*Dissertation on*

# A STUDY OF MEDIAN NERVE AND ITS VARIATIONS - FORMATION, COURSE AND DISTRIBUTION

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**and Rajiv Gandhi Government General Hospital,**

**Chennai -600 003**

**THE TAMILNADU Dr.M.G.R. MEDICAL UNIVERSITY**

**CHENNAI – 600 032 TAMILNADU**

**MAY-2020**

# CERTIFICATE

This is to certify that this dissertation entitled "**A STUDY OF MEDIAN NERVE AND ITS VARIATIONS - FORMATION, COURSE AND DISTRIBUTION**" is a bonafide record of the research work done by **Dr.P. CHRISTABEL DIVYA,** Post graduate student in the Institute of Anatomy, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-03, in partial fulfillment of the regulations laid down by The Tamil Nadu Dr.M.G.R. Medical University for the award of M.D. Degree Branch XXIII-Anatomy, under my guidance and supervision during the academic year from 2017-2020.

**Dr. R. JAYANTHI, MD., FRCP (Glasg)**
**DEAN,**
Madras Medical College &
Rajiv Gandhi Govt. General Hospital,
Chennai
Chennai – 600003.

**Dr. B. CHEZHIAN, M.S.,**
**Director & Professor,**
Institute of Anatomy,
Madras Medical College,
Chennai– 600 003.

# INSTITUTIONAL ETHICS COMMITTEE
# MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

## CERTIFICATE OF APPROVAL

To
Dr.P. Christabel Divya.
I Year Post Graduate in MD Anatomy
Institute of Anatomy
MMC/Chennai

Dear Dr.P. Christabel Divya,

The Institutional Ethics Committee has considered your request and approved your study titled **"A STUDY OF MEDIAN NERVE AND ITS VARIATIONS – FORMATION, COURSE AND DISTRIBUTION " - NO.11122017**

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We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Member Secretary – Ethics Committee

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URKUND

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This is to certify that this dissertation work titled "**A STUDY OF MEDIAN NERVE AND ITS VARIATIONS - FORMATION, COURSE AND DISTRIBUTION**" of the candidate **Dr.P. CHRISTABEL DIVYA,** with registration number **201733001** for the award of **M.D.** in the branch of **ANATOMY**. I have personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **3 Percentage** of plagiarism in the dissertation.

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# LEGEND

| | | | |
|---|---|---|---|
| 1. | GM | - | Gracilis muscle |
| 2. | CTS | - | Carpal Tunnel Syndrome |
| 3. | PMA | - | Persistent Median Artery |
| 4. | PT | - | Pronator teres |
| 5. | FDS | - | Flexor Digitorum Superficialis |
| 6. | FDP | - | Flexor Digitorum Profundus |
| 7. | MCN | - | Musculocutaneous nerve |
| 8. | CB | - | Coracobrachialis |
| 9. | BB | - | Biceps brachii |
| 10. | MN | - | Median nerve |
| 11. | FR | - | Flexor retinaculum |
| 12. | LC | - | Lateral cord |
| 13. | MC | - | Medial cord |
| 14. | UA | - | Ulnar artery |
| 15. | 1R | - | 1st root |
| 16. | 2R | - | 2nd root |
| 17. | 3R | - | 3rd root |
| 18. | AA | - | Axillary artery |
| 19. | DB | - | Digital branch |

# CONTENTS

# *Introduction*

# INTRODUCTION

Carpal tunnel syndrome (CTS) is a common focal peripheral neuropathy. Increased pressure in the carpal tunnel results in median nerve compression and impaired nerve perfusion, leading to discomfort and paraesthesia in the affected hand. Entrapment of the median nerve in the carpal tunnel is one of the most common entrapment neuropathy syndromes in clinical practice. The main causes of this syndrome include repetitive strain, wrist fracture, rheumatoid arthritis, a space occupying lesion, dialysis related amyloidosis, diabetes mellitus and cases with no apparent cause. It was found that thickening of the synovium or fibrosis was the most common cause of the syndrome[11].

Pronator syndrome is entrapment of the median nerve between the two heads of the pronator teres muscle. Entrapments of the median nerve may also occur during its course of entry into the forearm. Some of the factors responsible for its compression being, Struthers ligament, presence of anomalous arteries and abnormal muscles and pronator teres syndrome. Among these, pronator teres is one of commonest cause of entrapment neuropathies involving the median nerve[38].

The persistent median artery (PMA) usually originates from the anterior interosseus artery in the proximal one- third of the forearm. Median artery forms early in development alongside the median nerve prior to the development of the radial and ulnar arteries. It develops from the axis artery which represents axillary, brachial and anterior interosseus arteries. This usually regresses around 8$^{th}$ week

of gestation. The patient with thrombosed persistent median artery may develop acute Carpal tunnel syndrome[39].

Painful tingling numbness, weakness of the hands or upper extremities may be the result of the entrapment of a peripheral nerve[5]. The information of innervation pattern of Median nerve is of substantial importance in understanding the different presentation of Pronator teres syndrome. It is also significant in investigating the lesions of Median nerve and to plan suitable treatment. The knowledge of anatomy and its variations are helpful to prevent iatrogenic injuries during surgical repairs[9].

Pronator teres has a significant role not only as a muscle for pronation movement, but also as a donor muscle. It arises by humeral (superficial) and ulnar (deep) heads. The humeral head arises from the lower part of the supracondylar ridge of humerus and from the anterior and lower part of the medial epicondyle. The ulnar head arises from the medial border of coronoid process of ulna distal to the origin of flexor digitorum superficialis. The median nerve lies between the two heads. The two heads join, proceed downwards and laterally and inserted into the middle of the lateral surface of the shaft of the radius. It is innervated by a branch from the median nerve, usually before the latter passes between the two heads of pronator teres. It helps in pronation of the forearm and acts as a weak flexor of the elbow joint. Hence the relation of median nerve to this muscle and its motor innervation is of special importance for restoring functional ability of fingers after trauma[7].

A branch of median nerve to pronator teres can be considered for neurotization of the radial nerve in the cubital fossa. A detailed anatomy of number of branches to pronator teres will help in better surgical interventions and thus for a good postoperative outcome[51].

Anatomic variations of the median nerve are frequent and they are significant for wrist surgery particularly in the treatment of carpal tunnel syndrome. Awareness of the anatomical variations of the peripheral nerves is important in repair of traumatic injuries and treatment of compression syndromes, since in each situation precise dissection of the nerve is mandatory[28].

Median Nerve is formed in the axilla by the union of medial and lateral roots. The medial root is derived from the medial cord of the brachial plexus and conveys the fibres from ventral rami of C8 and T1 spinal segments; it crosses downward and laterally in front of the third part of axillary artery and joins with the lateral root. The lateral root is the continuation of lateral cord of brachial plexus and conveys fibres from the ventral rami of C5, C6 and C7 spinal segments.

After its formation the median nerve descends along the lateral side of the third part of axillary artery and the proximal part of brachial artery. At the middle of the arm, opposite the insertion of the Coracobrachialis muscle, the nerve crosses from lateral to medial usually in front of the brachial artery and then accompanies along the medial side of the artery.

It appears in the cubital fossa beneath the bicipital aponeurosis and rests on the brachialis. The nerve leaves the cubital fossa through a gap between superficial and deep heads of pronator teres. While doing so, the nerve crosses the lateral side of ulnar artery and is separated from the latter by the deep head of pronator teres.

The median nerve enters the flexor compartment of forearm undercover of the tendinous arch between the humero-ulnar and radial heads of flexor digitorum superficialis. As the nerve descends it intervenes between the Flexor digitorium superficialis and Flexor digitorium profundus muscle, and is closely applied to the posterior surface of the former muscle. In the lower forearm it is usually accompanied by a branch from the anterior interosseous artery (arteria nervi mediana).

About 5 cm above the flexor retinaculum, the nerve emerges undercover of the lateral border of flexor digitorum superficialis and becomes superficial as it approaches the wrist Here it lies between the flexor carpi radialis and palmaris longus. It enters the carpal tunnel deep to the flexor retinaculum and in front of the common synovial sheath (Ulnar bursa) enveloping the tendons of Flexor digitorium superficialis (FDS) and Flexor digitorium profundus (FDF)muscle. The median nerve reaches the palm beyond the distal border of flexor retinaculum, and divides into lateral and medial branches. The lateral branch gives off a recurrent muscular branch to supply the three thenar muscles (abductor pollicis brevis, flexor pollicis brevis and opponens pollicis) and then subdivides

into three proper palmar digital nerves to supply the adjacent sides of the thumb and the radial side of the index finger, the branch to the index finger provides a branch to the first lumbrical. The medial branch subdivides into two common palmar digital nerves, lateral and medial. The lateral common nerve gives a branch to the second lumbrical and subdivides to supply the adjacent sides of the index and middle fingers. The medial common nerve receives a communicating branch from the nearest palmar digital nerve from the superficial branch of ulnar nerve and then subdivides to supply the adjacent sides of the middle and ring fingers.

It gives off muscular branches to Pronator teres, Palmaris longus, Flexor carpi radialis, Flexor digitorum superficialis, Recurrent muscular branch to all three thenar muscles (Abductor pollicis brevis, Flexor pollicis brevis and opponens pollicis). Also it supplies flexor pollicis longus, lateral half of flexor digitorum profundus, pronator quadratus and gives an articular branch to wrist joint by anterior interosseus nerve. The articular branches are to Elbow joint, Superior and inferior radioulnar joints, Wrist joint.

Palmar cutaneous branch arises from median nerve at the level of forearm which supplies the skin of the thenar eminence and central region of palm. In the hand, lateral branch subdivides into three proper palmar digital nerves to supply the two sides of the thumb and radial side of the index finger. The medial branch subdivides into two common palmar digital nerves - lateral and medial. The lateral common nerve supplies the adjacent sides of the index and middle fingers

and medial common nerve supplies the adjacent sides of the middle and ring finger and thus terminal divisions of median nerve supplies the palmar aspect of lateral 3 ½ fingers[13,50].

The nerve communication between the median nerve and ulnar nerve is an anatomical variation that can occur in different locations in the upper limb. The nerve communication can occur in the forearm is Martin Gruber Anastomosis. Anatomical and electrophysiological studies that these communications have important clinical and surgical suggest that these communications have important clinical and surgical implications. Several case reports on isolated injuries of the median and ulnar nerves showed differences from the classic pattern of innervation of these muscles. The knowledge of anatomical variations in the innervation of these muscles is important for diagnosis and treatment of nerve damage and compression syndromes[15].

In case of absent musculocutaneous nerve, its function is taken over by median nerve. It is derived from the lateral cord of brachial plexus and conveys the fibres from C5,6,7 and accompanies the lateral side of the third part of axillary artery. It pierces the coracobrachialis muscle and then passes downwards and laterally across the front of the arm. It supplies coracobrachialis, biceps brachii and medial major part of brachialis. Just below the elbow, it pierces the deep fascia and extends downwards as the lateral cutaneous nerve of the forearm to supply the skin of the anterolateral region of the forearm.

# *Aim of the study*

# AIM OF THE STUDY

Knowledge on the normal anatomy and variations of median nerve is very important. Hence the present study aims at making the following observations in the specimens.

1) To study formation of median nerve and its variations.
2) To study the median nerve formation in relation to axillary artery.
3) To observe the median nerve in relation to musculocutaneous nerve.
4) To study the morphometry of branches of median nerve innervating pronator teres muscle.
    a) Number of branches to pronator teres
    b) Level of origin of branch to pronator teres in relation to inter.
    c) Average length of each branches.
5) Presence/ Absence of ulnar head of pronator teres.
6) To study the relation of median nerve and pronator teres.
7) To note the communication between ulnar nerve and median nerve in forearm (Martin Gruber anastomosis).
8) To observe the incidence persistent median artery with median nerve.
9) To study the level of division of median nerve.
10) To study the branching pattern of median nerve in the hand.

# *Embryology*

# EMBRYOLOGY

The limbs begin to appear at the end of 4$^{th}$ week. The base of the early limb bud is relatively broad in comparison with the length of the body and lies at the level of a greater number of somites than it does after further growth occurs.

In the stages of development, the sensory and motor neurons of the brain become interconnected in functional patterns and axons grow out of the Central nervous system and ganglia to innervate appropriate target organs (end organs). Axon travel to their target structures through the active locomotion of an apical structurecalled a Growth cone. The growth cone, which moves by means of filopodia, guides the axon to its destination by sensing molecular markers that designate the correct route. This activity of the growth cone is called path finding. Once the growth cone reaches its target, it halts and forms a synapse. Somatic motor and sensory fibres synapse directly with their end organs.

Numerous mechanisms have been proposed to explain the ability of the neurons to establish correct connections with each other and with end organs. It has been suggested that at the appropriate time during development the end organs secrete either a trophic substance (netrin-1 and netrin-2) that attracts the correct growth cones or a trophic substance brain-derived neural growth factor (BDNF) and insulin like growth factor (IGF) that supports the viability of the growth cones that happen to take the right path. It is also likely that the first or pioneer growth cones to traverse a route establish a pathway that is used by later growing axons.

This mechanism would account for the formation of nerves, in which many axons travel together.

Spinal nerves are neuroectodermal in origin. The cells of mantle zone in the ventral or basal lamina of developing spinal cord are motor in function, conveying motor fibres to somatic muscle. In the beginning of third week, paraxial mesoderm organized into segments known as somites. Each somite differentiates into ventromedial part called sclerotome, dorso-lateral part dermomyotome. By end of fifth week each myotome is divided into small dorsal portion called epimere, large ventral part called hypomere.

Nerves innervating segmental muscle also divide into dorsal primary ramus for epimere and ventral primary ramus for hypomere. Each mesodermal somite is supplied by the nerve of corresponding spinal segment. Once muscle is innervated by a spinal nerve it does not lose the nerve supply.

Since the segmentation of the spinal nerves is dependent upon that of the somites, the limb bud develops at the level of a number of spinal nerves, typically those from the 5th cervical through the 1st thoracic. Ventral branches of these spinal nerves join each other to form a plexus (dorsal branches supply the muscle derived directly from somites) which divides into dorsal and ventral (posterior and anterior) (extensor/flexor) corresponding to the division of the premuscle mass into dorsal and ventral or extensor and flexor parts.

The nerves from these divisions grow out with the developing limb, the dorsal portion of plexus (posterior cord) and its branches supplying corresponding part of premuscle mass, the ventral, anterior portion (medial and lateral cords) supplying the developing anterior or flexor muscles. The 5th cervical should develop a distribution along the radial or pre-axial border of the limb, the 1st thoracic should develop along the caudal or post axial border of the limb.

The median nerve is complex since it takes origin by 2 large roots, one from lateral cord (C-5,6,7) and one from medial cord (C-8, T-1). It can be expected to contain fibers from each of the 5 spinal nerves regularly entering the plexus, but the proportion of fibers from the various nerves cannot be estimated from usual dissection.

Embryological basis of observed variations may be attributed to over or undue expression of one or multiple transcription factors responsible for formation, relation and distribution of motor nerve fibres during their development. A group of cell surface receptors like neural cell adhesion molecule, L1 cell adhesion molecule and N-cadherin act as transcription factors which recognise and bind to components of extracellular matrix during neurite growth. Several trophic factors e.g. nerve growth factor, neurotrophin 3 and 4, released from the target tissue regulate expression of these cellular adhesion molecules. The axonal growth cones act as sensors to the concentric gradient of trophic factors in the environment and grow along the gradient towards the target.

The guidance of the developing axons is regulated by expression of chemoattractants and chemorepulsants. Any alterations in signalling between mesenchymal cells and neuronal growth cones can lead to significant variations.

# *Materials and methods*

# MATERIALS & METHODS

The present study was done in 25 adult human embalmed cadavers of either sex ranging from 50 to 80 years of age. This study was conducted for a period of 15 months (May 2018- July 2019) in the Institute of Anatomy, Madras Medical College, Chennai-03 during undergraduate training. The specimens obtained from dissection hall were properly embalmed and formalin fixed. The parameters were studied using thread and ruler. Photographs were taken using 16 megapixel camera.

**INCLUSION CRITERIA**:

- Upper limb specimens of human adult and viable foetal cadavers with no previous surgeries in hand region.

**EXCLUSION CRITERIA:**

- Any gross evidence of congenital disorders/surgeries.
- Muscular anomalies in carpal tunnel.

# METHODS

Skin was incised from the nipple through the axilla to the front of the arm. Superficial and deep fasciae were dissected in layers. Skin and superficial fascia was reflected laterally by blunt dissection. Removed the loose areolar tissue, fat and lymph nodes in the axilla to expose its contents. Axillary artery and vein were identified. Followed the course of axillary vessels to the outer border of first rib by cutting across the pectoralis minor. Medial, lateral and posterior cords of the brachial plexus lie around the artery posterior to the muscle. Longitudinal incision was extended from the front of arm to the tip of middle finger. Strip the skin and superficial fascia of the forearm from the deep fascia by blunt dissection. The deep fascia of forearm was reflected laterally. The flexor retinaculum was divided at the midline, palmar aponeurosis was exposed and divided at the distal border of flexor retinaculum and reflected distally. The superficial palmar arch was removed by avoiding damage to underlying structures. Thenar muscles and lumbricals were identified. Course and branches of median nerve were traced, studied and looked for any variations.

The dissected specimens were numbered. The observations were noted down and photographs were taken and kept for records.

**Parameters studied:**

- Number of roots forming median nerve were observed.
- Site of formation of the median nerve in relation to the third part of axillary artery were noted.
- Presence/ Absence of musculocutaneous nerve has been noted. In case of absent musculocutaneous nerve, innervation of muscles of anterior compartment of arm was observed.
- Number of median nerve branches to Pronator teres muscle was studied.
- The distance between the origin of branches of median nerve and Hueter's line (line through the tips of the epicondyles of the humerus) was measured.
- Length of the branch of the median nerve to Pronator teres muscle was measured using thread and ruler.
- Presence /Absence of Ulnar head of Pronator teres was observed.
- Passage of median nerve in relation to Humeral and Ulnar head was noted.
- Communication between ulnar nerve and median nerve in forearm (Martin Gruber anastomosis) was observed.
- Presence of persistent median artery was looked for.
- Level of terminal division of median nerve was observed in relation to flexor retinaculum of wrist.
- Digital innervation pattern of median nerve was studied.

# *Review of literature*

# REVIEW OF LITERATURE

## 1. FORMATION OF MEDIAN NERVE

In a study done by V. Budhiraja (2011) on 174 specimens, median nerve was formed by 3 roots in 42 specimens (24.1%) in which third root from lateral cord in 28 specimens (16.1%) and musculocutaneous nerve in 14 specimens (8%). Median nerve was formed by four roots in 4 specimens (2.3%) in which third root from lateral cord and fourth root from musculocutaneous nerve[6].

Ashraf Y. Nasr (2011) observed that in 60 specimens, median nerve was formed by 3 roots in 7 specimens (11.7%) in all which third root arises from lateral cord[3].

Sheetal V Pattanshetti (2012) concuded that 7 specimens (11.66%) were found to have trifurcate origin in the formation of median nerve. In all 7 specimens, third root arise from lateral cord. The study was done in 60 specimens[48].

In a study done by Lakshmi Kumari. K (2015) on 106 specimens, in 28 specimens (26.41%) trifurcate origin in the formation of median nerve and 4 roots were taking part in the formation of median nerve which is found in 2 specimens (1.88%). In 28 specimens of trifurcate origin, third root arise from lateral cord of brachial plexus in 18 specimens. In 2 specimens of tetrafurcate origin, 2 roots from medial and 2 roots were from lateral cord[24].

Amirta Bharti (2015) noticed that in 10 cadavers, 2 specimens (10%) were found to have trifurcate origin in all which third root arise from lateral cord[2].

According to D. A. Patil (2016) study on 20 specimens, 2 specimens (10%) were found to have trifurcate origin in the formation of median nerve. In 1 specimen, third root arise from the lateral cord while in other specimen, third root is from medial cord[32].

In a study done by Humberto Ferreira Arquez (2016) on 28 specimens, median nerve was formed by 3 roots in 1 specimen (3.57%) while the third root from musculocutaneous nerve[19].

Samarawickrama. M.B (2017) concluded that in 98 specimens, 7 specimens (7.12) were found to have trifurcate origin in the formation of median nerve and 2 specimens (2.04) had tetrafurcate origin. Out of 7 specimens of trifurcate origin, third root arise from lateral cord in 6 specimens while it arise from medial cord in 1 specimen. 2 specimens of tetrafurcate origin, 2 roots were from medial cord and 2 roots were from lateral cord[44].

Ritu Agarwal (2017) studied that in 13 cadavers, 3 specimens (11.5%) were found to have trifurcate origin in which third root arise from lateral cord[40].

Malivalaya Namking (2017) noticed that in 292 specimens, 4 specimens (1.37%) were found to have trifurcate origin in the formation of median nerve. Out of 4 specimens, third root arise from the lateral cord in 3 specimens[29].

## 2. FORMATION OF MEDIAN NERVE IN RELATION TO AXILLARY ARTERY

According to V. Budhiraja (2011) study on 174 specimens, median nerve was formed medial to axillary artery in 18 specimens (10.3%)[6].

Ashraf Y. Nasr (2011) reported that in 60 specimens, median nerve was formed anterior to axillary artery in 5 specimens (8.3%)[3].

Lakshmi Kumari. K (2015) concluded that in 106 specimens, median nerve was formed medial to axillary artery in 9 specimens (8.49%)[24].

## 3. VARIATION OF MEDIAN NERVE WITH RESPECT TO MUSCULOCUTANEOUS NERVE

In a study done by Jamuna M (2011) on 50 specimens, musculocutaneous nerve was absent in 3 specimens (6%). In 1 specimen, coracobrachialis was innervated by branches from lateral cord while rest of the anterior compartment muscles of arm are innervated by median nerve. In rest of the 2 specimens, muscles of anterior compartment of arm were innervated by median nerve[20].

Dr. Priti Chaudhary (2013) found out that musculocutaneous nerve was absent in 6 specimens (10%) in a study done on 60 specimens. In 4 specimens, coracobrachialis was innervated by branches from lateral cord while rest of the anterior compartment muscles of arm were innervated by median nerve. In rest of

the 2 specimens, muscles of anterior compartment of arm were innervated by median nerve[34].

Parminder Kaur (2014) noticed that in 30 specimens, musculocutaneous nerve was absent in 4 specimens. In 2 specimens, small branch was seen coming from lateral root to supply coracobrachialis, later it joined median nerve after a few centimeters only. In this case rest of the anterior compartment muscles (brachialis and biceps brachii) of arm were innervated by median nerve. In other 2 cases, nerve to coracobrachialis was given off immediately after the union then it gave branches to biceps and brachialis[31].

Balachandra N (2015) concluded that in 20 specimens, musculocutaneous nerve was absent in 1 specimen (5%) in which coracobrachialis was innervated by branches from lateral cord while rest of the anterior compartment muscles of arm were innervated by median nerve. In 1 specimen, musculocutaneous nerve was seen arising from the median nerve[4].

Malivalaya Namking (2017) found out that musculocutaneous nerve was absent and had unusual splitting of median nerve that supplied the muscles of anterior compartment of arm in 5 specimens (1.71%) out of 292 specimens[29].

## 4(a) NUMBER OF BRANCHES OF MEDIAN NERVE TO PRONATOR TERES

Chandini Gupta (2015) studied that in 24 specimens, number of motor nerve branches to pronator teres was one in 5 specimens (20.8%), two in 12 specimens (50%), three in 5 specimens (20.8%) and four in 2 specimens (8.3%)[8].

According to Channabasangouda (2017), number of motor nerve branches to median nerve as one in 47 specimens (75.9%), two in 13 specimens (20.9%), three in 2 specimens (3.2%). This study was done in 62 specimens[9].

Łukasz Olewnik (2017) noticed that in 50 specimens, number of motor nerve branches to median nerve was one in 7 specimens (14%), two in 33 specimens (66%), three in 10 specimens (20%)[26].

Dr Gaikwad A P (2018) found out that in 39 specimens, number of motor nerve branches to median nerve was one in 1 specimen (3%), two in 9 specimens (23%), three in 21 specimens (54%) and four in 3 specimens (8%) and five in 3 specimens (8%)[12].

## 4(b) LEVEL OF ORIGIN OF MEDIAN NERVE BRANCHES TO PRONATOR TERES

Channabasangouda (2017) concluded that in 62 specimens, for 33 pronator teres muscles branch from median nerve arose less than 5 cm proximal to the interepicondylar line, for 17 specimens it was less than 5cm distal to the

interepicondylar line, for 12 specimens it was 5-10cm distal to the interepicondylar line[9].

Chandini Gupta (2017) noticed that in 24 specimens, the origin of 1st branch in 17 cases (70.8%) at the level of interepicondylar line and in 7 cases (29.2%) below the level of interepicondylar line[8].

In a study done by Dr Gaikwad A P (2018) on 39 specimens, the origin of 1st branch in 17 (45%) cases above the interepicondylar line, in 14 cases (37%) at the level of interepicondylar line and in 7 cases (18%) below the level of interepicondylar line[12].

**4(c) LENGTH OF MEDIAN NERVE BRANCH TO PRONATOR TERES**

According to NIlton Alves (2004), the mean length of the branches of the median nerve to pronator teres was 6.5 cm, varying from 2.2 to 9.3 cm[1].

Tubbs RS (2011) concluded that average length of the branches of median nerve to pronator teres was 3.6cm[51].

Pushpalatha (2011) concluded the mean length of the branches of the median nerve to pronator teres was 3.6 cm[35].

In a study done by Ehab M (2016), the average length of the branches of the median nerve to pronator teres was 3 cm, varying from 1.5 to 4.5 cm[17].

## 5. ABSENCE OF ULNAR HEAD OF PRONATOR TERES:

Sharma M (2014) observed absence of ulnar head of pronator teres in 8 out of 60 specimens (13.3%)[47]

Katerina Vymazalova (2015) concluded in a study on 68 specimens, he found that ulnar head of pronator teres was absent in 3 specimens (4.4%)[22]

Channabasangouda (2017) noticed absence of ulnar head of pronator teres in 2 out of 62 specimens (3.4%)[9]

According to Lukasz Olewnik (2017) study on 52 specimens,ulnar head of pronator teres was absent in 7 specimens (14%)[26]

In a study done by Edie Benedito Caetano (2017) on 100 specimens, he found that ulnar head of pronator teres was absent in 14 specimens (14%)[15]

## 6. RELATION BETWEEN MEDIAN NERVE AND PRONATOR TERES:

Katerina Vymazalova (2015) concluded in a study on 68 specimens, in 59 specimens (86.8%) median nerve passing between the two heads of pronator teres, in 4 specimens (5.9%) nerve was passing through the ulnar head, in 2 specimens (2.9%) nerve was passing deep to the muscle and in 3 specimens (4.4%) ulnar head was absent[22].

Channabasangouda (2017) noticed that in 62 specimens, in 54 specimens (87%) median nerve passing between the two heads of pronator teres, in 3 specimens (4.8%) nerve was passing through the ulnar head, in 3 specimens (4.8%) nerve was passing deep to the muscle and in 2 specimens (3.4%) ulnar head was absent[9].

According to Lukasz Olewnik (2017), in 37 specimens (74%) median nerve passing between the two heads of pronator teres, in 6 specimens (12%) nerve was passing deep to the muscle and in 7 specimens (14%) ulnar head was absent. This study was done in 52 specimens[26].

In a study done by Edie Benedito Caetano (2017) on 100 specimens, in 72 specimens (72%) median nerve passing between the two heads of pronator teres, in 11 specimens (11%) nerve was passing through the ulnar head, in 3 specimens (3%) nerve was passing deep to the muscle and in 14 specimens (14%) ulnar head was absent[15].

## 7. MARTIN GRUBER ANASTOMOSIS (NERVE COMMUNICATION BETWEEN MEDIAN NERVE AND ULNAR NERVE):

Levent Sarikcioglu (2003) observed that in 2 out of 30 (6%) specimens, there was Martin Gruber anastomosis[45].

In a study done by Johnn Taylor Casediago Duran (2016) observed that 1 out of 28 (3%) specimens have communications between median and ulnar nerve[21].

Neelamjit Kaur (2016) concluded that communications between median and ulnar nerve was seen in 7 out of 60 (11%) specimens[30].

Cristina Schmitt Cavalheiro (2016) found out that 27 out of 100 (27%) specimens have communications between median and ulnar nerve[10].

Rajasri Chunder (2017) noticed that in 2 out of 30 (6%) specimens, he observed communicating branches originated from the median nerve proximally to join with the ulnar nerve[37].

## 8. INCIDENCE OF PERSISTENT MEDIAN ARTERY WITH MEDIAN NERVE:

Soubhagya R Nayak (2009) observed persistent median artery in 13 out of 84 specimens (15.4%)[49]

Rajan Kumar Singhla (2012) noticed presence of persistent median artery in 4 out of 60 specimens (6.6%)[36]

Raviprasanna KH (2014) concluded persistent median artery was present in 4 out of 50 specimens (8%)[38]

In a study done by Pawan Agarwal (2014) observed persistent median artery in 6 out of 52 specimens (1.53% )[33]

Madhumitha Patnaik (2016) found out persistent median artery in 6 out of 100 specimens (6%)[27]

In a study done by Eid N(2017) observed presence of persistent median artery in 2 out of 50 specimens (4%)[18]

## 9. HIGH DIVISION OF MEDIAN NERVE:

Lanz U (1977) observed that in 7 out of 246 specimens, there was high division of median nerve into medial and lateral branches[25].

E.Mizia (2011) noticed that in 3 out of 60 specimens (5%), there was high division of median nerve into medial and lateral branches[14].

Pawan Agarwal (2014) concluded that in 6 (11.53%) out of 52 specimens, there was early division of median nerve into medial and lateral branches[33].

In a study done in 50 specimens by Vijayamma Kunnath Narayanan(2016), 6 specimens (12%) have higher division of median nerve into medial and lateral branches[52].

## 10. DIGITAL INNERVATION OF MEDIAN NERVE:

In a study done in 50 specimens by Kuntal Vashishtha (2011) observed five digital branches were observed to arise from the divisions of median nerve in 47 hands (94%) supplying lateral three and half digits. In two hands (4%) digital branches supplied lateral two and half digits. In one hand (2%) they supplied lateral three digits[23].

Vijayamma Kunnath Narayanan(2016) concluded that digital branches of median nerve were supplying lateral three and half digits in all cases. This study was done in 50 specimens[52].

# *Observation*

# OBSERVATION

**1. Formation of median nerve:**

In the present study, it was observed that in 43 (86%) out of 50 specimens, median nerve was formed by union of two roots (Bifurcate origin) in which one root was from the medial cord and the other root was from lateral cord. In 1 specimen (2%), median nerve was formed by two roots in which one root was from medial cord and the other root was from musculocutaneous nerve at about distal one- third of arm.

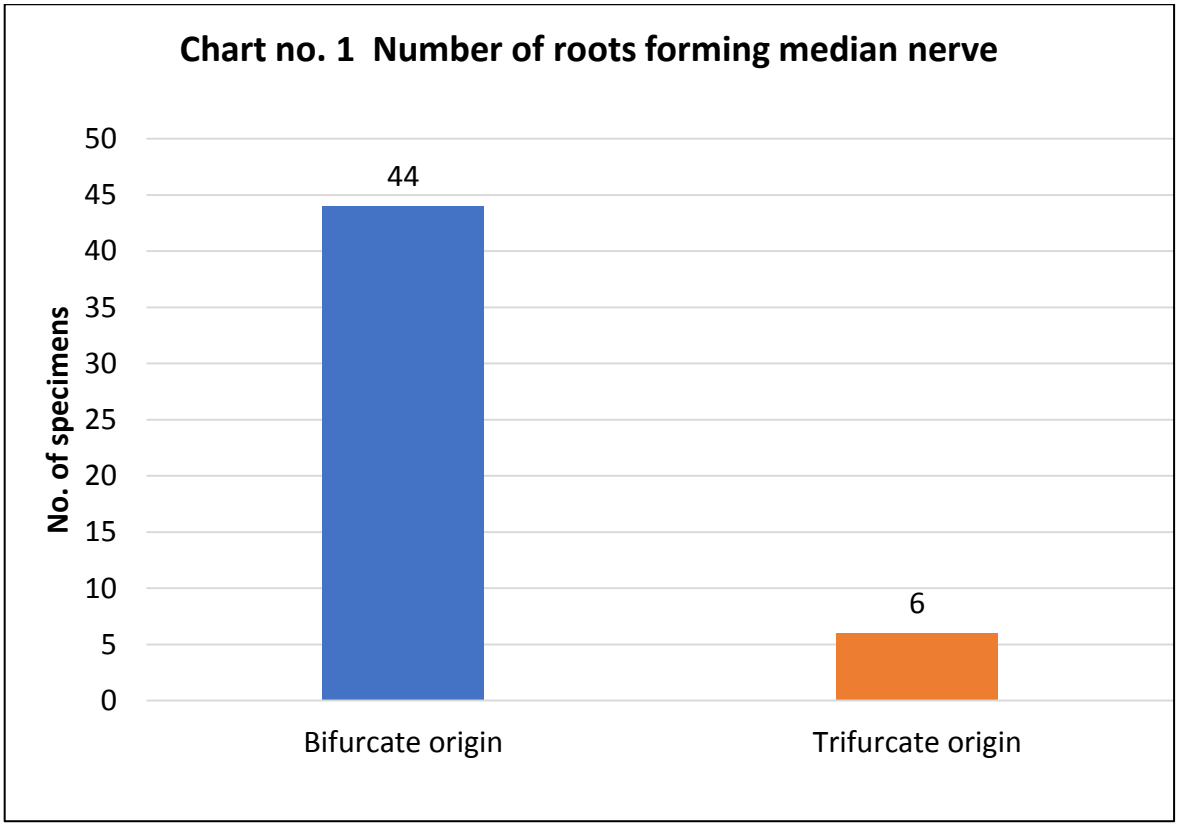
In 6 specimens, median nerve was formed by union of three roots (Trifurcate origin). Out of 6 specimens, in 5 specimens (10%) median nerve was formed by first root from medial cord, second root from lateral cord and the third additional root also from lateral cord. In rest of the 1 specimen (2%), median nerve was formed by first root from medial cord, second root from lateral cord and the third additional root from medial cord.

**Table no. 1 Number of roots forming median nerve**

| Specimen No | No of roots |
|---|---|
| 1 | Two - one from medial cord and one from lateral cord |
| 2 | Two - one from medial cord and one from lateral cord |
| 3 | Two - one from medial cord and one from lateral cord |
| 4 | Two - one from medial cord and one from lateral cord |
| 5 | Two - one from medial cord and one from lateral cord |
| 6 | Three - one from medial and one from lateral cord with the third room from lateral cord |
| 7 | Two - one from medial cord and one from lateral cord |
| 8 | Two - one from medial cord and one from lateral cord |
| 9 | Two - one from medial cord and one from lateral cord |
| 10 | Two - one from medial cord and one from lateral cord |
| 11 | Two - one from medial cord and one from lateral cord |
| 12 | Two - one from medial cord and one from lateral cord |
| 13 | Two - one from medial cord and one from lateral cord |
| 14 | Two - one from medial cord and one from lateral cord |
| 15 | Two - one from medial cord and one from lateral cord |
| 16 | Two - one from medial cord and one from lateral cord |
| 17 | Two - one from medial cord and one from lateral cord |
| 18 | Two - one from medial cord and one from lateral cord |
| 19 | Two - one from medial cord and one from lateral cord |

| Specimen No | No of roots |
|---|---|
| 20 | Three - one from medial and one from lateral cord with the third room from lateral cord |
| 21 | Two - one from medial cord and one from lateral cord |
| 22 | Two - one from medial cord and one from lateral cord |
| 23 | Two - one from medial cord and one from lateral cord |
| 24 | Two - one from medial cord and one from lateral cord |
| 25 | Three - one from medial and one from lateral cord with the third room from medial cord |
| 26 | Two - one from medial cord and one from lateral cord |
| 27 | Two - one from medial cord and one from lateral cord |
| 28 | Two - one from medial cord and one from lateral cord |
| 29 | Two - one from medial cord and one from lateral cord |
| 30 | Two - one from medial cord and one from lateral cord |
| 31 | Two - one from medial cord and one from lateral cord |
| 32 | Three - one from medial and one from lateral cord with the third room from lateral cord |
| 33 | Two - one from medial cord and one from lateral cord |
| 34 | Two - one from medial cord and one from lateral cord |
| 35 | Two - one from medial cord and one from lateral cord |
| 36 | Two - one from medial cord and one from lateral cord |
| 37 | Two - one from medial cord and one from lateral cord |
| 38 | Two - one from medial cord and one from lateral cord |
| 39 | Three - one from medial and one from lateral cord with the third room from lateral cord |
| 40 | Two - one from medial cord and one from lateral cord |

| Specimen No | No of roots |
|---|---|
| 41 | Two - one from medial cord and one from lateral cord |
| 42 | Two - one from medial cord and one from lateral cord |
| 43 | Two - one from medial cord and one from lateral cord |
| 44 | Two - one from medial cord and one from lateral cord |
| 45 | Two - one from medial cord and one from lateral cord |
| 46 | Three - one from medial and one from lateral cord with the third room from lateral cord |
| 47 | Two - one from medial cord and one from lateral cord |
| 48 | Two - one from medial cord and one from lateral cord |
| 49 | Two - one from medial cord and one from lateral cord |
| 50 | Two - one from medial cord and one from lateral cord |



## 2. Formation of median nerve in relation to axillary artery:

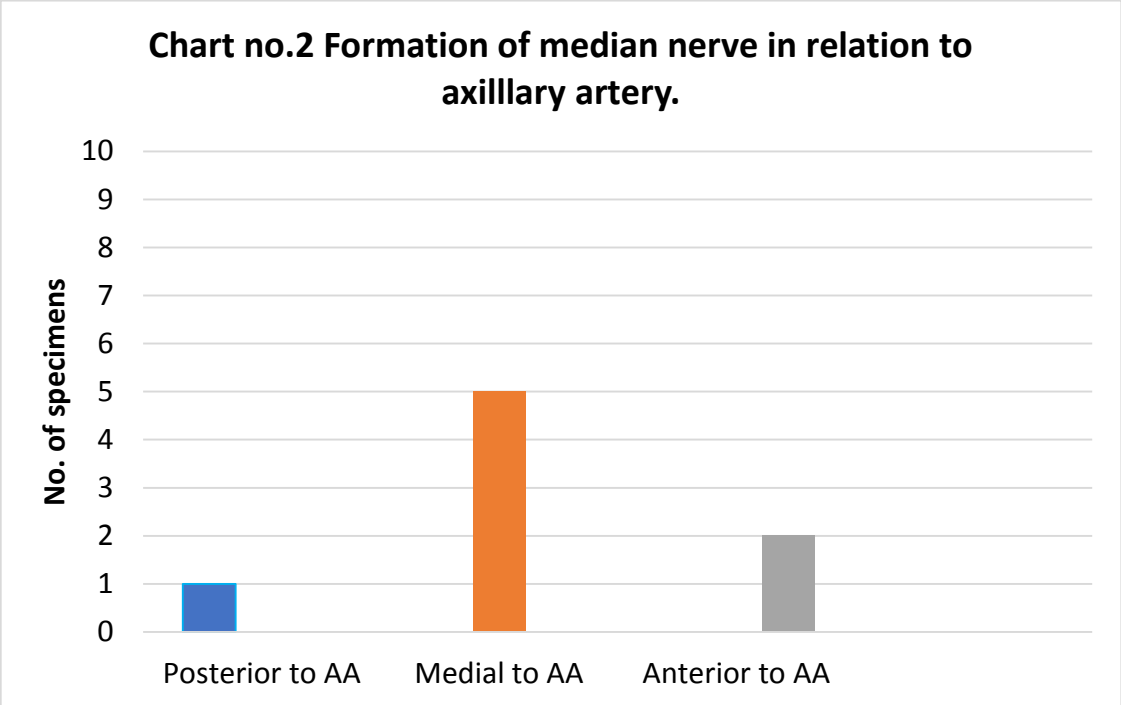
In the present study, median nerve was formed medial to axillary artery in 5 specimens (10%), posterior to axillary artery in 1 specimen (2%) and anterior to axillary artery in 2 specimens (4%).

**Table no.2 Formation of median nerve in relation to axillary artery**

| Specimen No | In relation to axillary artey |
|---|---|
| 1 | Lateral to AA |
| 2 | Lateral to AA |
| 3 | Medial to AA |
| 4 | Lateral to AA |
| 5 | Medial to AA |
| 6 | Lateral to AA |
| 7 | Lateral to AA |
| 8 | Lateral to AA |
| 9 | Medial to AA |
| 10 | Lateral to AA |
| 11 | Lateral to AA |
| 12 | Lateral to AA |
| 13 | Lateral to AA |
| 14 | Lateral to AA |
| 15 | Lateral to AA |
| 16 | Lateral to AA |
| 17 | Lateral to AA |

| Specimen No | In relation to axillary artey |
|---|---|
| 18 | Lateral to AA |
| 19 | Lateral to AA |
| 20 | Lateral to AA |
| 21 | Lateral to AA |
| 22 | Lateral to AA |
| 23 | Medial to AA |
| 24 | Lateral to AA |
| 25 | Lateral to AA |
| 26 | Anterior to AA |
| 27 | Lateral to AA |
| 28 | Lateral to AA |
| 29 | Lateral to AA |
| 30 | Lateral to AA |
| 31 | Lateral to AA |
| 32 | Lateral to AA |
| 33 | Lateral to AA |
| 34 | Lateral to AA |
| 35 | Lateral to AA |
| 36 | Medial to AA |
| 37 | Lateral to AA |
| 38 | Lateral to AA |
| 39 | Lateral to AA |
| 40 | Anterior to AA |

| Specimen No | In relation to axillary artey |
|---|---|
| 41 | Lateral to AA |
| 42 | Lateral to AA |
| 43 | Lateral to AA |
| 44 | Lateral to AA |
| 45 | Lateral to AA |
| 46 | Lateral to AA |
| 47 | Lateral to AA |
| 48 | Lateral to AA |
| 49 | Posterior to AA |
| 50 | Lateral to AA |



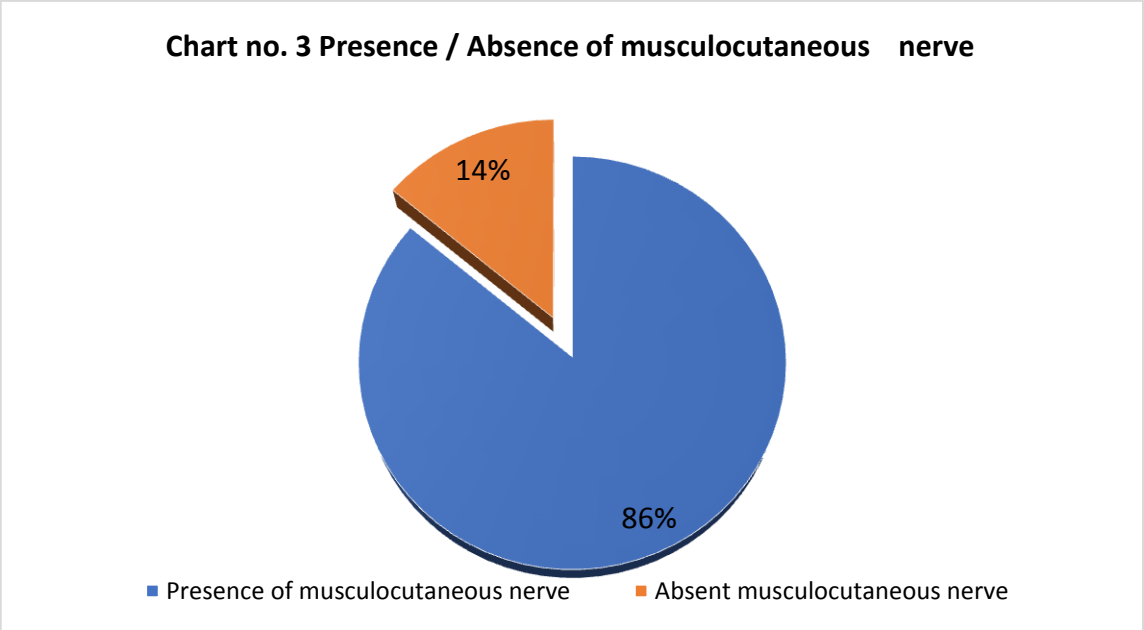
### 3. Variations of median nerve with respect to the absent musculocutaneous nerve:

In the present study, musculocutaneous nerve was absent in 7 specimens. In 1 specimen (2%), coracobrachialis muscle was innervated by a branch from lateral cord which then joined the medial cord of brachialis plexus to form median nerve. Rest of the muscles of anterior compartment of arm were innervated by median nerve. In other 6 specimens (12%), all muscles of anterior compartment of arm were innervated by median nerve.

**Table no.3 Presence or Absence of musculocutaneous nerve**

| Specimen No | Presence / Absence of musculocutaneous nerve |
|---|---|
| 1 | Present |
| 2 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 3 | Present |
| 4 | Present |
| 5 | Present |
| 6 | Present |
| 7 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 8 | Present |
| 9 | Present |
| 10 | Present |
| 11 | Present |
| 12 | Present |
| 13 | Present |
| 14 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 15 | Present |
| 16 | Present |
| 17 | A small branch from the lateral cord supplied the coracobrachialis and then joined the medial cord to form median nerve. Rest of the muscles of anterior compartment of arm were innervated by median nerve. |

| Specimen No | Presence / Absence of musculocutaneous nerve |
|---|---|
| 18 | Present |
| 19 | Present |
| 20 | Present |
| 21 | Present |
| 22 | Present |
| 23 | Present |
| 24 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 25 | Present |
| 26 | Present |
| 27 | Present |
| 28 | Present |
| 29 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 30 | Present |
| 31 | Present |
| 32 | Present |
| 33 | Present |
| 34 | Present |
| 35 | Present |
| 36 | Present |
| 37 | Present |
| 38 | Present |
| 39 | Present |
| 40 | Present |
| 41 | Present |
| 42 | Present |
| 43 | Present |
| 44 | Absent with all muscles of anterior compartment of arm were supplied by median nerve |
| 45 | Present |
| 46 | Present |
| 47 | Present |
| 48 | Present |
| 49 | Present |
| 50 | Present |



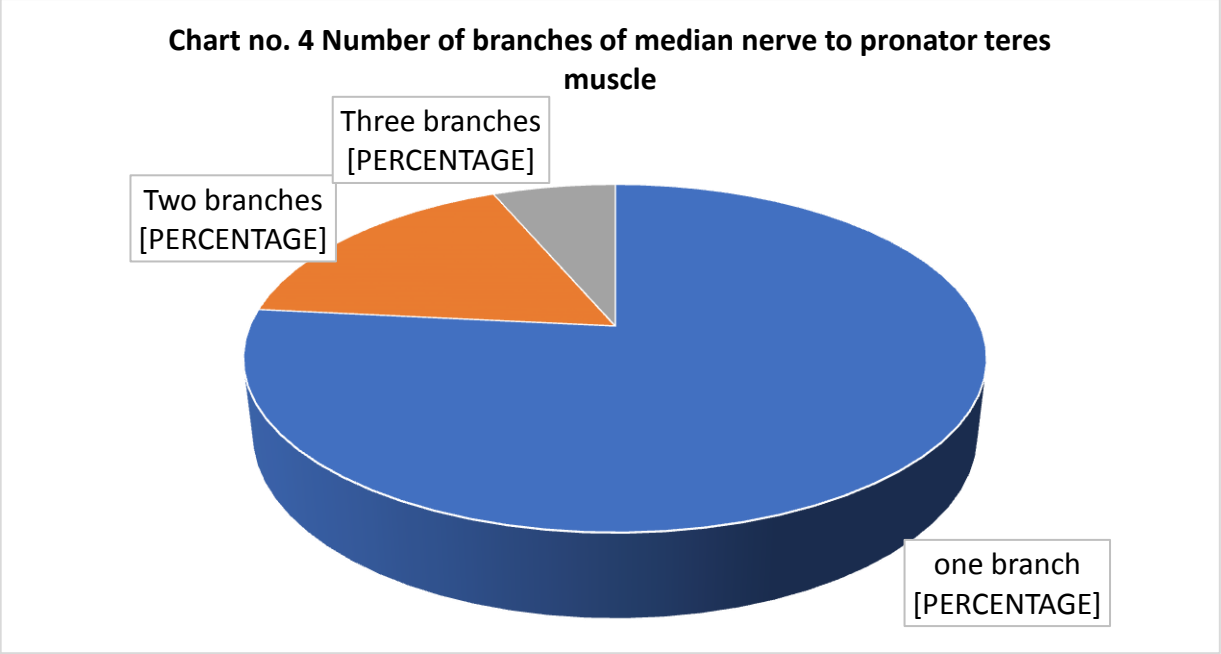

**4. (a) Number of branches of median nerve to pronator teres:**

In the present study, it was observed that number of branches of median nerve to pronator teres was one in 36 specimens (72%), two in 11 specimens (22%) and three in 3 specimens (6%).

**Table no. 4 Number of branches of median nerve to pronator teres**

| Specimen No | Branches of median nerve to pronator teres |
|---|---|
| 1 | One |
| 2 | Three |
| 3 | One |
| 4 | One |
| 5 | One |
| 6 | Two |
| 7 | One |
| 8 | One |
| 9 | One |
| 10 | Two |
| 11 | Two |
| 12 | One |
| 13 | One |
| 14 | One |

| Specimen No | Branches of median nerve to pronator teres |
|---|---|
| 15 | Three |
| 16 | One |
| 17 | One |
| 18 | One |
| 19 | One |
| 20 | One |
| 21 | One |
| 22 | One |
| 23 | One |
| 24 | One |
| 25 | One |
| 26 | One |
| 27 | One |
| 28 | One |
| 29 | One |
| 30 | Two |
| 31 | One |
| 32 | One |
| 33 | Two |
| 34 | One |
| 35 | One |
| 36 | One |
| 37 | Two |
| 38 | One |
| 39 | One |
| 40 | One |
| 41 | One |
| 42 | One |
| 43 | One |
| 44 | Two |
| 45 | Three |
| 46 | One |
| 47 | Two |
| 48 | One |
| 49 | One |
| 50 | Two |




**4. (b) Level of origin of median nerve branch to pronator teres:**

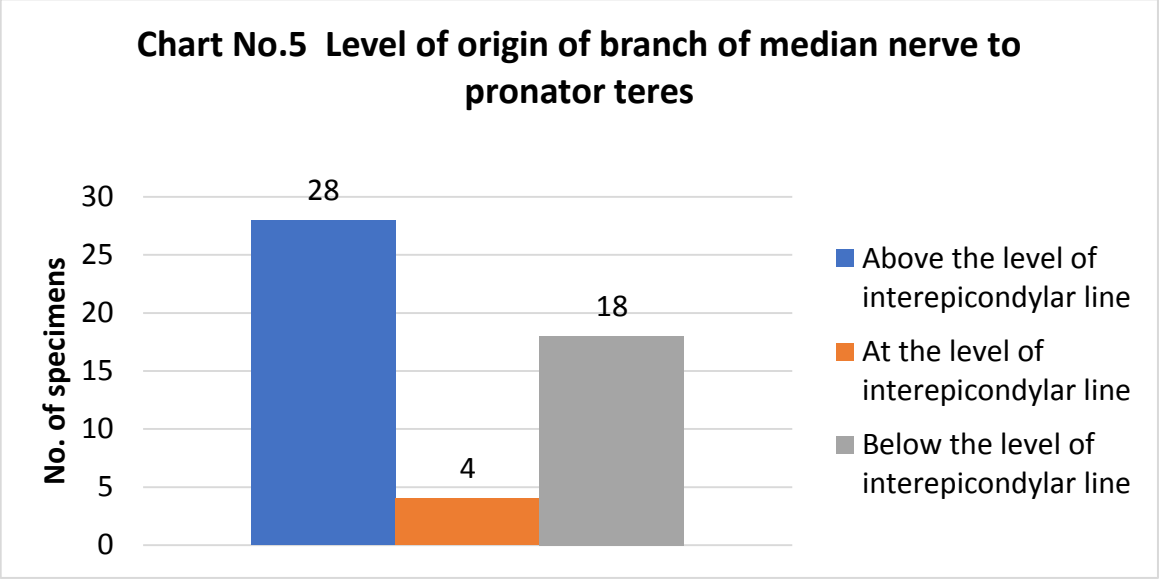
In the present study, origin of 1st branch of median nerve to pronator teres muscle was above the level of interepicondylar line in 28 specimens (56%), at the level of interepicondylar line in 4 specimens (8%)and below the level of interepicondylar line in 18 specimens (36%).

**Table no. 5 Level of origin of branch to pronator teres**

| Specimen No | Level of origin |
|---|---|
| 1 | Above the level of intercondylar line |
| 2 | Above the level of intercondylar line |
| 3 | At the level of intercondylar line |
| 4 | Below the level of intercondylar line |
| 5 | Above the level of intercondylar line |
| 6 | Above the level of intercondylar line |
| 7 | Below the level of intercondylar line |

| Specimen No | Level of origin |
|---|---|
| 8 | Above the level of intercondylar line |
| 9 | At the level of intercondylar line |
| 10 | Above the level of intercondylar line |
| 11 | Above the level of intercondylar line |
| 12 | Above the level of intercondylar line |
| 13 | Above the level of intercondylar line |
| 14 | Below the level of intercondylar line |
| 15 | Below the level of intercondylar line |
| 16 | At the level of intercondylar line |
| 17 | Above the level of intercondylar line |
| 18 | Below the level of intercondylar line |
| 19 | Above the level of intercondylar line |
| 20 | Below the level of intercondylar line |
| 21 | Above the level of intercondylar line |
| 22 | Above the level of intercondylar line |
| 23 | Above the level of intercondylar line |
| 24 | Below the level of intercondylar line |
| 25 | Below the level of intercondylar line |
| 26 | Below the level of intercondylar line |
| 27 | Below the level of intercondylar line |
| 28 | Above the level of intercondylar line |
| 29 | Above the level of intercondylar line |
| 30 | Below the level of intercondylar line |
| 31 | Above the level of intercondylar line |
| 32 | Above the level of intercondylar line |
| 33 | Below the level of intercondylar line |
| 34 | Above the level of intercondylar line |

| Specimen No | Level of origin |
|---|---|
| 35 | Above the level of intercondylar line |
| 36 | Above the level of intercondylar line |
| 37 | Below the level of intercondylar line |
| 38 | Above the level of intercondylar line |
| 39 | Below the level of intercondylar line |
| 40 | Above the level of intercondylar line |
| 41 | Above the level of intercondylar line |
| 42 | Above the level of intercondylar line |
| 43 | Below the level of intercondylar line |
| 44 | Below the level of intercondylar line |
| 45 | At the level of intercondylar line |
| 46 | Above the level of intercondylar line |
| 47 | Below the level of intercondylar line |
| 48 | Above the level of intercondylar line |
| 49 | Above the level of intercondylar line |
| 50 | Below the level of intercondylar line |



**4. (c) Length of median nerve branches to pronator teres:**

In the present study, the average length of branches of median nerve to pronator teres was 3.8 cms, with a range varying from 2.2 cms to 5.4cms

**Table no. 6 Length of median nerve branches to pronator teres**

| Specimen No | Length of branch |
|---|---|
| 1 | 2.8 |
| 2 | 3.5 |
| 3 | 4.5 |
| 4 | 5.2 |
| 5 | 2.7 |
| 6 | 4.3 |
| 7 | 3.1 |
| 8 | 4.7 |
| 9 | 2.9 |
| 10 | 3 |
| 11 | 4.2 |
| 12 | 2.9 |
| 13 | 3.4 |
| 14 | 4 |
| 15 | 4.3 |
| 16 | 3.8 |
| 17 | 4.5 |
| 18 | 3.7 |
| 19 | 2.6 |
| 20 | 4.6 |
| 21 | 2.7 |
| 22 | 3.4 |
| 23 | 4.2 |
| 24 | 4.5 |
| 25 | 5 |
| 26 | 2.6 |

| Specimen No | Length of branch |
|---|---|
| 27 | 4.9 |
| 28 | 3.4 |
| 29 | 2.9 |
| 30 | 3.6 |
| 31 | 2.7 |
| 32 | 4.9 |
| 33 | 3.6 |
| 34 | 4.5 |
| 35 | 4.9 |
| 36 | 3.1 |
| 37 | 4.7 |
| 38 | 3.9 |
| 39 | 2.2 |
| 40 | 2.9 |
| 41 | 3.4 |
| 42 | 2.9 |
| 43 | 3.8 |
| 44 | 4.9 |
| 45 | 5.1 |
| 46 | 2.9 |
| 47 | 5.4 |
| 48 | 3.2 |
| 49 | 4.8 |
| 50 | 3.6 |

## 5. Absent ulnar head of pronator teres:

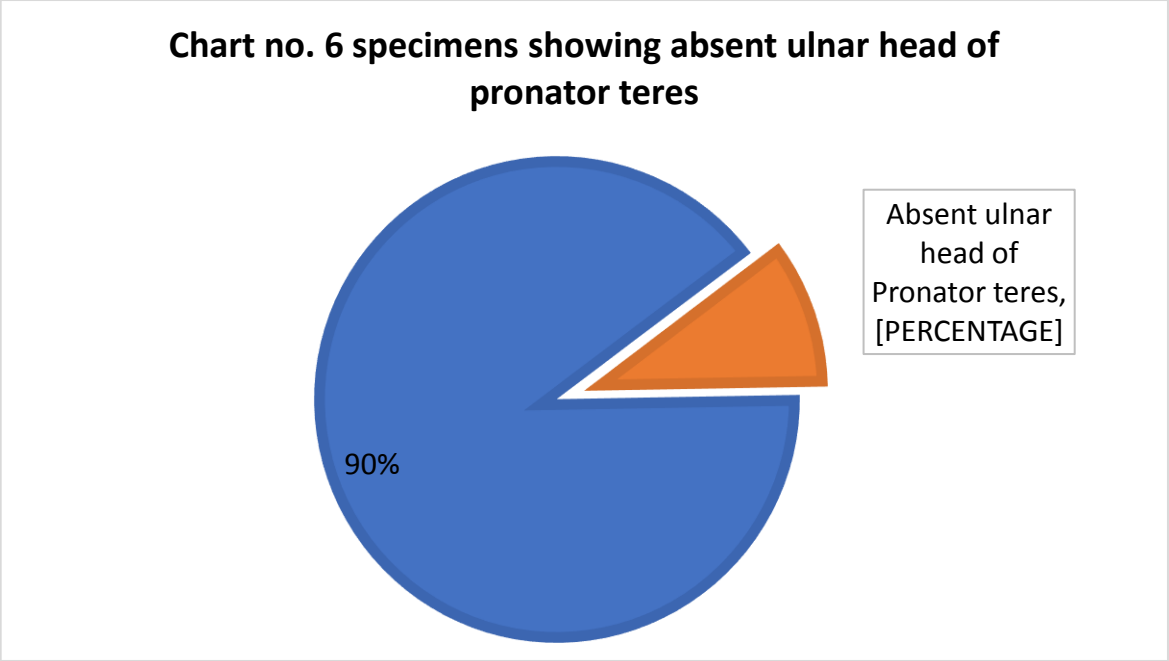
In the present study, it was observed that ulnar head of pronator teres was absent in 5 specimens (10%) out of 50 specimens. In rest of the specimens(90%), both humeral and ulnar head of pronator teres.

**Table no.7 Specimens showing absent ulnar head of pronator teres**

| Specimen No | Presence / Absence of ulnar head |
|---|---|
| 1 | Present |
| 2 | Present |
| 3 | Absent |
| 4 | Present |
| 5 | Present |
| 6 | Present |
| 7 | Present |
| 8 | Present |
| 9 | Present |
| 10 | Present |
| 11 | Present |
| 12 | Present |
| 13 | Absent |
| 14 | Present |
| 15 | Present |
| 16 | Present |
| 17 | Present |
| 18 | Present |
| 19 | Present |

| Specimen No | Presence / Absence of ulnar head |
|---|---|
| 20 | Present |
| 21 | Present |
| 22 | Present |
| 23 | Present |
| 24 | Present |
| 25 | Present |
| 26 | Present |
| 27 | Present |
| 28 | Present |
| 29 | Present |
| 30 | Present |
| 31 | Present |
| 32 | Present |
| 33 | Present |
| 34 | Present |
| 35 | Present |
| 36 | Present |
| 37 | Absent |
| 38 | Present |
| 39 | Present |
| 40 | Present |
| 41 | Present |
| 42 | Present |
| 43 | Present |
| 44 | Present |
| 45 | Present |

| Specimen No | Presence / Absence of ulnar head |
|---|---|
| 46 | Present |
| 47 | Present |
| 48 | Absent |
| 49 | Present |
| 50 | Absent |



## 6. Relation of median nerve and pronator teres muscle:

In the present study, median nerve passing between humeral and ulnar heads of pronator teres muscle was observed in 41 specimens (82%)

Median nerve passing through the ulnar head of pronator teres in 3 specimens (6%)

Median nerve passing below the ulnar head in 1 specimen(2%)

Median nerve passing deep to the humeral head, when ulnar head of pronator teres was absent in 5 specimens (90%)

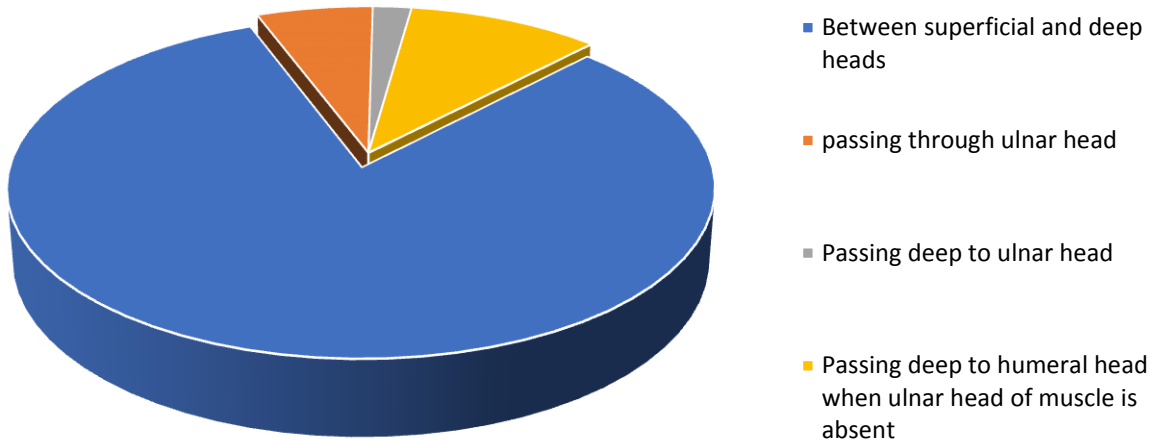
**Table no.8 Relation of median nerve to pronator teres**

| Specimen No | Relation of median nerve and pronator teres |
|---|---|
| 1 | Passing between humeral and ulnar head |
| 2 | Passing between humeral and ulnar head |
| 3 | Absent ulnar head |
| 4 | Passing between humeral and ulnar head |
| 5 | Passing through the ulnar head |
| 6 | Passing between humeral and ulnar head |
| 7 | Passing between humeral and ulnar head |
| 8 | Passing between humeral and ulnar head |
| 9 | Passing between humeral and ulnar head |

| Specimen No | Relation of median nerve and pronator teres |
|---|---|
| 10 | Below the ulnar head |
| 11 | Passing between humeral and ulnar head |
| 12 | Passing through the ulnar head |
| 13 | Absent ulnar head |
| 14 | Through the ulnar head |
| 15 | Passing between humeral and ulnar head |
| 16 | Passing between humeral and ulnar head |
| 17 | Passing between humeral and ulnar head |
| 18 | Passing between humeral and ulnar head |
| 19 | Passing between humeral and ulnar head |
| 20 | Passing between humeral and ulnar head |
| 21 | Passing between humeral and ulnar head |
| 22 | Passing between humeral and ulnar head |
| 23 | Passing between humeral and ulnar head |
| 24 | Passing between humeral and ulnar head |
| 25 | Passing between humeral and ulnar head |
| 26 | Passing between humeral and ulnar head |
| 27 | Passing between humeral and ulnar head |
| 28 | Passing between humeral and ulnar head |
| 29 | Passing between humeral and ulnar head |
| 30 | Through the ulnar head |

| Specimen No | Relation of median nerve and pronator teres |
|---|---|
| 31 | Passing between humeral and ulnar head |
| 32 | Passing through the ulnar head |
| 33 | Passing between humeral and ulnar head |
| 34 | Passing between humeral and ulnar head |
| 35 | Passing between humeral and ulnar head |
| 36 | Passing between humeral and ulnar head |
| 37 | Absent ulnar head |
| 38 | Through the ulnar head |
| 39 | Passing between humeral and ulnar head |
| 40 | Passing between humeral and ulnar head |
| 41 | Passing between humeral and ulnar head |
| 42 | Passing between humeral and ulnar head |
| 43 | Passing between humeral and ulnar head |
| 44 | Passing between humeral and ulnar head |
| 45 | Passing between humeral and ulnar head |
| 46 | Passing between humeral and ulnar head |
| 47 | Passing between humeral and ulnar head |
| 48 | Absent ulnar head |
| 49 | Passing between humeral and ulnar head |
| 50 | Absent ulnar head |

**Chart no.7 Specimens showing relation between median nerve and heads of pronator teres**




## 7. Martin Gruber anastomosis

## (Communication between median and ulnar nerve):

There is no obvious communication of nerve fibres running from median nerve to ulnar nerve (Martin Gruber anastomosis) in all cases that were studied.

8. **Incidence of Persistent median artery:**

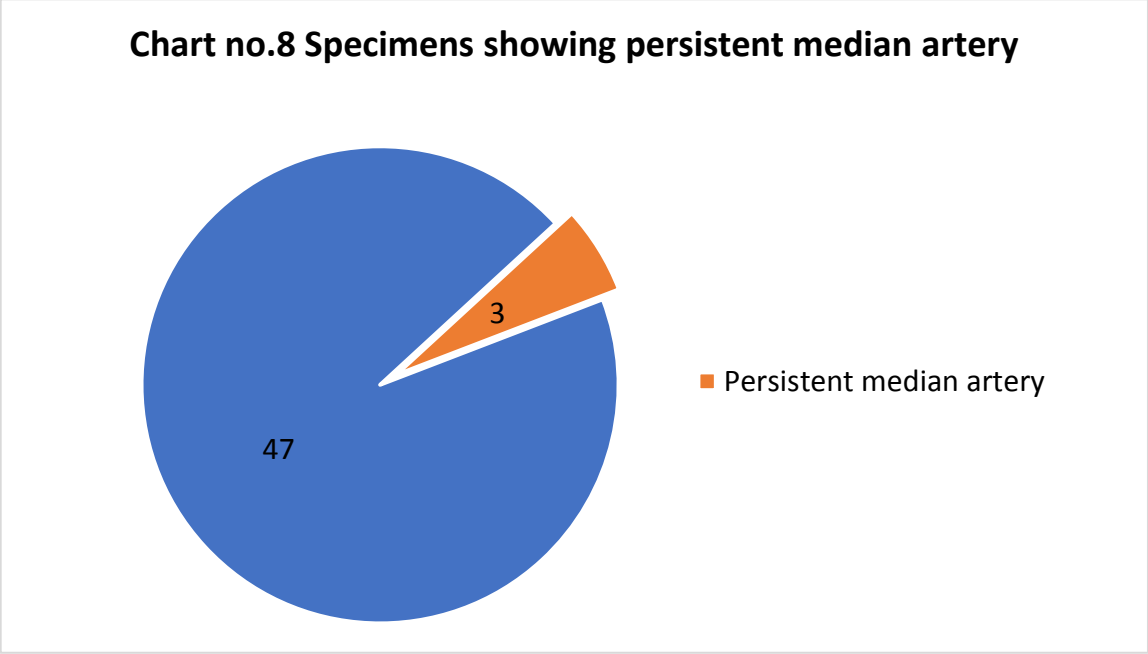
In the present study it is observed that persistent median artery was seen in 3 specimens (6%). Persistent median artery was seen to be arising from anterior interosseus artery.

**Table no.9 Specimens showing persistent median artery**

| Specimen No | Incidence of persistent median artery |
|---|---|
| 1 | Not seen |
| 2 | Not seen |
| 3 | Not seen |
| 4 | Presence of persistent median artery |
| 5 | Not seen |
| 6 | Not seen |
| 7 | Not seen |
| 8 | Not seen |
| 9 | Not seen |
| 10 | Not seen |
| 11 | Not seen |
| 12 | Not seen |
| 13 | Not seen |
| 14 | Not seen |
| 15 | Not seen |
| 16 | Presence of persistent median artery |
| 17 | Not seen |

| Specimen No | Incidence of persistent median artery |
|---|---|
| 18 | Not seen |
| 19 | Not seen |
| 20 | Not seen |
| 21 | Not seen |
| 22 | Not seen |
| 23 | Not seen |
| 24 | Not seen |
| 25 | Not seen |
| 26 | Not seen |
| 27 | Not seen |
| 28 | Not seen |
| 29 | Not seen |
| 30 | Not seen |
| 31 | Presence of persistent median artery |
| 32 | Not seen |
| 33 | Not seen |
| 34 | Not seen |
| 35 | Not seen |
| 36 | Not seen |
| 37 | Not seen |
| 38 | Not seen |
| 39 | Not seen |
| 40 | Not seen |

| Specimen No | Incidence of persistent median artery |
|---|---|
| 41 | Not seen |
| 42 | Not seen |
| 43 | Not seen |
| 44 | Not seen |
| 45 | Not seen |
| 46 | Not seen |
| 47 | Not seen |
| 48 | Not seen |
| 49 | Not seen |
| 50 | Not seen |



9. **High division of median nerve:**

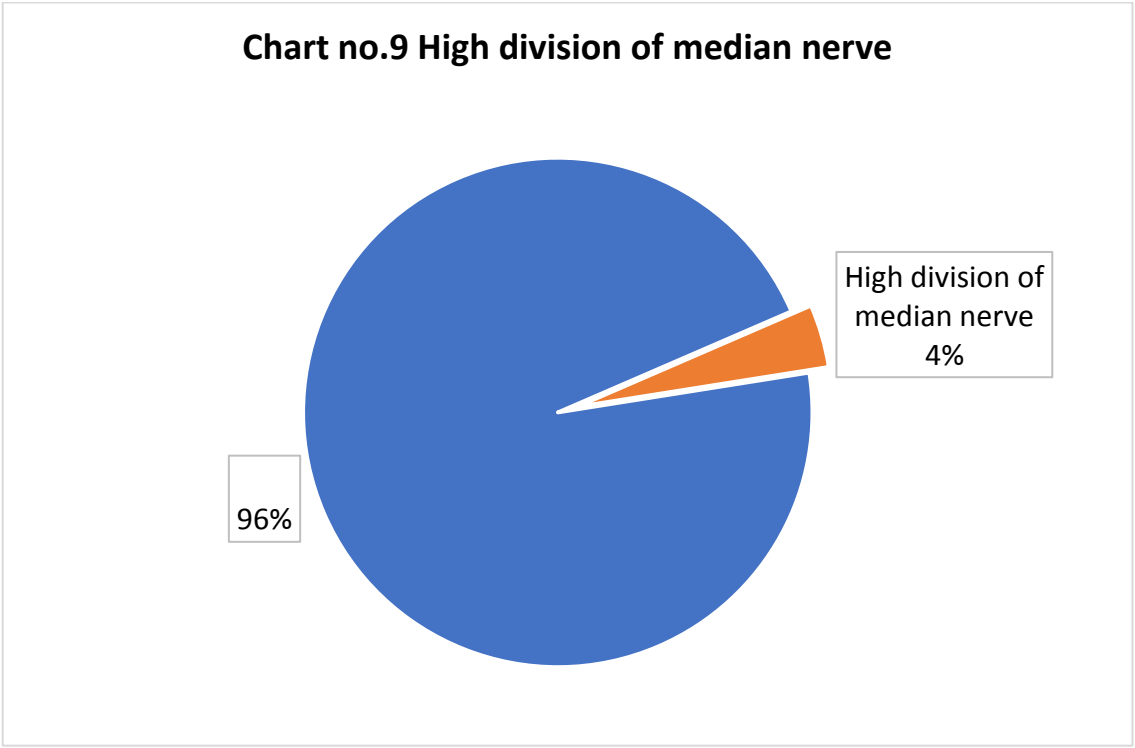
It is observed that median nerve was seen to be divided into medial and lateral divisions below the level of flexor retinaculum in 48 specimens (96%). In rest of the 2 specimens (4%), median nerve was divided into terminal branches – medial and lateral above the level of flexor retinaculum (High division).

**Table no.10 Specimens showing level of terminal division of median nerve**

| Specimen No | Level of terminal division of median nerve |
|---|---|
| 1 | Terminal division distal to flexor retinaculum |
| 2 | Terminal division distal to flexor retinaculum |
| 3 | Terminal division distal to flexor retinaculum |
| 4 | Terminal division distal to flexor retinaculum |
| 5 | Terminal division distal to flexor retinaculum |
| 6 | Terminal division distal to flexor retinaculum |
| 7 | Terminal division distal to flexor retinaculum |
| 8 | Terminal division distal to flexor retinaculum |
| 9 | Terminal division distal to flexor retinaculum |
| 10 | Terminal division distal to flexor retinaculum |
| 11 | Terminal division distal to flexor retinaculum |
| 12 | Terminal division distal to flexor retinaculum |
| 13 | Terminal division distal to flexor retinaculum |
| 14 | Terminal division distal to flexor retinaculum |
| 15 | Terminal division distal to flexor retinaculum |
| 16 | Terminal division distal to flexor retinaculum |

| Specimen No | Level of terminal division of median nerve |
|---|---|
| 17 | Terminal division proximal to flexor retinaculum |
| 18 | Terminal division distal to flexor retinaculum |
| 19 | Terminal division distal to flexor retinaculum |
| 20 | Terminal division distal to flexor retinaculum |
| 21 | Terminal division distal to flexor retinaculum |
| 22 | Terminal division distal to flexor retinaculum |
| 23 | Terminal division distal to flexor retinaculum |
| 24 | Terminal division distal to flexor retinaculum |
| 25 | Terminal division distal to flexor retinaculum |
| 26 | Terminal division distal to flexor retinaculum |
| 27 | Terminal division distal to flexor retinaculum |
| 28 | Terminal division distal to flexor retinaculum |
| 29 | Terminal division distal to flexor retinaculum |
| 30 | Terminal division distal to flexor retinaculum |
| 31 | Terminal division distal to flexor retinaculum |
| 32 | Terminal division distal to flexor retinaculum |
| 33 | Terminal division distal to flexor retinaculum |
| 34 | Terminal division distal to flexor retinaculum |
| 35 | Terminal division distal to flexor retinaculum |
| 36 | Terminal division distal to flexor retinaculum |
| 37 | Terminal division distal to flexor retinaculum |
| 38 | Terminal division distal to flexor retinaculum |
| 39 | Terminal division distal to flexor retinaculum |

| Specimen No | Level of terminal division of median nerve |
|---|---|
| 40 | Terminal division distal to flexor retinaculum |
| 41 | Terminal division distal to flexor retinaculum |
| 42 | Terminal division distal to flexor retinaculum |
| 43 | Terminal division distal to flexor retinaculum |
| 44 | Terminal division distal to flexor retinaculum |
| 45 | Terminal division distal to flexor retinaculum |
| 46 | Terminal division distal to flexor retinaculum |
| 47 | Terminal division proximal to flexor retinaculum |
| 48 | Terminal division distal to flexor retinaculum |
| 49 | Terminal division distal to flexor retinaculum |
| 50 | Terminal division distal to flexor retinaculum |



10. **Digital innervation of median nerve:**

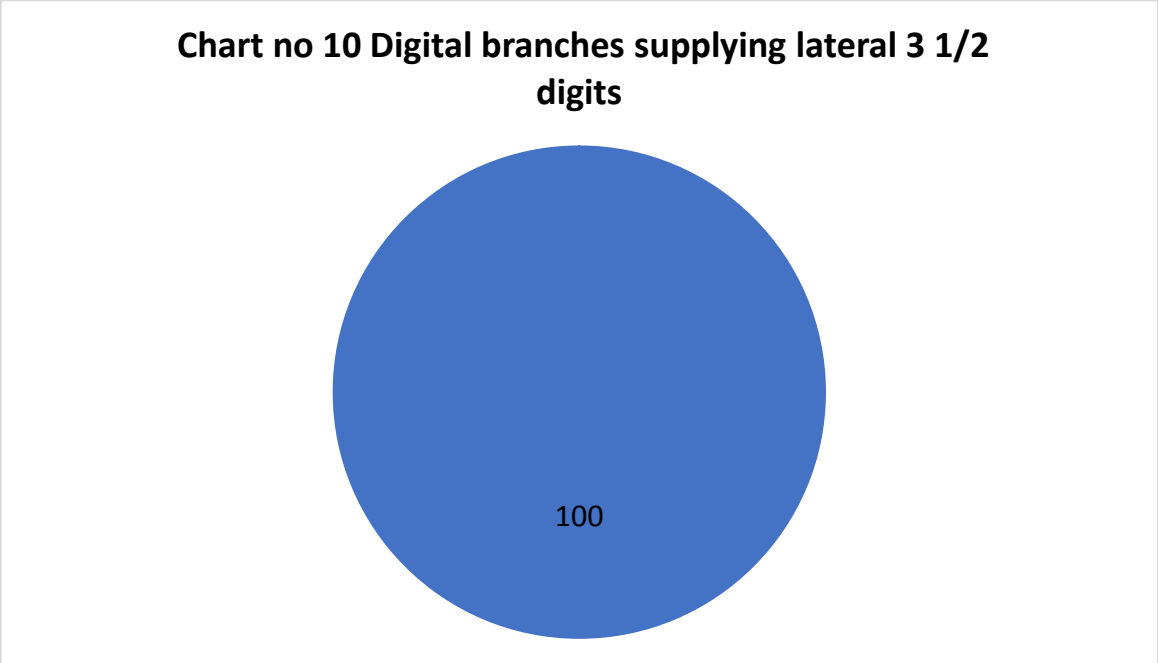
All median nerve studied were given off 5 digital branches which supply lateral three and half fingers.

**Table No.11 Digital innervation of median nerve**

| Specimen No | Digital innervation of median nerve |
|---|---|
| 1 | Lateral three and half digits |
| 2 | Lateral three and half digits |
| 3 | Lateral three and half digits |
| 4 | Lateral three and half digits |
| 5 | Lateral three and half digits |
| 6 | Lateral three and half digits |
| 7 | Lateral three and half digits |
| 8 | Lateral three and half digits |
| 9 | Lateral three and half digits |
| 10 | Lateral three and half digits |
| 11 | Lateral three and half digits |
| 12 | Lateral three and half digits |
| 13 | Lateral three and half digits |
| 14 | Lateral three and half digits |
| 15 | Lateral three and half digits |
| 16 | Lateral three and half digits |
| 17 | Lateral three and half digits |

| | |
|---|---|
| 18 | Lateral three and half digits |
| 19 | Lateral three and half digits |
| 20 | Lateral three and half digits |
| 21 | Lateral three and half digits |
| 22 | Lateral three and half digits |
| 23 | Lateral three and half digits |
| 24 | Lateral three and half digits |
| 25 | Lateral three and half digits |
| 26 | Lateral three and half digits |
| 27 | Lateral three and half digits |
| 28 | Lateral three and half digits |
| 29 | Lateral three and half digits |
| 30 | Lateral three and half digits |
| 31 | Lateral three and half digits |
| 32 | Lateral three and half digits |
| 33 | Lateral three and half digits |
| 34 | Lateral three and half digits |
| 35 | Lateral three and half digits |
| 36 | Lateral three and half digits |
| 37 | Lateral three and half digits |
| 38 | Lateral three and half digits |
| 39 | Lateral three and half digits |

| | |
|---|---|
| 40 | Lateral three and half digits |
| 41 | Lateral three and half digits |
| 42 | Lateral three and half digits |
| 43 | Lateral three and half digits |
| 44 | Lateral three and half digits |
| 45 | Lateral three and half digits |
| 46 | Lateral three and half digits |
| 47 | Lateral three and half digits |
| 48 | Lateral three and half digits |
| 49 | Lateral three and half digits |
| 50 | Lateral three and half digits |



# *Discussion*

# DISCUSSION

## 1. FORMATION OF MEDIAN NERVE:

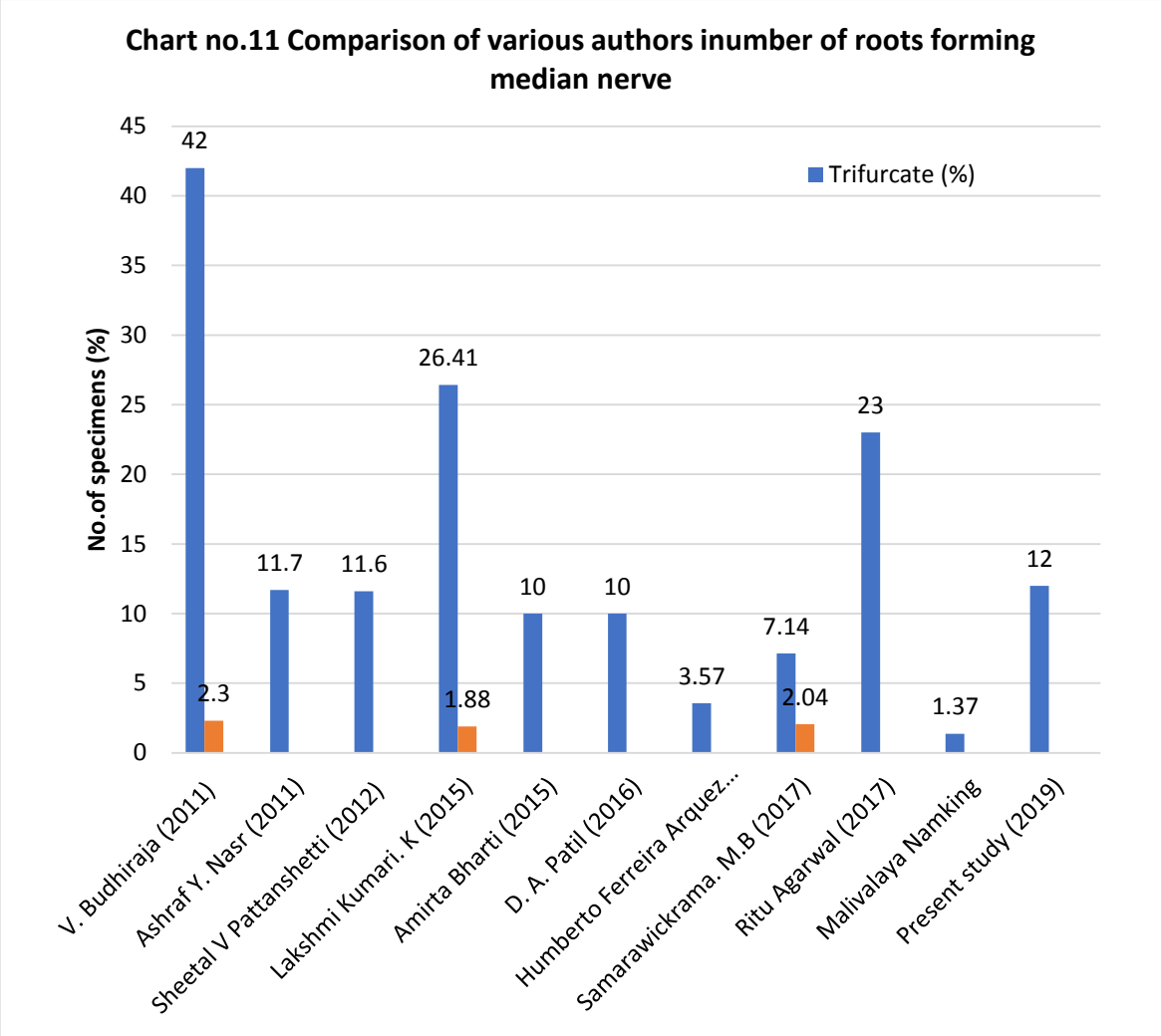
In a study done by Amirta Bharti (2015) done on 10 cadavers, 2 specimens (10%) were found to have trifurcate origin in all which third root arise from lateral cord. According to a study done by Ashraf Y. Nasr (2011) study on 60 specimens, median nerve was formed by 3 roots in 7 specimens (11.7%) in all which third root arises from lateral cord and Sheetal V Pattanshetti study (2012) done on 60 specimens, 7 specimens (11.66%) were found to have trifurcate origin in the formation of median nerve. In all 7 specimens, third root arise from lateral cord. There was no tetrafurcate origin of median nerve. The present study observation of 12% with trifurcate origin of median nerve is correlating with the above observation.

The present study observation is less when compared to a study done V. Budhiaja and Lakshmi Kumari. K, where median nerve was formed by three roots in 42 specimens (24.1%), four roots in 4 specimens (2.3%) and three roots in 28 specimens (26.41%), four roots in 2 specimens (1.88%) respectively.

The other observations of trifurcate origin done by Samarawickrama. M.B and Malivalaya Namking were 7 specimens (7.12) and 4 specimens (1.37%) which were found to be less compared to the present observation.

**Table No.12 Comparisons of various authors in number of roots forming median nerve**

| AUTHORS | TRIFURCATE ORIGIN | TETRAFURCATE ORIGIN |
|---|---|---|
| V. Budhiraja et al(2011) (India) | 42% | 2.3% |
| Ashraf Y. Nasr (2011) (India) | 11.7% | - |
| Sheetal V Pattanshetti (2012) (India) | 11.6% | - |
| K.Lakshmi Kumari et al(2015) (India) | 26.41% | 1.88% |
| Amirta Bharti (2015) (India) | 10% | - |
| D. A. Patil(2016) (India) | 10% | - |
| Humberto Ferreira Arquez (2016) (Colombia) | 3.57% | |
| Samarawickrama(2017) (Sri Lanka) | 7.14% | 2.04% |
| Ritu Agarwal(2017) (India) | 23% | - |
| Malivalaya Namking et al(2017) (Thailand) | 1.37% | - |
| Present study | 12% | - |



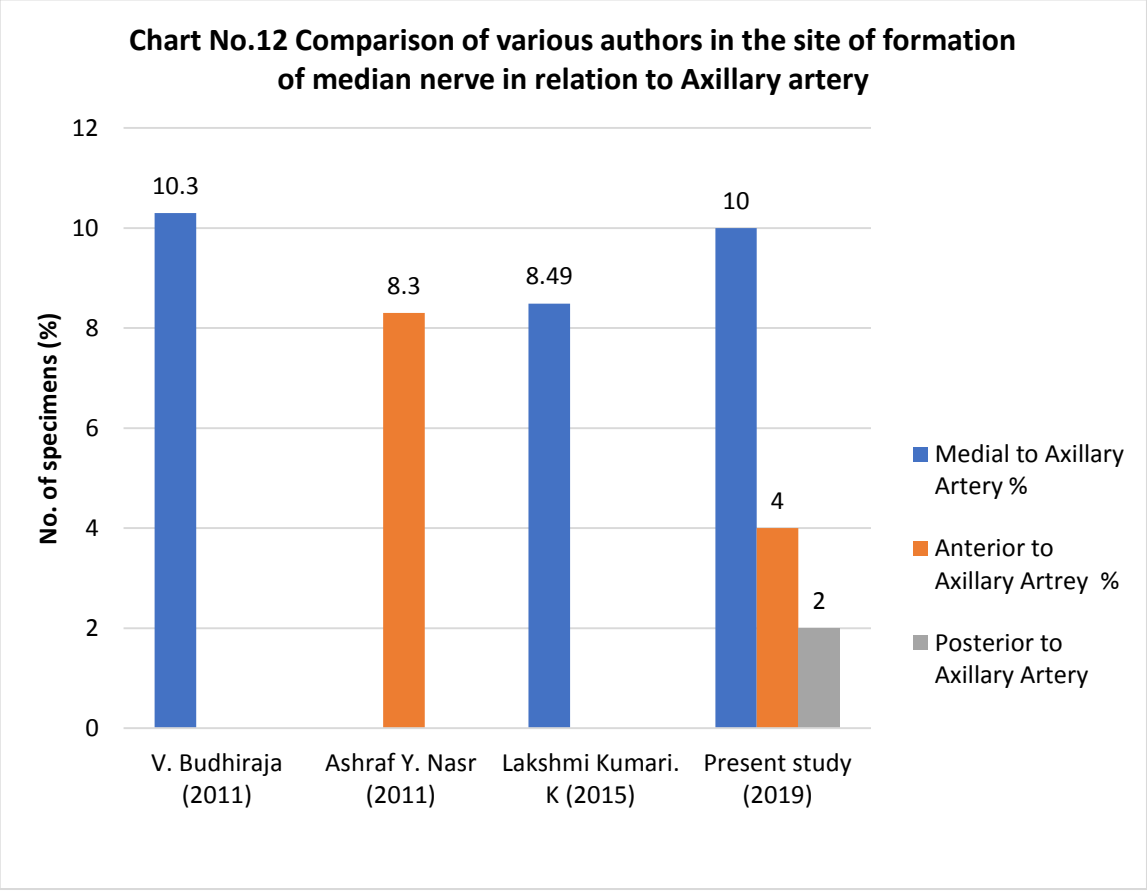

## 2. FORMATION OF MEDIAN NERVE IN RELATION TO AXILLARY ARTERY:

The observation in the present study is that median nerve was formed medial to axillary artery in 10% were close to observations done by V. Budhiraja (2011) and Lakshmi Kumari. K (2015) which were 10.3% and 8.49% respectively.

According to a study done by Ashraf Y. Nasr (2011) on 60 specimens, median nerve was formed anterior to axillary artery in 5 specimens (8.3%) which is high when compared to the present observation.

**Table no.13 Comparisons showing relation of median nerve formation in relation to axillary artery**

| AUTHORS | Medial to axillary artery | Anterior to axillary artery | Posterior to axillary artery |
|---|---|---|---|
| Budhiraja. V (2011) India | 10.3% | - | - |
| Ashraf Y. Nasr (2011) India | - | 8.3% | - |
| K. Lakshmi Kumari (2015) India | 8.49% | - | - |
| Present study | 10% | 4% | 2% |



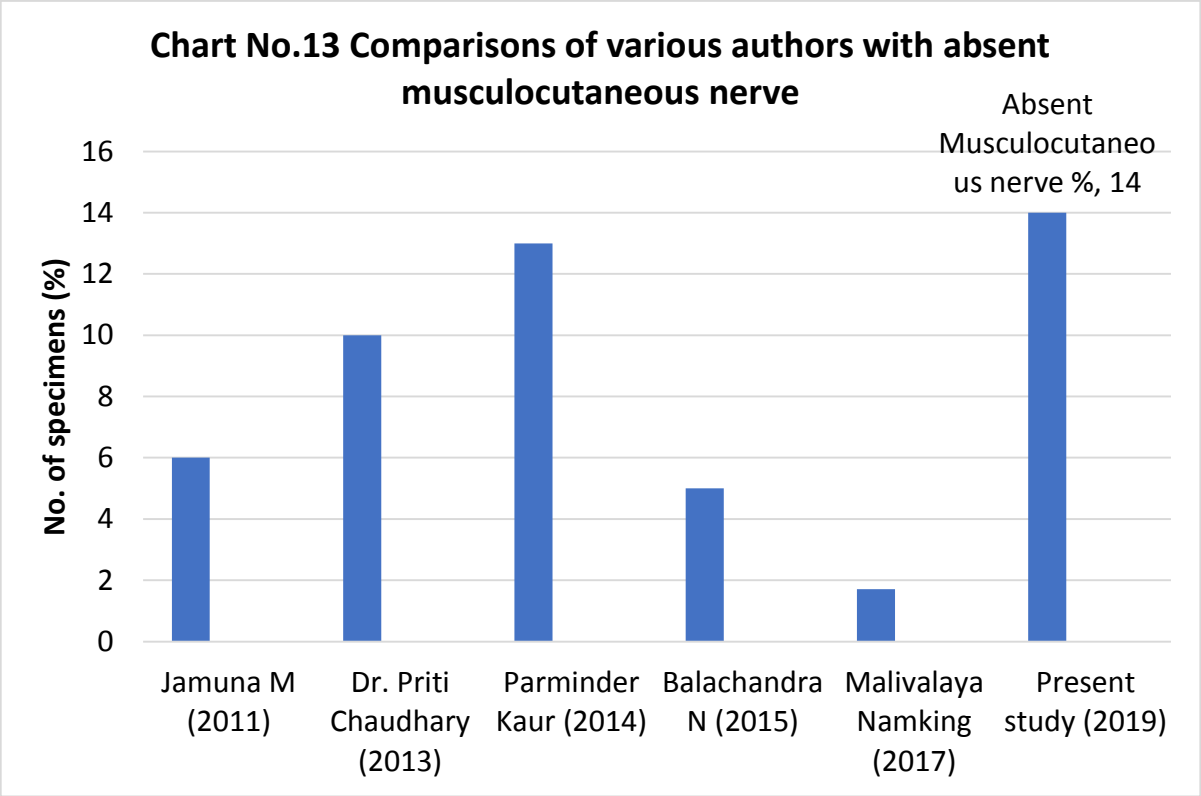
### 3. Variation of median nerve with respect to musculocutaneous nerve:

According to a study done by Parminder Kaur (2014) on 30 specimens, musculocutaneous nerve was absent in 4 specimens. In 2 specimens, small branch was seen coming from lateral root to supply coracobrachialis, later it joined median nerve after a few centimeters only. In this case rest of the anterior compartment muscles (brachialis and biceps brachii) were innervated by median nerve. In other 2 cases, Nerve to coracobrachialis was given off immediately after the union then it gave branches to biceps and brachialis. The present study finding of 7 out of 50 specimens is in correlation with the above study.

The other studies which were done by Malivalaya Namking (2017) on 292 specimens, Jamuna M (2011) on 50 specimens observed absent musculocutaneous nerve in 5 and 6 specimens respectively. This finding was very low compared to the present observations.

**Table no.14 Comparisons showing absent musculocutaneous nerve**

| AUTHORS | OBSERVATION (ABSENT MCN) |
|---|---|
| Jamuna M et al (2011) (India) | 6% (3 out of 50 arms) |
| Priti Chaudhary (2013) (India) | 10% (6 out of 60 arms) |
| Parminder Kaur (2014) (India) | 13% (4 out of 30 arms) |
| Balachandra N (2015) (India) | 5% (1 out of 20 arms) |
| Malivalaya Namking et al(2017) (Thailand) | 1.71% (5 out of 292 arms) |
| Present study (2019) | 14% (7 out of 50 arms) |




4. **(a) Number of branches of median nerve to pronator teres:**

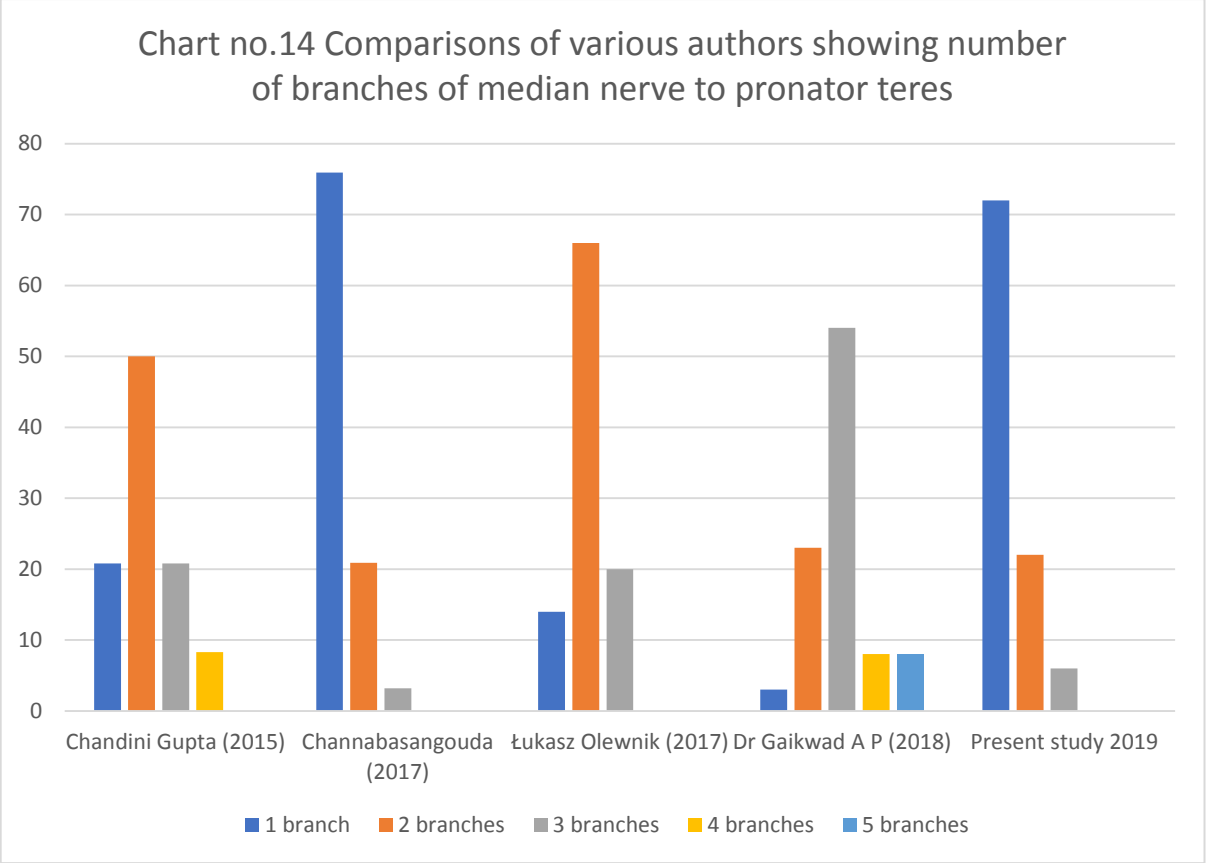
Channabasangouda (2017) study on 62 specimens observed that number of motor nerve branches to median nerve was one in 47 specimens (75.9%), two in 13 specimens (20.9%), three in 2 specimens (3.2%). The above finding is in correlation with the present observation of number of branches of median nerve to pronator teres was one in 36 specimens, two in 11 specimens and three in 3 specimens.

The other observations done by Łukasz Olewnik (2017) on 50 specimens showed number of motor nerve branches to median nerve was one in 7 specimens (14%), two in 33 specimens (66%), three in 10 specimens (20%) and by Dr

Gaikwad A P (2018) study on 39 specimens, one branch in 1 specimens (3%), two in 9 specimens (23%), three in 21 specimens (54%) and four in 3 specimens (8%) and five in 3 specimens (8%).

**Table no.15 Comparisons of various authors showing number of branches of median nerve to pronator teres**

| AUTHORS | NUMBER OF BRANCHES TO PRONATOR TERES | | | | |
|---|---|---|---|---|---|
| | 1 branch | 2 branches | 3 branches | 4 branches | 5 branches |
| Chandhini Gupta(2015) (India) | 20.8% | 50% | 20.8% | 8.3% | - |
| Channabasanagouda et al(2017) (India) | 75.9% | 20.9% | 3.2% | - | - |
| Lukasz Olewnik(2017) (Poland) | 14% | 66% | 20% | - | - |
| Dr Gaikwad A P (2018) (India) | 3% | 23% | 54% | 8% | 8% |
| Present study (2019) | 72% | 22% | 6% | - | - |

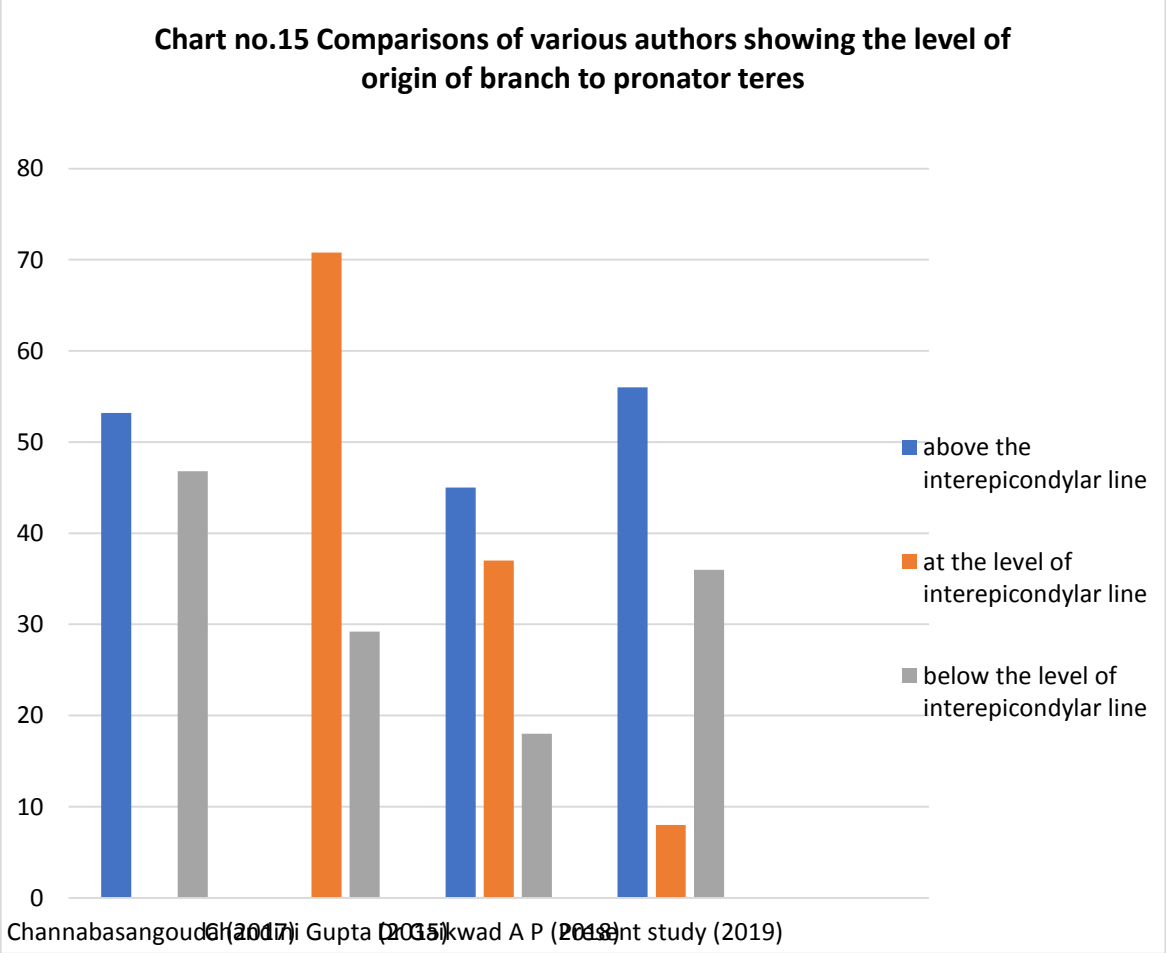



**4. (b) Level of origin of median nerve branch to pronator teres:**

The observation in this present study is that origin of 1st branch of median nerve to pronator teres muscle was above the level of interepicondylar line in 28 specimens, at the level of interepicondylar line in 4 specimens and below the level of interepicondylar line in 18 specimens. This finding is in similar to the observations done by Channabasangouda et al (2017) in which 53.2% of specimens found to have branches arising above the level and 46.8% below the level of intercondylar line. The other study done by Chandini Gupta(2015) found out that in 70.8% and 29.2% of specimens, motor branch to pronator teres arises at the level and below the level of intercondylar line respectively.

**Table no.16 Comparisons of various authors showing level of branch to pronator teres**

| AUTHORS | ABOVE THE LEVEL OF INTEREPI CONDYLAR LINE | AT THE LEVEL OF INTEREPI CONDYLAR LINE | BELOW THE LEVEL OF INTEREPI CONDYLAR LINE |
|---|---|---|---|
| Channabasanagouda et al (2017) India | 53.2% | - | 46.8% |
| Chandhini Gupta (2015) India | - | 70.8% | 29.2% |
| Dr Gaikwad A 1P (2018) India | 45% | 37% | 18% |
| Present study (2019) | 56% | 8% | 36% |

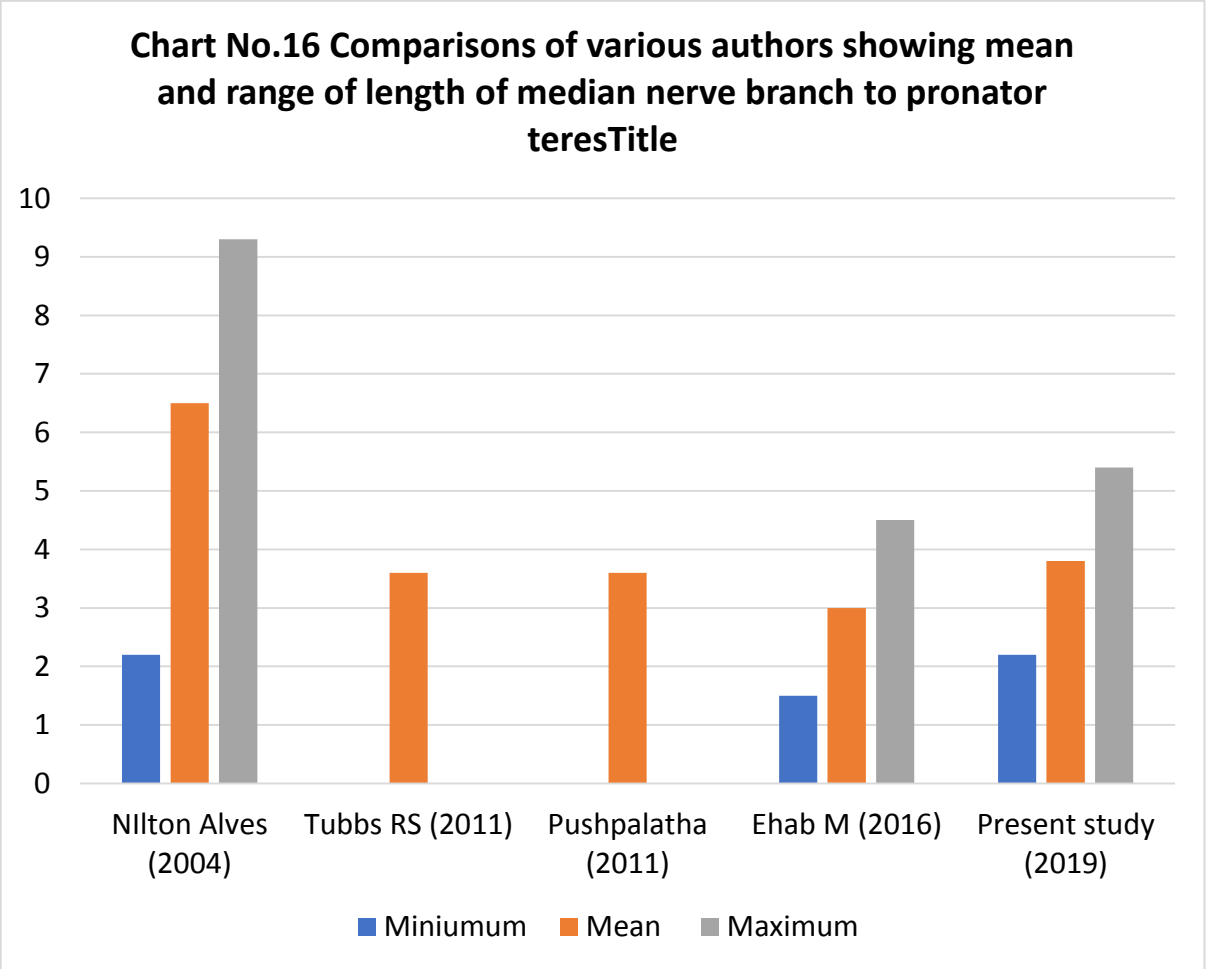


**4 (c) Length of median nerve branches to pronator teres:**

According to a study done by Ehab M et al(2016), mean length of the branches to pronator teres was 1.5 to 4.5cms. This was similar to the present study finding which was of about 2.2 to 5.4cms. The various authors, Nilton Alves, Shane Tubbs, Pushpalatha observed the average length of these branches were 5.9, 3.6 and 3.6 cms respectively.

**Table no.17 Comparisons of various authors showing mean length of branch to pronator teres**

| AUTHORS | LENGTH OF BRANCHES TO PRONATOR TERES |
|---|---|
| Nilton Alves et al(2004) (Brazil) | 2.3 to 9.5cms |
| Shane Tubbs et al(2011) (Alabama) | 3.6cms |
| Pushpalatha et al(2011) (India) | 3.6cms |
| Ehab M et al(2016) (Egypt) | 1.5 to 4.5cms |
| Present study | 2.2 to 5.4 cms |



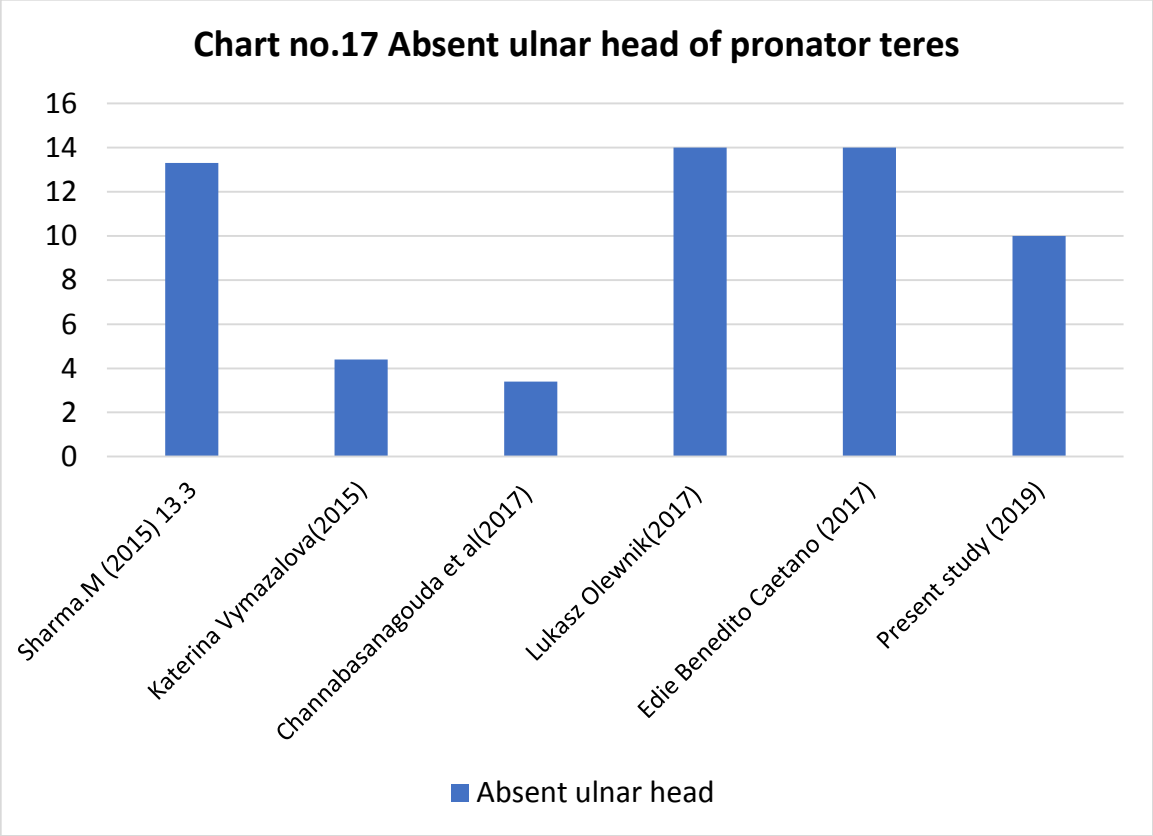

**5) Absent ulnar head of pronator teres:**

According to a study done by Sharma. M, absent ulnar head was seen in 8 (13%)out of 60 specimens. This observation is in correlation with the present study finding of 5 (10%) out of 50 specimens. The other studies done by various authors such as Lukasz Olewnik(2017) and Edie Benedito Caetano (2017) observed to have similar finding of 14% each.

The findings of Channabasangouda and Katerina Vymazalova were 3.4 and 4.4% respectively which is less when compared to the present study.

**Table no.18 Comparisons of various authors absent ulnar head of pronator teres**

| AUTHOR | OBSERVATION |
|---|---|
| Sharma M (2015) | 13.3% |
| Katerina Vymazalova(2015) | 4.4% |
| Channabasanagouda et al(2017) | 3.4% |
| Lukasz Olewnik(2017) | 14% |
| Edie Benedito Caetano (2017) | 14% |
| Present study | 10% |



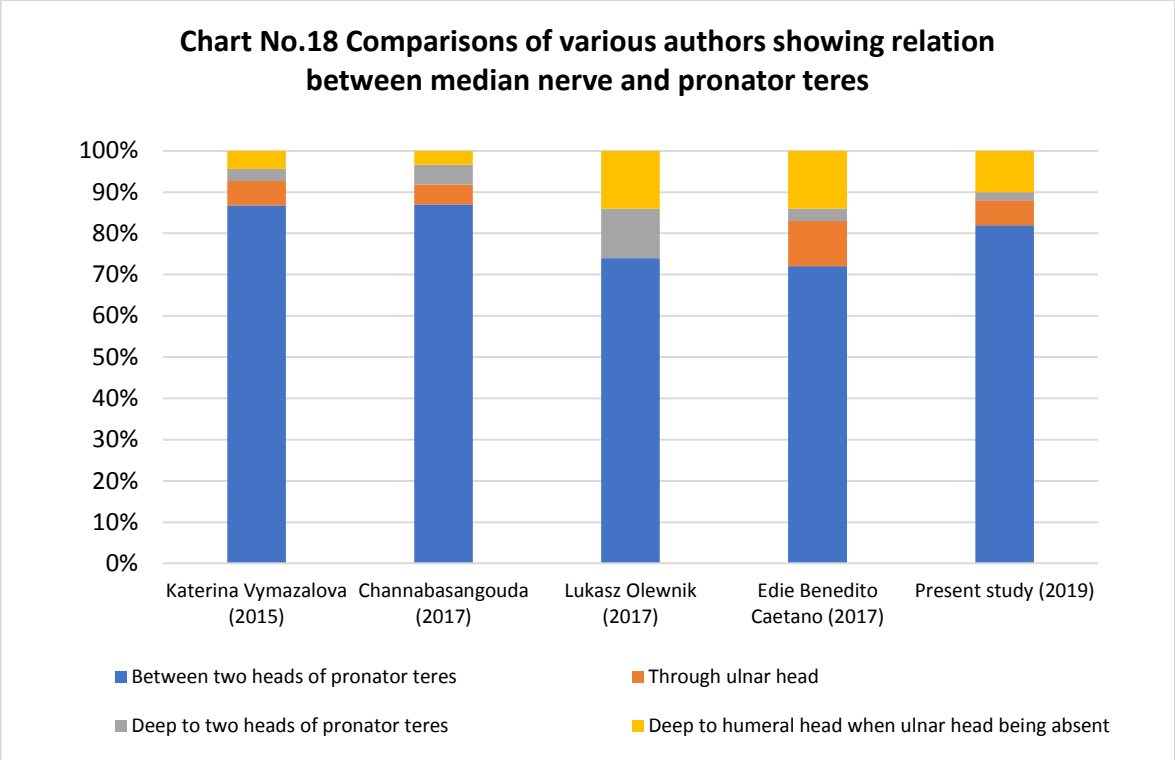
**6) Relation of median nerve and pronator teres muscle:**

The observation done in the present study is similar to a study done by Channabasangouda (2017) on 62 specimens, median nerve passing between the two heads of pronator teres in 54 specimens, through the ulnar head in 3 specimens and passing deep to the muscle in 3 specimens and absent ulnar head in 2 specimens. In the present study, median nerve passing between humeral and ulnar heads of pronator teres muscle was observed in 41 specimens. According to Katerina Vymazalova(2015), , median nerve passing between the two heads of pronator teres in 86 % specimens, through the ulnar head in 5.9% specimens and passing deep to the muscle in 2.9% specimens and absent ulnar head in 4.4% specimens.

The study done by Lukas Olewink observed that median nerve passing deep to two heads of pronator teres was 12% which is high when compared to the present study finding.

**Table no.19 Comparisons of various authors showing relation of median nerve and pronator teres**

| AUTHORS | BETWEEN 2 HEADS OF PRONATOR TERES | THROUGHT THE ULNAR HEAD | DEEP TO TWO HEADS OF PRONATOR TERES | DEEP TO THE HUMERAL HEAD AND ULNAR HEAD BEING ABSENT |
|---|---|---|---|---|
| Katerina Vymazalova(2015) (Czezh Republic) | 86.8% | 5.9% | 2.9% | 4.4% |
| Channabasanagouda et al(2017) (India) | 87% | 4.8% | 4.8% | 3.4% |
| Lukasz Olewnik(2017) (Poland) | 74% | - | 12% | 14% |
| Edie Benedito Caetano (2017) | 72% | 11% | 3% | 14% |
| Present study | 82% | 6% | 2% | 10% |

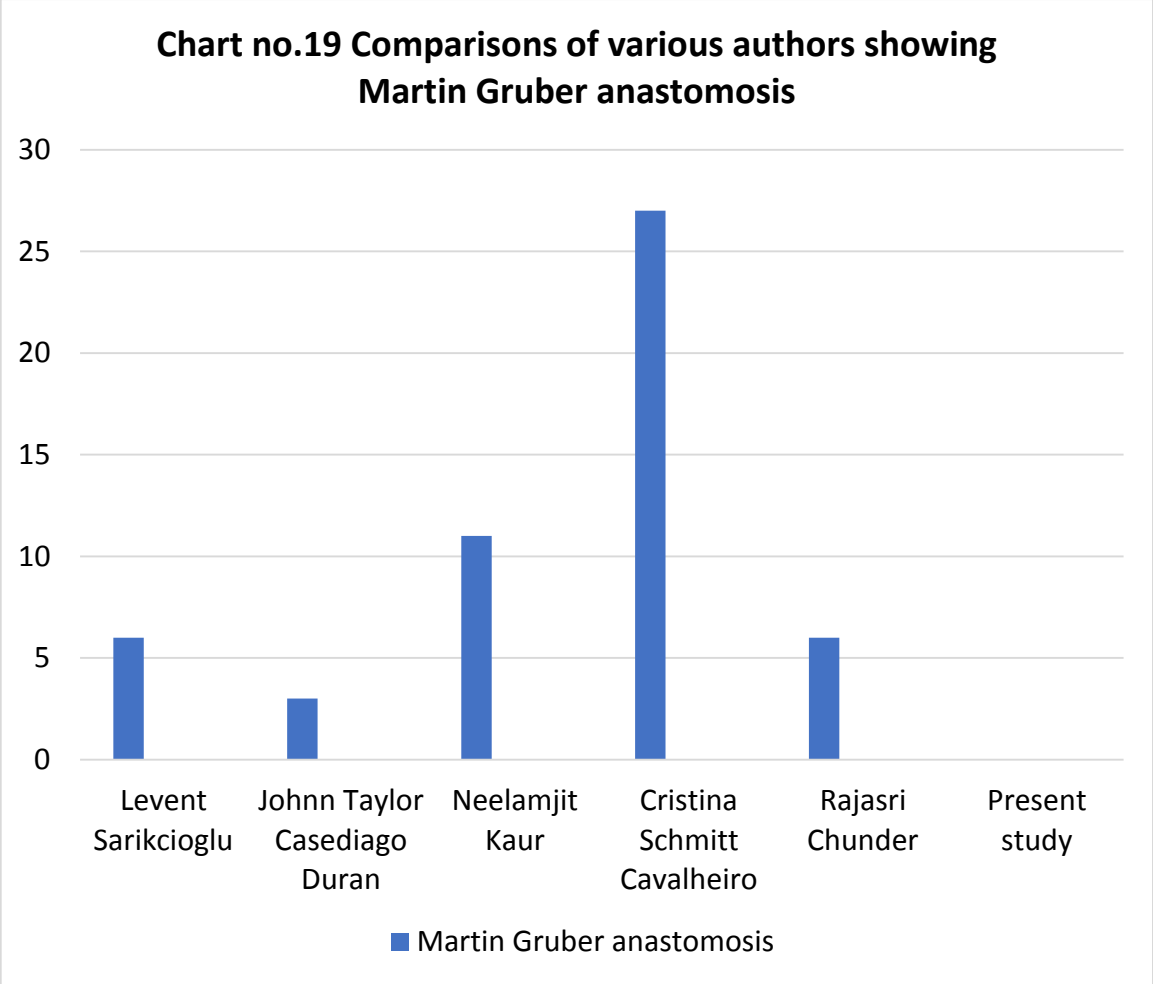


**7) Martin Gruber anastomosis (Communication between median and ulnar nerve):**

Cristina Schmitt Cavalheiro (2016) study observed that communication between median and ulnar nerve exist in 27% of cases. The studies by various authors such as Levent sarikcioglu and Johnn Taylor Casediago Duran observed it to be 6% and 3% respectively.

**Table no.20 Martin Gruber anastomosis (Communication between median and ulnar nerve**

| AUTHOR | OBSERVATION |
|---|---|
| Levent Sarikcioglu (2003) | 6% |
| Johnn Taylor Casediago Duran (2016) | 3% |
| Neelamjit Kaur (2016) | 11% |
| Cristina Schmitt Cavalheiro (2016) | 27% |
| Rajasri Chunder (2017) | 6% |
| Present study | Nil |

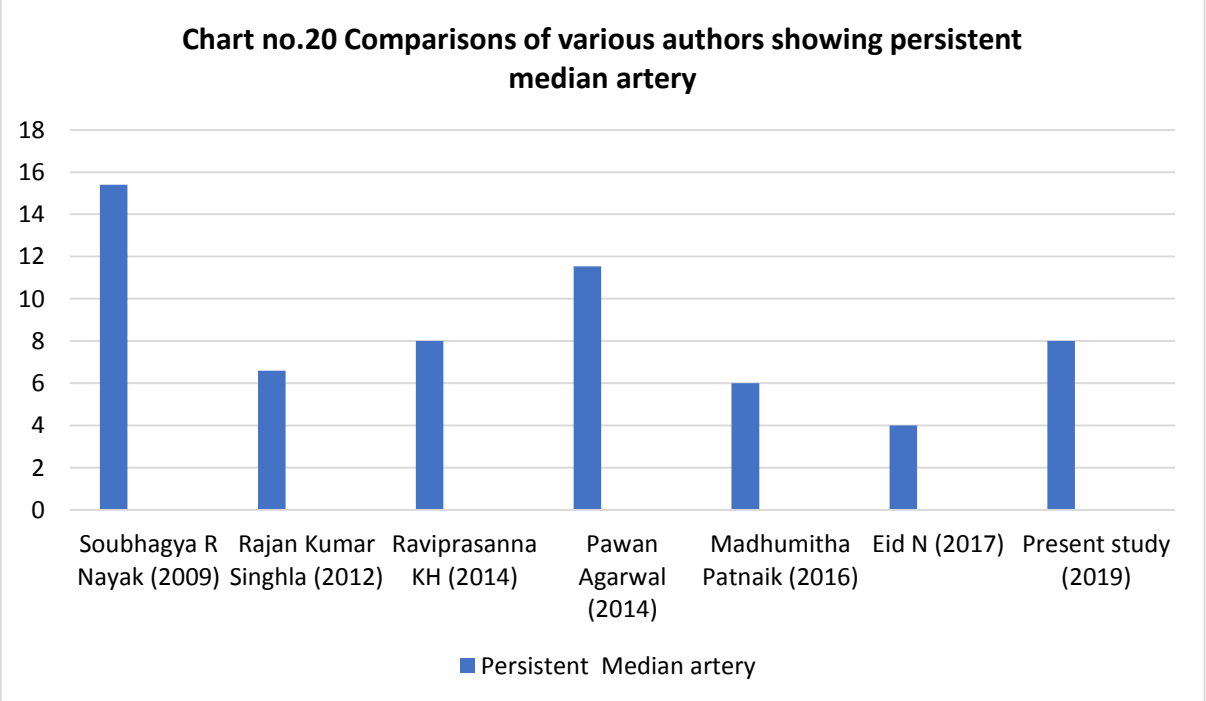



**8) Incidence of Persistent median artery:**

Raviprasanna KH(2014) observed the incidence of persistent median artery was 8% . This finding is similar to the observation made in the present study. According to Soubhagya R Nayak (2009), incidence was found to be 15.4% which is high when compared to the current observation. Eid N stated that incidence is 4% which is less than the present study finding.

**Table No.21 Comparisons of various authors showing incidence of Persistent median artery**

| AUTHOR | OBSERVATION |
|---|---|
| Soubhagya R Nayak (2009) India | 15.4% |
| Rajan Kumar Singhla (2012) India | 6.6% |
| Raviprasanna.K.H(2014) India | 8% |
| Agarwal P et al(2014) India | 11.53% |
| Madhumitha Patnaik (2016) India | 6% |
| Eid N(2017) India | 4% |
| Present study | 8% |

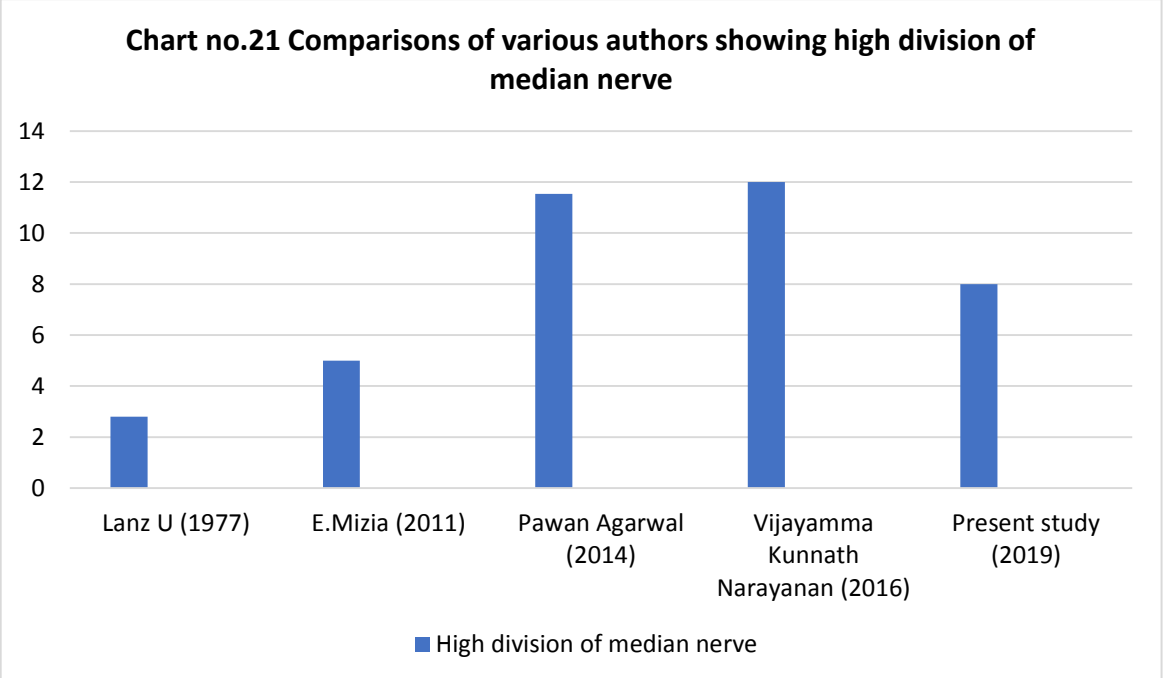


**9) High division of median nerve:**

According to a study done Mizia and Agarwal, median nerve was found to be divided into two terminal branches, medial and lateral, proximal to flexor retinaculum in 5% and 11.53% respectively. This observation is in correlation with the present study finding.

**Table No.22 Comparisons of various authors showing incidence of high division of median nerve**

| AUTHOR | OBSERVATION |
|---|---|
| Lanz U (1977) | 2.8% |
| E. Mizia (2011) Poland | 5% |
| Agarwal P et al (2014) India | 11.53% |
| Vijayamma Kunnath Narayanan(2016) India | 12% |
| Present study | 8% |

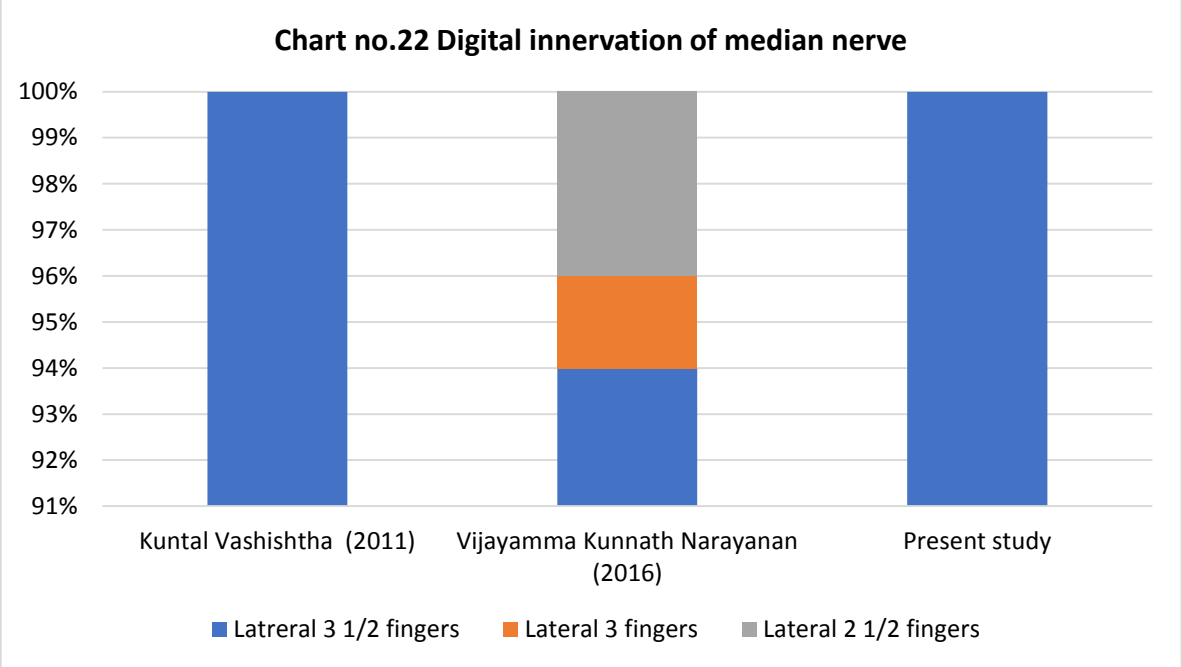


## 10) Digital innervation of median nerve:

Vijayamma Kunnath Narayanan(2016) study observed that median nerve supplied the lateral three and half digits in all cases. This is similar to the current observation.

**Table No. 23 Comparisons of various authors showing digital innervation pattern of median nerve**

| AUTHORS | OBSERVATION | | |
|---|---|---|---|
| | Lateral 3 ½ fingers | Lateral 3 fingers | Lateral 2 ½ fingers |
| Kuntal Vashishth(2011) India | 94% | 2% | 4% |
| Vijayamma Kunnath Narayanan(2016) India | 100% | - | - |
| Present study | 100% | - | - |



# *Conclusion*

# CONCLUSION

Knowledge of the anatomical variations is particularly important with regard to performing physical examinations, making diagnoses, determining the prognosis and implementing surgical treatment.

Number of branches, their level of origin is significant in muscle transfer and neurotization procedures which will help neurosurgeons and orthopedicians. Nerve communications between the median and ulnar nerves may cause alterations to clinical symptoms, especially in patients with carpal tunnel syndrome, since these variations may exacerbate or attenuate the symptoms and cause motor and sensory alterations that differ from the usual pattern.

The present study concludes that the different types of variations in cadavers which have been studied would be of immense help for successful clinical approaches. Such variations of peripheral nerves noticed in routine surgical procedures or in traumatic injuries should be included into the surgical training programmes to help avoiding iatrogenic injuries. The following conclusions were drawn from the present study

1. Bifurcate origin of median nerve seen in 44 specimens while trifurcate origin seen in 6 specimens.

2. Median nerve was formed medial to axillary artery in 5 specimens, posterior to axillary artery in 1 specimen and anterior to axillary artery in 2 specimens.

3. Musculocutaneous nerve was absent in 7 specimens, in 6 specimens all muscles of anterior compartment of arm were innervated by median nerve.

4. Number of branches of median nerve to pronator teres was one in 36 specimens, two in 11 specimens and three in 3 specimens.

5. Origin of 1$^{st}$ branch of median nerve to pronator teres muscle was above the level of interepicondylar line in 28 specimens, at the level of interepicondylar line in 4 specimens and below the level of interepicondylar line in 18 specimens.

6. The average length of branches of median nerve to pronator teres was 3.8 cms, with a range varying from 2.2 cms to 5.4cms.

7. Ulnar head of pronator teres was absent in 5 specimens (10%) out of 50 specimens.

8. Median nerve passing between humeral and ulnar heads of pronator teres muscle was observed in 41 specimens, through the ulnar head in 3 specimens, below the ulnar head in 1 specimen.

9. No obvious communication of nerve fibres running from median nerve to ulnar nerve (Martin Gruber anastomosis).

10. Persistent median artery was seen in 3 specimens.

11. Median nerve divided into two terminal branches above the level of flexor retinaculum in 2 specimens.

12. Digital branches supplying lateral three and half digits.

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**Fig No.1 Normal formation of median nerve by two roots with one from medial cord and the other from lateral cord**

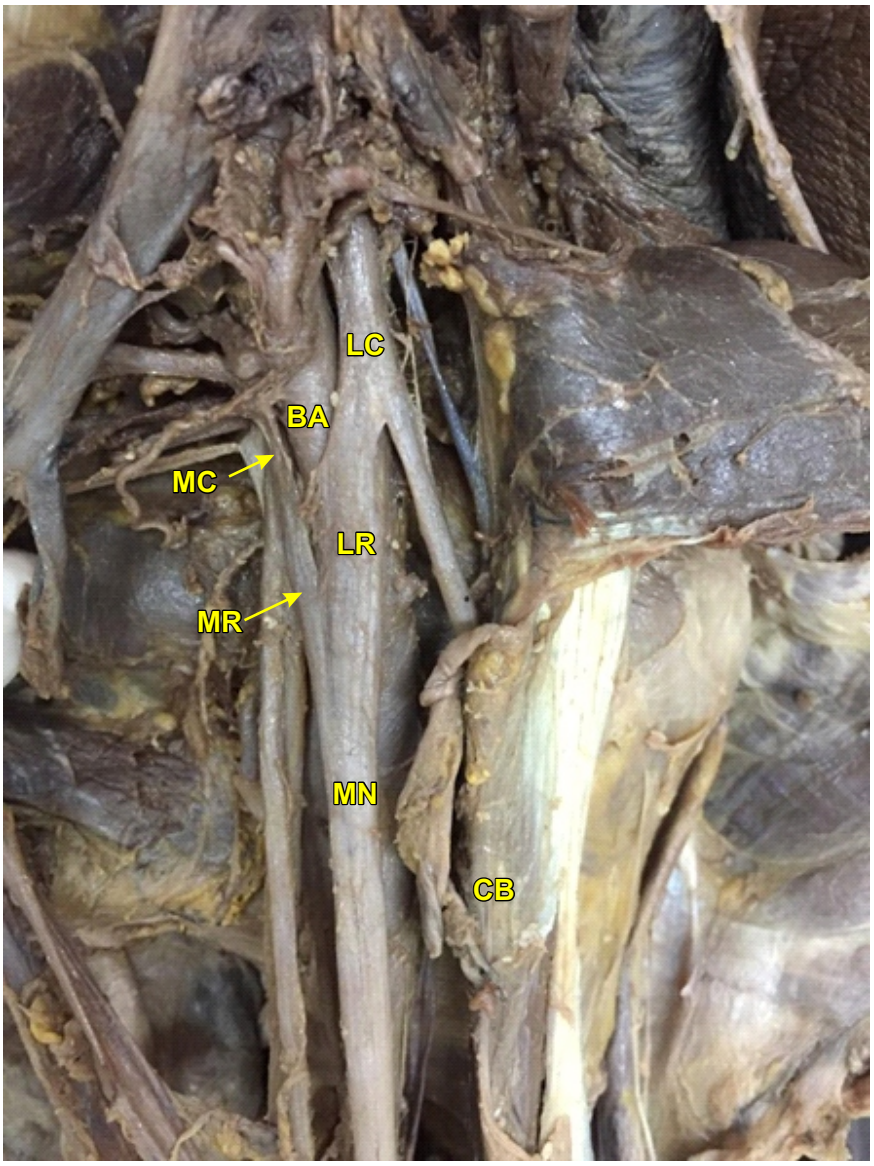

**Fig No.2 Two roots forming median nerve with one root from medial cord and the other from musculocutaneous nerve**

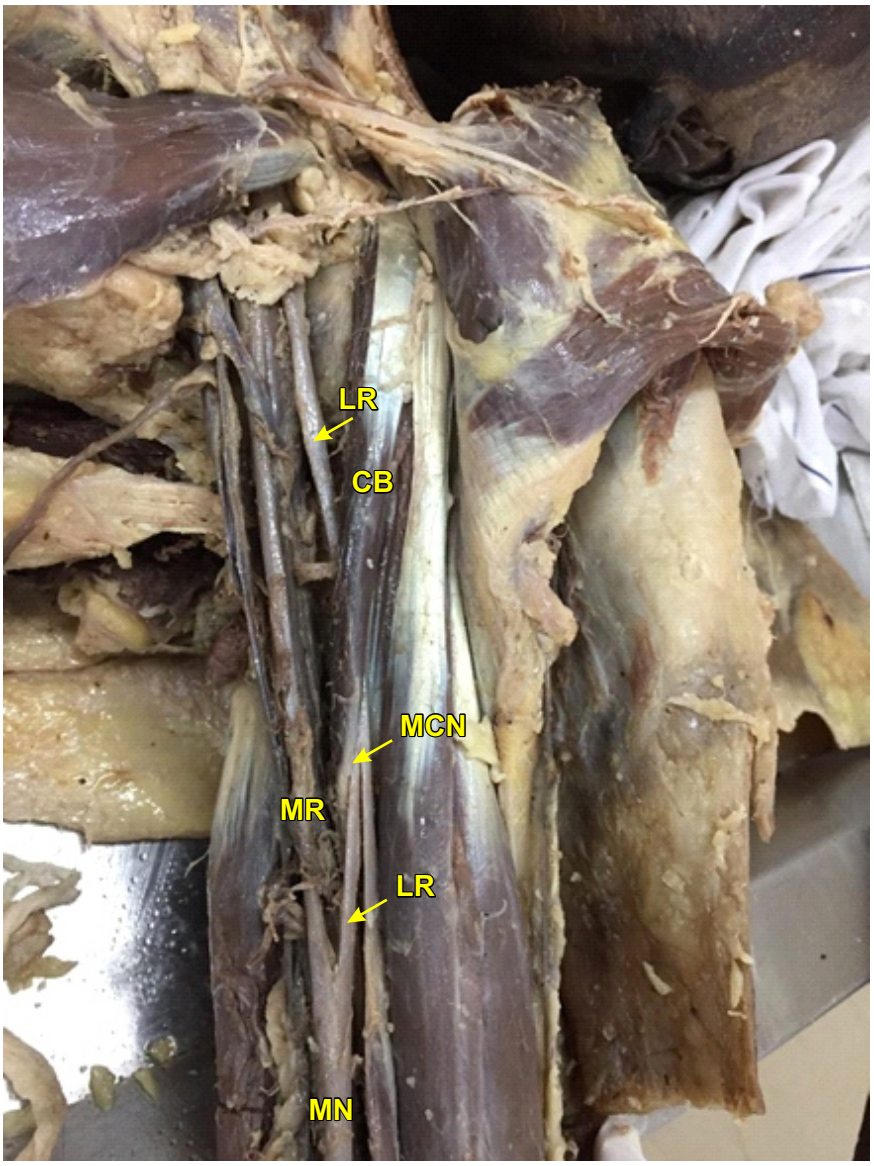

**Fig No.3 Three roots forming median nerve with the third root from medial cord**

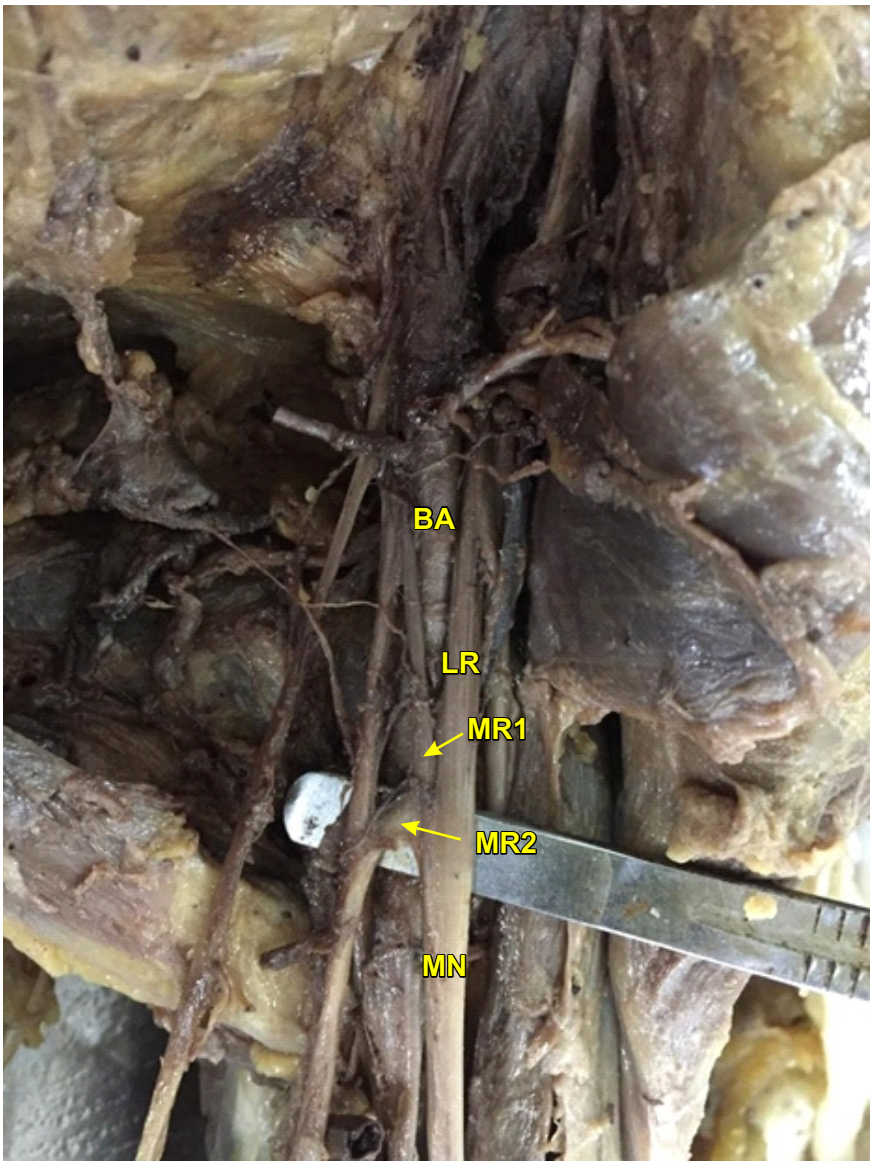

**Fig No.4 Three roots forming median nerve with the third root from lateral cord**

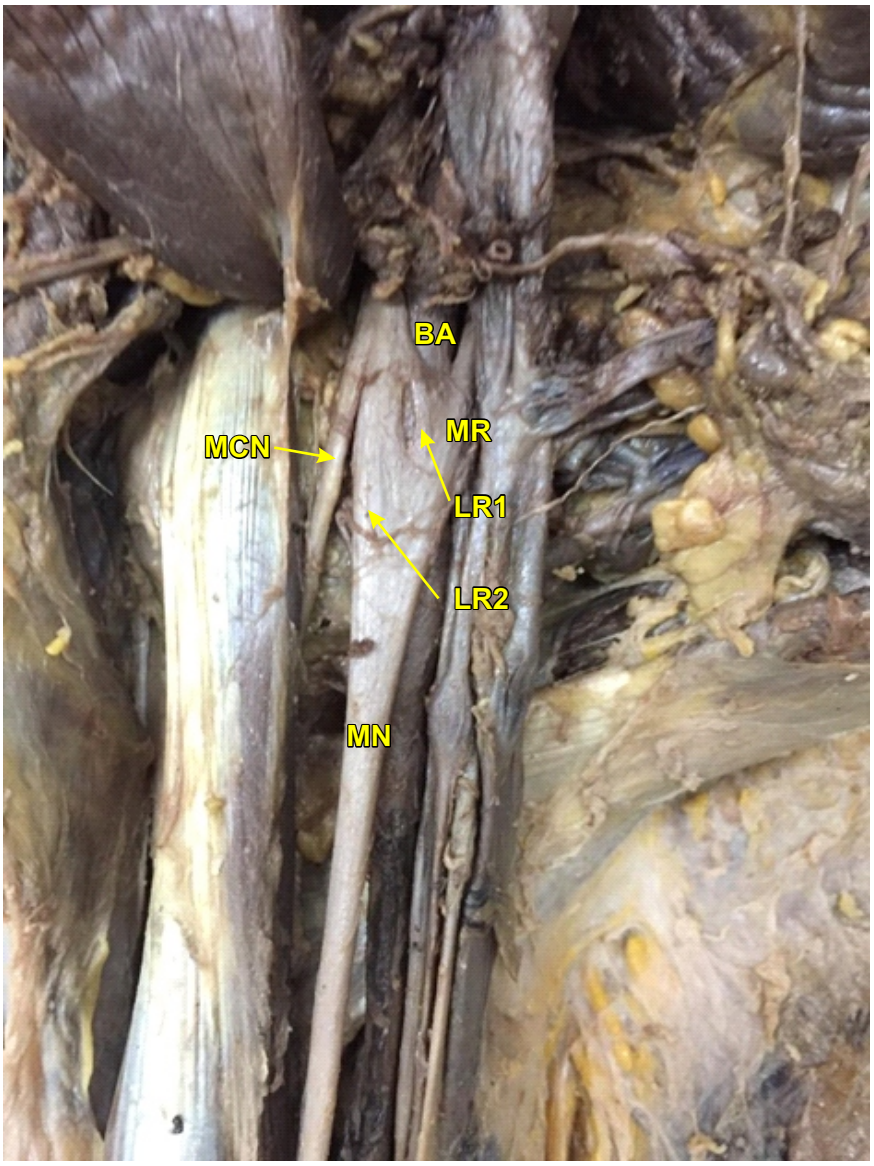

**Fig No.5 Median nerve formed anterior to Axillary artery**

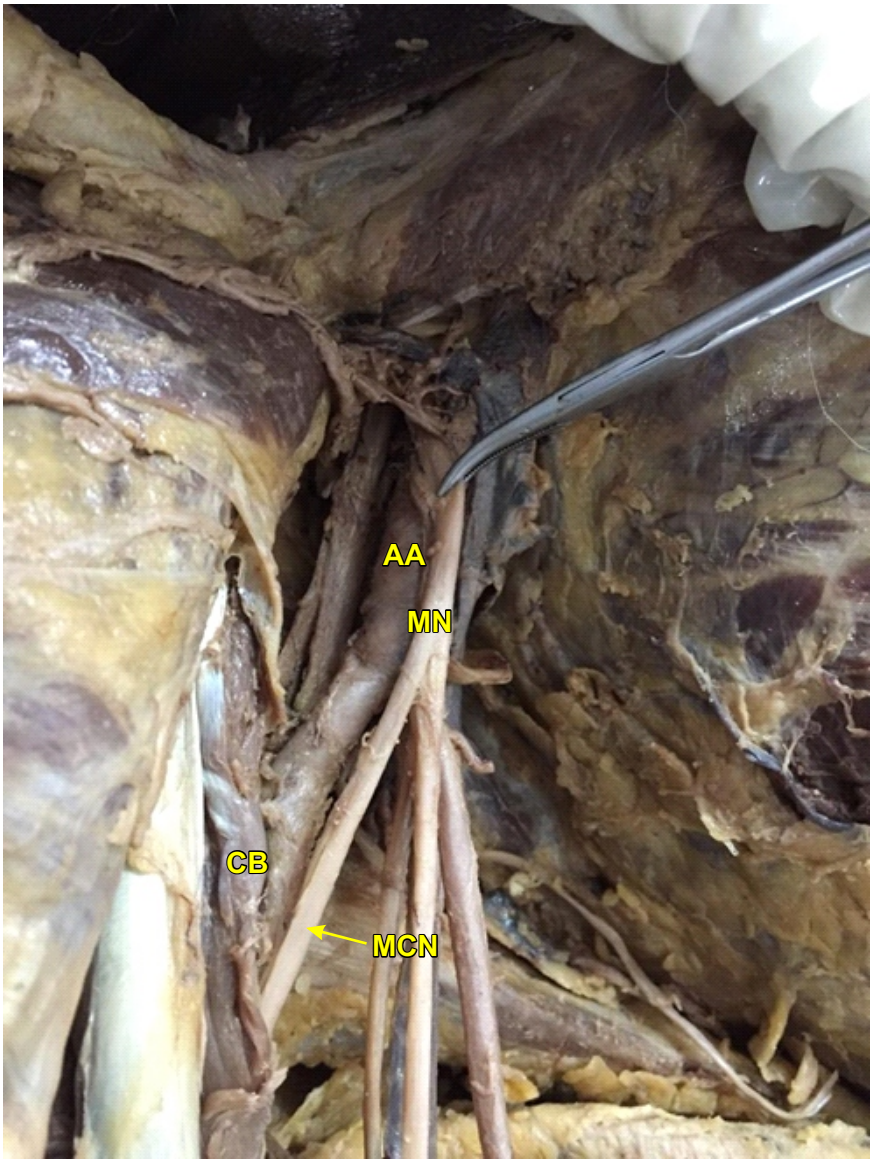

**Fig No.6 Median nerve formed medial to Axillary artery**

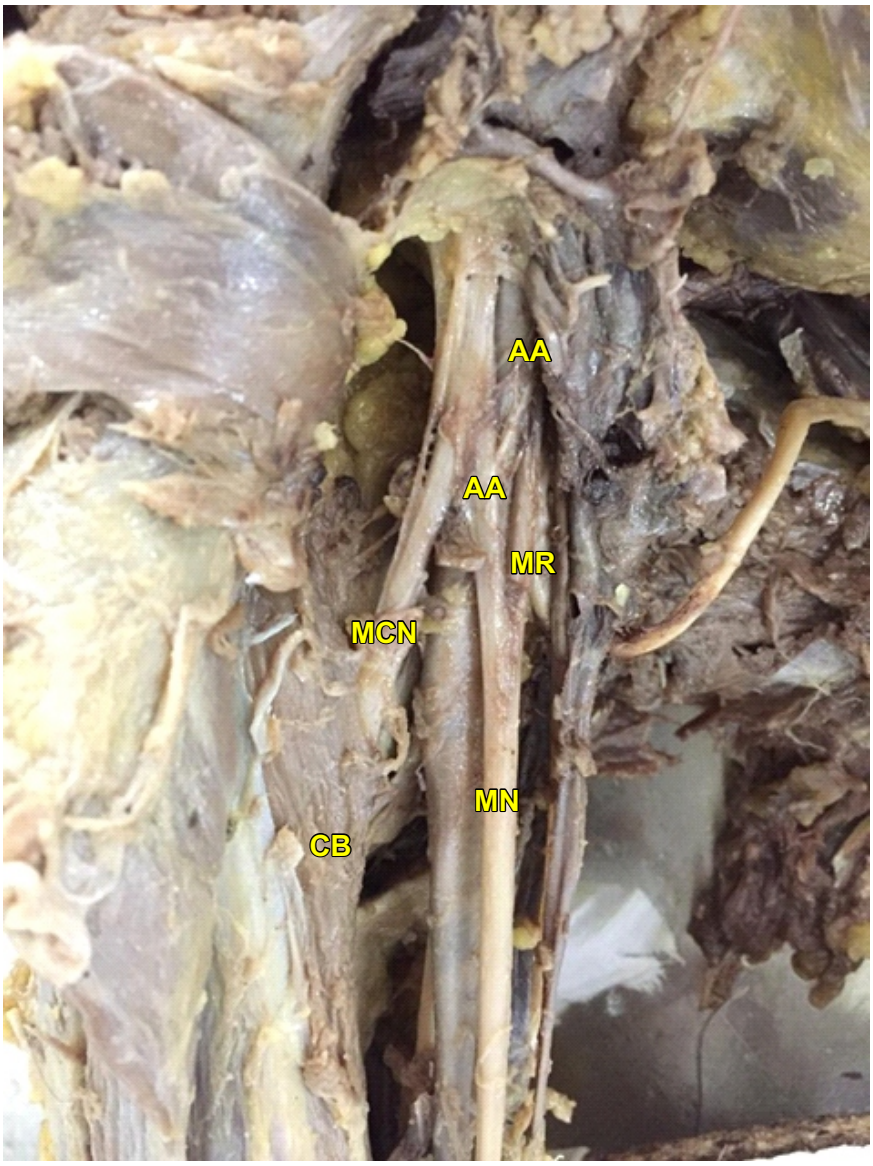

**Fig No.7 Median nerve formed posterior to Axillary artery**

**Fig No.8 Absent musculocutaneous nerve with a branch from median nerve supplying coracobrachialis**

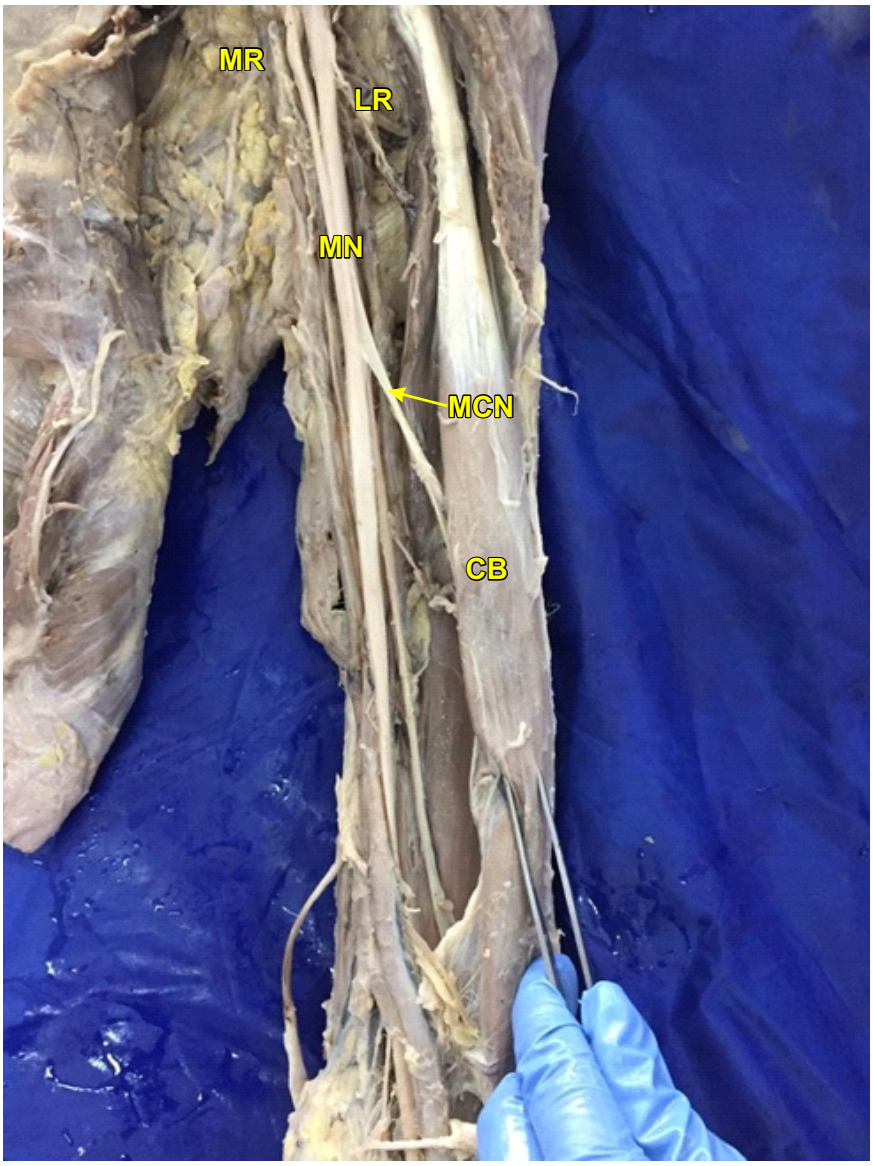

**Fig No. 9 Two branches from median nerve supplying pronator teres**

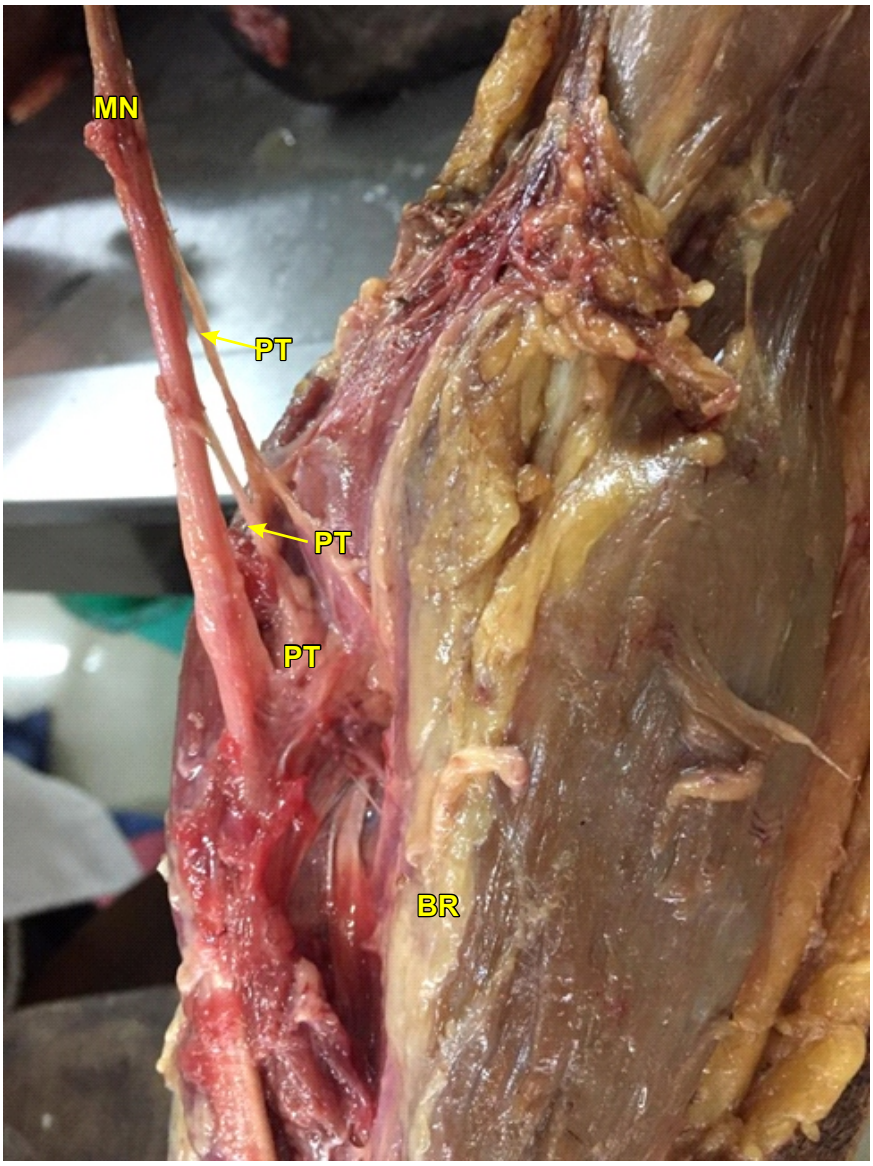

**Fig No.10 Three branches from median nerve supplying pronator teres**

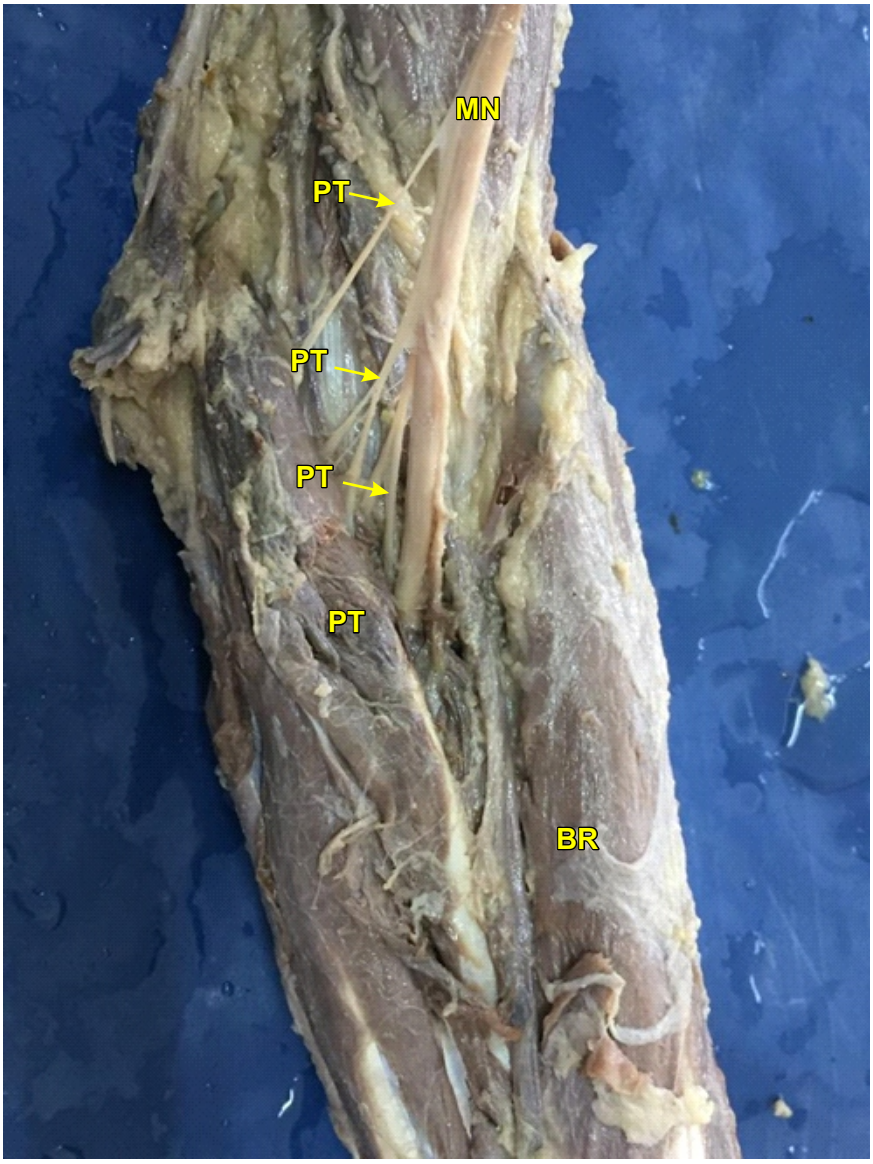

**Fig No. 11 Origin of 1st branch to PT at the level of intercondylar line**

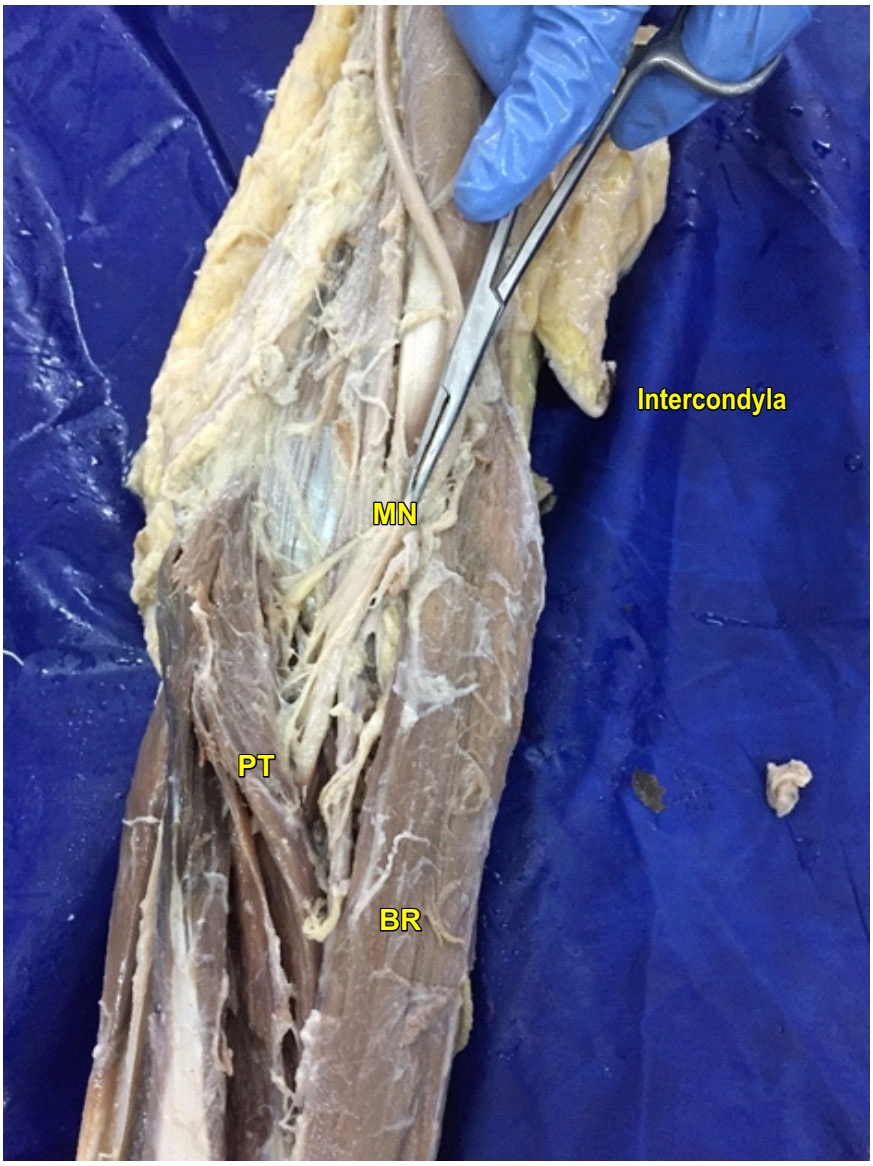

**Fig No.12 Origin of 1st branch to PT below the level of intercondylar line**

**Fig No.13 Length of branch of median nerve to Pronator teres**

**Fig No.14 Thread and Ruler**

**Fig No.15 Absent ulnar head of pronator teres**

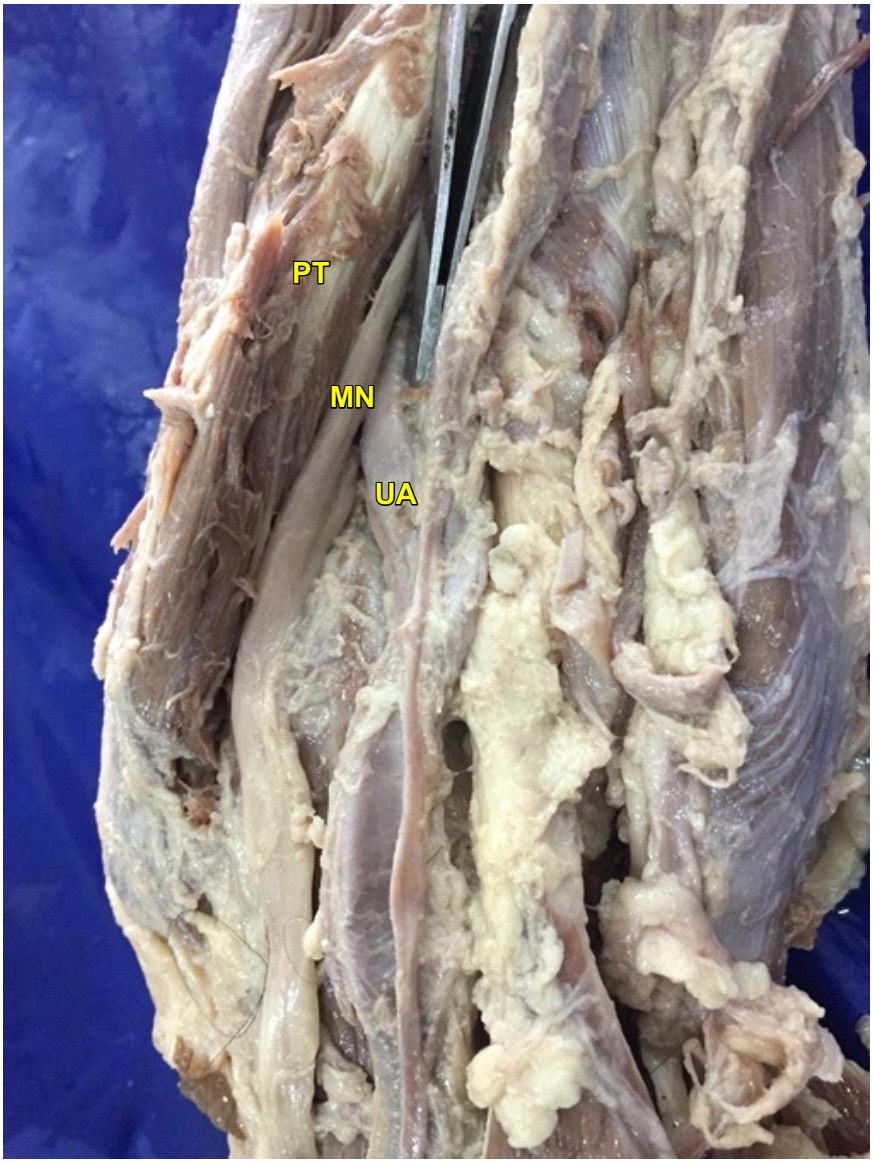

**Fig No.16 Median nerve passing between through ulnar head of pronator teres**

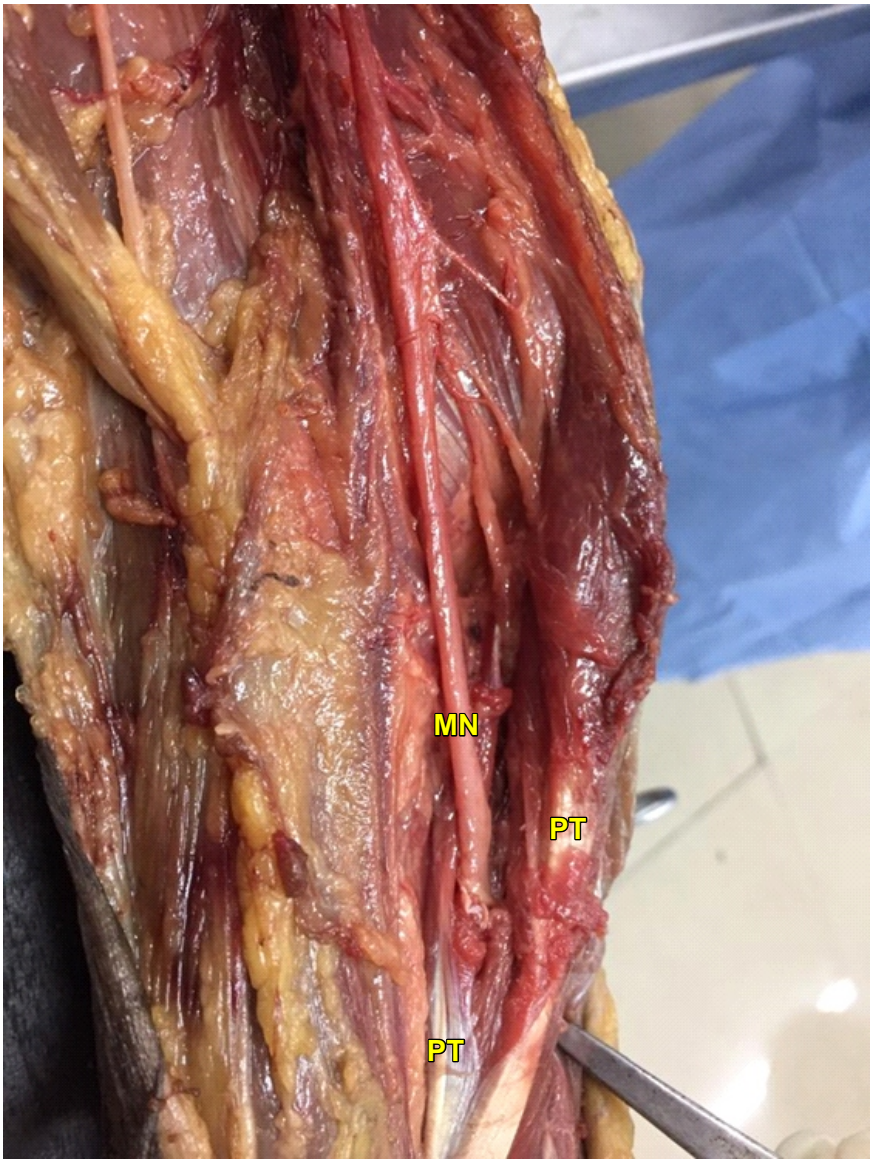

**Fig No.17 Median nerve passing below the ulnar head of pronator teres**

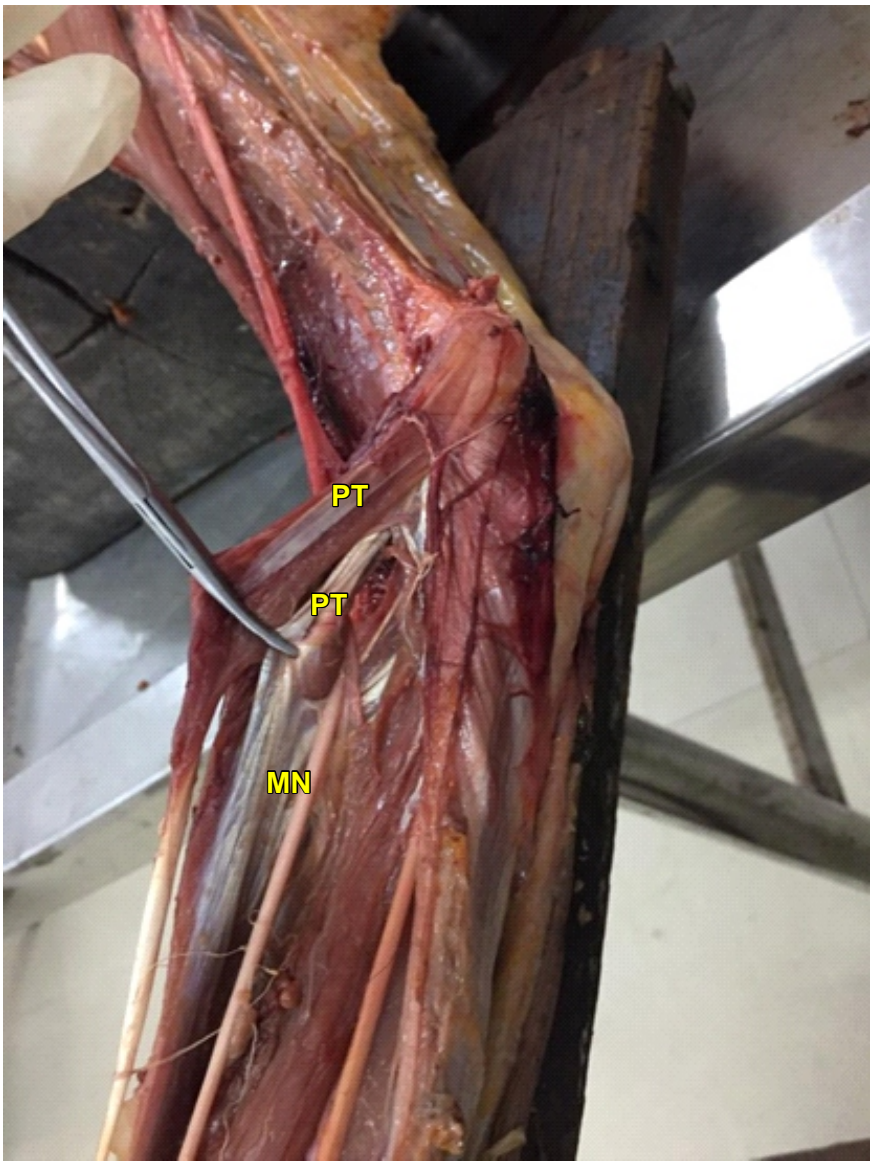

**Fig No.18  Persistent Median Artery**

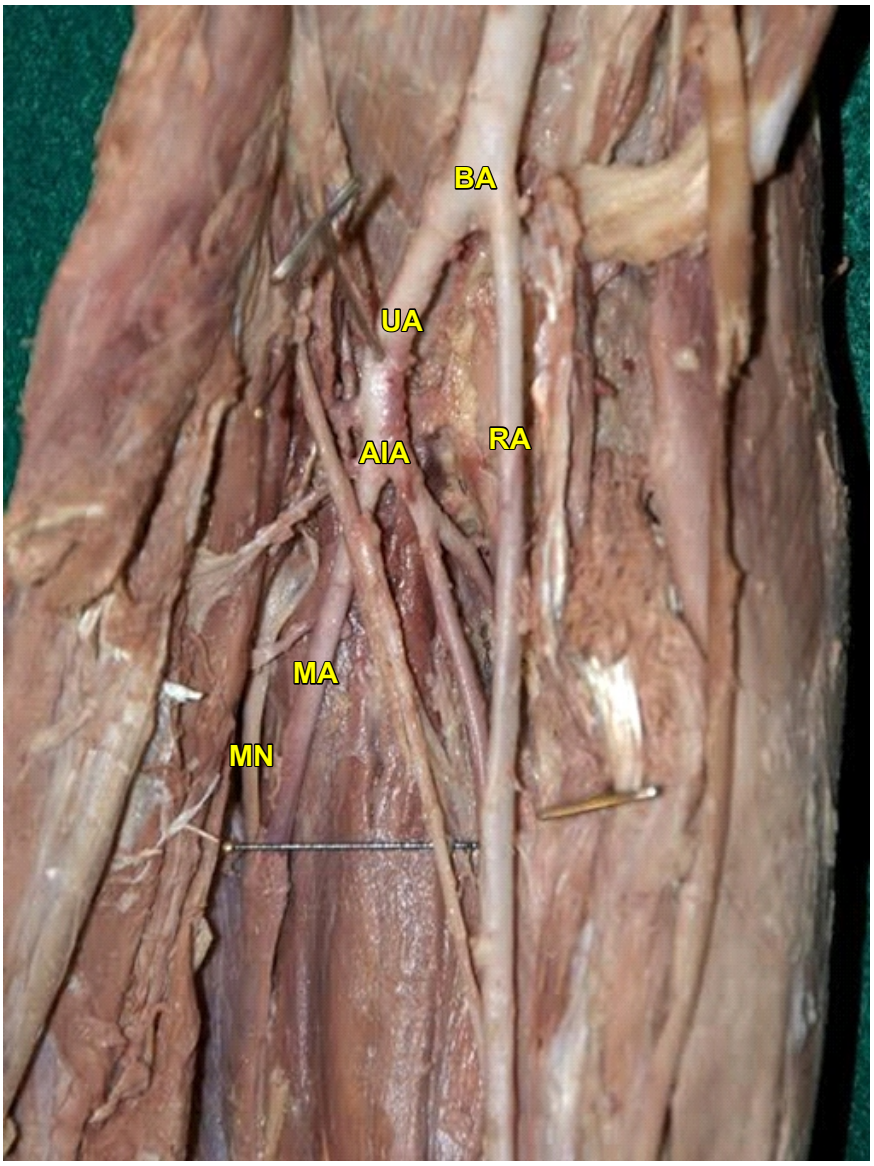

**Fig No.19 Terminal division of median nerve above the level of flexor retinaculum**

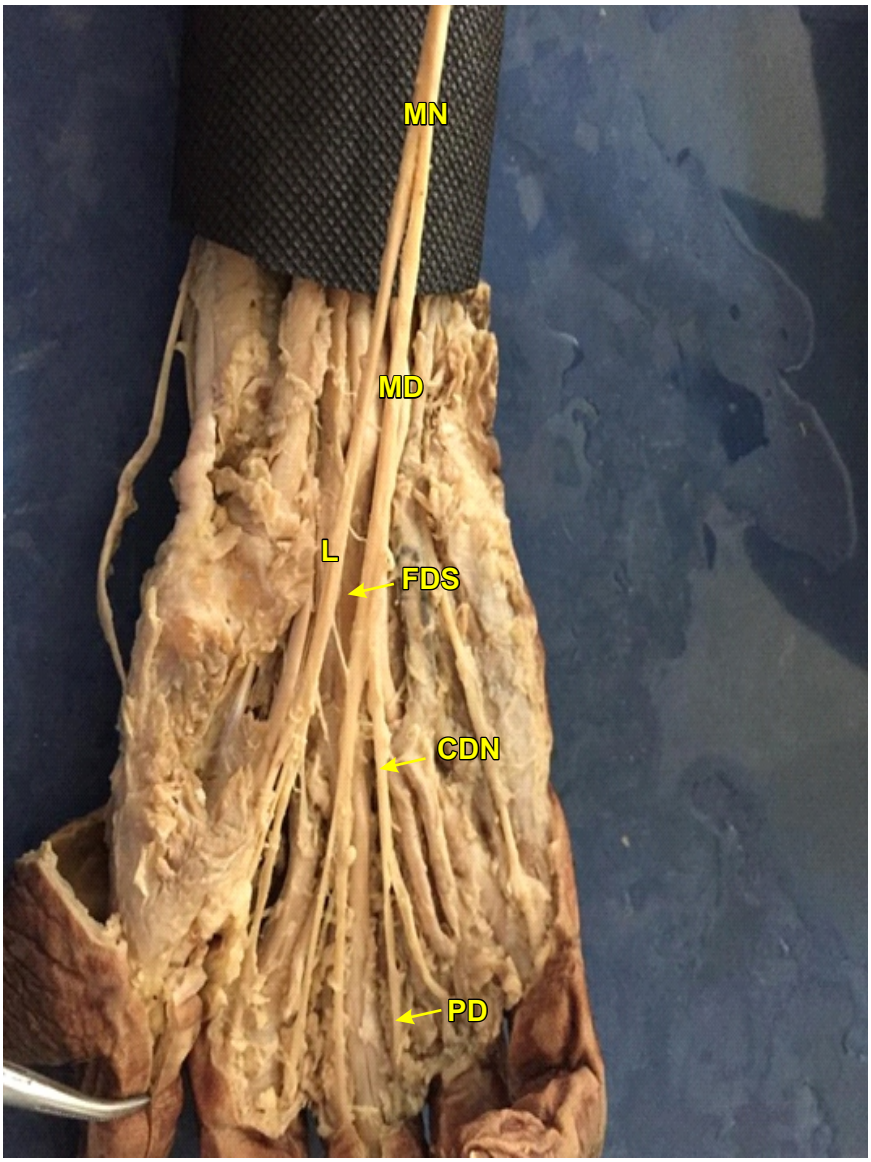

**Fig No.20 Digital branches of median nerve supplying lateral three and half digits**