189 (94.5%) patients. The variation observed was high bifurcation (division) of median nerve before passing beneath flexor retinaculum. It was observed in 11 (5.5%) cases, out of which 4 (2%) were accompanying persistent median artery, Lanz classification Group 3.

### Conclusion:

The study shows anatomical variation in the course of median nerve in the form of high division of nerve. This variation is also observed with a persistent median artery.

### Keywords:

Carpal tunnel syndrome, Median nerve, Transverse carpal ligament

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## INTRODUCTION

A surgeon usually appreciates a number of anatomical variations during common surgical techniques. One such practice is the carpal tunnel release surgery in patients presented with moderate and severe carpal tunnel syndrome.<sup>1</sup> The carpal tunnel has been documented as a site where various anatomical deviations can occur.<sup>2</sup> These variations can include difference in the course and branches of median nerve.

Median nerve is one of the terminal branches of brachial plexus.<sup>3</sup> It is formed from both the medial and lateral cords of brachial plexus. It enters arm on the lateral side of brachial artery then it runs anterior to the artery and continues on its medial side to the elbow. Normally no

muscular branches are given off in axilla and arm until the nerve reaches the forearm. The median nerve descends towards the forearm between the two heads of pronator teres muscle and at the same time crosses the ulnar artery which lies deep to both heads. It gives muscular branches to superficial and deep groups of flexor compartments of forearm.<sup>4</sup> It passes deep to the flexor retinaculum and through the carpal tunnel where it lies superficial to the long flexor tendons.<sup>5</sup> Here the pressure on or irritation of the nerve leads to carpal tunnel syndrome.<sup>6,7,8</sup> This leads to weakness or paralysis of the thenar muscles and paresthesia of the skin. The nerve after emerging from the reticulum divides into numerous branches such as muscular branch and palmar digital nerves.

This article may be cited as: Aamir S, Ghani F, Khan B, Tariq Z, Ambreen S, Khattak MS. Median Nerve Variations at the Carpal Tunnel, an Anatomical Study. *Adv Basic Med Sci.* 2019;3(2):97-100

The anatomical variation of median nerve at the wrist can well be explained by Lanz classification.<sup>2,9</sup> According to Lanz variation of the median nerve at wrist can be classified into four groups. Group 0: extraligamentous thenar branch, Group I: Variations in the course of the thenar branch, further classified in four subgroups 1A: subligamentous, 1B: transligamentous, 1C: ulnarwards, 1D: supraligamentous. Group 2: Accessory thenar branches distal to the carpal tunnel, Group 3: High divisions of the median nerve, 3A: without median artery, 3B: with artery, 3C: with lumbrical muscle. Group4: proximal accessory thenar branches.

Knowledge of the anatomic variations of nerves is essential for clinicians in evaluating neuropathies and inferring atypical clinical symptoms.<sup>10,11</sup> If these variations remain unnoticed, there is always a threat of injury to the involved structures leading to unfavorable clinical outcomes. The purpose of the present study is to highlight the documented structural variations near the carpal tunnel to help practitioners conduct safe surgery.

## METHODOLOGY

### Inclusion criteria

The cross-sectional study of 10 months duration was conducted on 200 patients aged 30–65 years with moderate and severe carpal tunnel syndrome visiting OPD of Khyber Teaching Hospital from different parts of Khyber-Pakhtunkhwa. The major complaints presented were numbness, tingling and pain in the thumb, index and middle fingers as well as difficulty in handling small objects. Detailed patient history and thorough clinical examination parameters were recorded.

### Exclusion criteria

Subjects with fracture in hand and wrist, diabetes mellitus and pregnancy were excluded from the study. Those patients with mild or moderate carpal tunnel syndrome who responded to medical therapy were also excluded from the study.

Tinel's and Phalen's tests were performed in all cases.<sup>12</sup> The patients were operated as day case under local anesthesia in Khyber Teaching Hospital main operation theater after getting their informed written consent. The median nerve was identified and carefully observed during surgery, **Figure-1**. Any variation in the morphology of median nerve and its branches within and around carpal tunnel was noted on a proforma. Lanz classification of the median nerve anatomical variations at the wrist was applied. Data were recorded and presented

as percentages.



Figure 1: Carpal tunnel sectioned showing median nerve (Black arrow)

## RESULTS

Out of 200 patients, 124 (62%) were female and 76 (38%) were male. Normal anatomy of median nerve was found in 189 patients and variations were observed in 11 cases. The variation observed was high bifurcation (division) of median nerve before passing beneath flexor retinaculum, Lanz Group 3 (Table 1). The mean age of Lanz Group 3A was 39 years and Group 3B was 43yrs. There was more or less equal distribution of high bifurcation in both genders. (Table 2)

Serial Number	Lanz	Observed variation of median nerve	Frequency n = 200	Percentage
1	Group 3	High bifurcation of median nerve	11	5.5%
2	Group 3B	High bifurcation associated with persistent median artery	4	2%
3	Group 3A	High bifurcation not associated with persistent median artery (isolated finding)	7	3.5%

Table 1: Variation of median nerve at wrist.

S. No	Observed variation of median nerve	Female	Male
1	High bifurcation of median nerve	2.5%	3%
2	High bifurcation associated with persistent median artery	1%	1%
3	High bifurcation not associated with persistent median artery	2%	1.5%

Table 2: Distribution of median nerve variation at wrist in male and female

## DISCUSSION

The distribution of the median nerve is subjected to certain variations.<sup>13,14</sup> Variations of the nerve and nearby structures may present clinically or may be detected at surgery, cadaveric dissection and autopsy. The knowledge of structural variation of median nerve at wrist is required in procedures where accurate dissection of the nerve is needed such as traumatic injuries, repair and release of the carpal tunnel. This study was conducted to determine the incidence of variations in the median nerve in tertiary hospital of Khyber Pakhtunkhwa in patients selected for carpal tunnel release surgery.

Anatomical variations of the median nerve near carpal tunnel have been seen in various studies. One such study conducted by Pawan Agarwal and his colleagues in 2014 on hands of fresh cadavers, reported occurrence of early bifurcation of median nerve into medial and lateral divisions in 11.5% cases.<sup>15</sup>

The survey of 3300 operated cases of carpal tunnel syndrome performed by Castorina et al reported 18 cases of early division of the median nerve<sup>16</sup> while in our study the high bifurcation was observed among 11 cases (5.5%) out of 200 patients. This anatomical variation fits according to Lanz classification of median nerve variation at wrist in Lanz group 3.

The occurrence of a persistent median artery (PMA) must be kept in consideration in clinical practice. The incidence of PMA ranges from 2.2% to 27.1%. The presence of median artery with high division of nerve comes in group 3B of Lanz classification. PMA may cause numerous complications such as carpal tunnel syndrome, pronator syndrome and anterior interosseous nerve compression.<sup>17</sup>

In a study carried out by Gassner *et al* on 100 wrists and forearms of 50 candidates by using ultrasonography and colour Doppler ultrasonography, a PMA was found in 26% cases with average diameter of 1.12 mm. In 63% of cases, the PMA was observed with early bifurcation of the median nerve or a bifid nerve pattern in the carpal tunnel.<sup>18</sup>

In our study, the incidence of the PMA (Lanz group 3B) was observed in 4 cases (2%) out of 200 patients and its presence was also accompanied by high division of median nerve. These findings were in agreement with study performed by Eiken *et al* and a study by Natsis *et al* reported some cases of PMA originating from the ulnar artery associated with early bifurcation of the median nerve.<sup>17,19</sup>

The clinical significance of the presence of this artery at the wrist is well recognized reason for the carpal tunnel syndrome. The damage of this artery may affect blood supply of the upper limb as this vessel nourishes the median nerve and the nearby muscles as well as the thumb and radial side of the index finger. Awareness of occurrence of persistent median artery should be a part of the preoperative preparation, so to avoid the risk of injury during carpal release surgery.

## CONCLUSION

The study shows anatomical variation in the course of median nerve in the form of high division of nerve into lateral and medial branches. This variation is also observed with the presence of persistent median artery. If persistent median artery is present, there are probabilities of related median nerve anomalies.

## LIMITATIONS

During carpal tunnel surgery the exposed area is very small. So, the median nerve cannot be studied in much detail unlike dissection where whole nerve can be traced from its origin at the brachial plexus, its course in the arm and forearm as well as its branches. Moreover in Khyber Teaching Hospital during surgery, no loop or microscope were used to see properly the small branches of median nerve.

## CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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