



## THE CLINICAL AND DEVELOPMENTAL SIGNIFICANCE OF ULNAR ARTERY VARIATION DURING SURGERIES AND MEDICAL INTERVENTIONS

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**ABSTRACT** **Background** – Ulnar artery is a branch of brachial artery, it descends superficially and vertically between the FCU and FDS in lower two third of forearm. Then it passes above the flexor retinaculum at wrist later forming superficial palmar arch. **Case Report**- During routine dissection in S.N Medical College, Agra, an unusual finding was identified in both the upper limb of a 60 year old male cadaver. Ulnar artery runs laterally to ulnar nerve and then passes underneath the flexor retinaculum. Then it joins with the Superficial Branch of Radial Artery to form Superficial palmar arch. Variation of Ulnar artery is uncommon. It is important in surgical cases of Carpal tunnel release surgery, also can be confused with superficial veins during interventions.

**KEYWORDS :** Variation ; Ulnar Artery ; Course ; Flexor Retinaculum

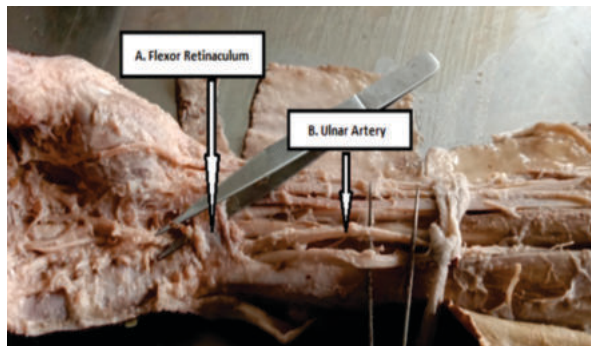
### INTRODUCTION

Axillary artery, is continued as brachial artery after passing from the lower border of Teres major muscle. Brachial artery is divided into ulnar and radial artery at the level of cubital fossa, in front of neck of radius just 1 cm below the flexion crease. The ulnar artery is the larger terminal branch, which descends obliquely and runs deeply in the upper one – third of forearm between Flexor Digitorum Superficialis, Flexor Carpi Ulnaris and Pronator Teres from above, Brachialis and Flexor Digitorum Profundus from below. In the lower two third of forearm, the Ulnar artery descends vertically and comes superficial just below the deep fascia, it runs between Flexor carpi ulnaris (medially) and Flexor Digitorum superficialis (laterally).

It then passes, above the flexor retinaculum at the wrist joint running lateral to the ulnar nerve and pisiform bone. Then, the ulnar artery enters the hand via Guyon's Canal, along with ulnar nerve which lies medially to it. Later, it terminates by giving off superficial and deep branches after entering the palm. The superficial branch of ulnar artery joins with the superficial branch of radial artery, to form superficial palmar arch. Whereas deep branch contributes to the formation of dorsal carpal arch. It supply the medial aspect of forearm and hand<sup>1</sup>.

### Case Report

During routine dissection, in the Department of Anatomy for the undergraduate course, S.N Medical College, Agra, U.P, India. A 60 year old male cadaver, seen to have a bilateral variation of the arterial pattern in both the upperlimbs. The ulnar artery had a normal course until upper one - third of forearm. In the lower two – third of the forearm, ulnar artery descend deeply between FCU (ulnarly) and FDS (radially). In both the upper limb of the cadaver, it was found that the ulnar artery passed underneath the flexor retinaculum, lying laterally to the ulnar nerve and medial to the median nerve (Fig 1 and Fig 2). Ulnar artery entered the palm, and terminated by giving two branches, superficial branch joins with the superficial branch of radial artery to form superficial palmar arch.



**Fig – 1 : Right Hand : A. Ulnar artery B. Flexor retinaculum**

The picture given above is of right hand of a cadaver showing ulnar artery passes underneath the flexor retinaculum



**Fig – 2: Left Hand : A. Ulnar artery B. Flexor retinaculum**

The picture given above is of left hand of a cadaver showing ulnar artery passes underneath the flexor retinaculum

### Embryology Of Upper Limb

#### Day 24 –

Appearance of upper limb bud at ventrolateral aspect of body developing from lateral plate mesoderm, by the expression of HOX gene family. It is covered by ectoderm with core of denser condensed mesenchyme. At tip of limb bud it has Apical Endodermal Ridge (AER), which secretes Fibroblast growth factor 8 (FGF- 8) that helps in stimulation of limb elongation. HOX gene releases Tbx – 5 which is determinant of upper limb identity.

#### Day 26 –

Upper limb bud grows and later paddle shaped hand plate is formed, containing a dispersed capillary network inside the undifferentiated mesenchymal tissues

#### Day 28 –

Dorsal aorta develops the Axial trunk, as soon it reaches the base of limb bud it ramifies into capillaries. Digital rays develops giving rise to primordial digits later forming digits.

#### Day 32 –

The Axial trunk or axis artery is developed into subclavian artery which enters into the limb bud.

#### Day 33 –

After formation of sub clavian into axillary artery, it crosses the neural plate and ramifies into its own capillary network.

#### Day 37 –

The neural plate is divided into anterior and posterior division. Posterior division condensation forms extensor muscles, anterior division condensation form flexor muscles. Mesenchymal tissues of

humerus begins to chondrify, ulna and radius are formed by condensed mesenchymal tissues.

Zeugopod (arm) forms humerus under the influence of HOXD 9 and HOXD 10, Stylopod (forearm) forms radius and ulna by controlling gene HOXD 10, HOXD 11 and HOXD 13, Autopod (hand) forms carpals, metacarpals, digits by controlling gene HOX 13. Positioning of limbs and its patterning along cranio caudal is determined by HOX genes, it also promotes cell growth and differentiation. Forelimb positioning is determined by TBX5 gene. SHH gene leads to differentiation of zeugopod and autopod.

#### Day 41 –

Axillary artery continues as brachial artery until forearm then it ramifies into capillaries along forearm and hand. Mesenchymal condensation of carpal and metacarpal begins.

#### Day 44 –

Humerus, ulna and radius are chondrified. Ulnar, median and interosseous arteries are formed by the brachial artery. Radial artery remains in capillary net. Nerves until the hand is developed.

#### Day 47 – Palmar arch formation starts.

#### Day 52 –

Arterial pattern, skeletal and neural elements achieved definitive morphology. Arterial wall continued to differentiate. Radial artery is completely developed forming palmar arches<sup>2,7</sup>.

#### At Cellular Level –

Vascular cells are of 2 types derived from mural cells, first type is pericyte found in small vessels, and the second type is vascular smooth muscle cells found in large vessels. Mural cells maintain the morphology of the vessels<sup>8</sup>.

#### At Biochemical Level –

Some molecules stimulate the maturation of mural cells for example Fibroblast growth factor (FGF), beta – FGF, TGF – alpha, angiogenin, IL-8, angiopoietins<sup>9</sup>.

#### At Molecular Level –

PDGFB, VEGF, BMP, Notch, Gata families, T-Box, myocardin, semaphorin family are protein molecules which induce a normal and correct embryological development of aortic arch, which later on forms the dorsal aorta which subsequently, give rise to seventh intersegmental arteries and finally the axillary artery<sup>9</sup>.

HOX gene (homeobox genes) are developmental regulators that determine the correct position of a structure in the human body along the antero-posterior axis. Retinoic acid regulates expression of HOX genes<sup>10</sup>.

### DISCUSSION.

#### Hypothesis – 1 :

If the HOXD 13 gene is hindered, it may be responsible for delay in development of muscles, deep fascia of forearm and further hand differentiation, leading to late formation of flexor retinaculum as it's a modification of deep fascia. As we already know that, ulnar artery runs deep in the upper one – third of forearm it may be possible that it continued to descend deeply in the lower two – third of forearm due to delay in the development of flexor retinaculum. Hence, the ulnar artery passes beneath the flexor retinaculum. Retinoic acid and maternal factors play an important role in regulation of HOX gene.

#### Hypothesis – 2 :

On day 44, brachial artery is divided into median, ulnar and interosseous arteries whereas the entire skeletal system is formed by day 52. Ingrowth or involution of limb bud primordial post development of ulnar artery, positioning of ulnar artery may vary.

#### Hypothesis – 3 :

Genetics play an important role in positioning of vessels. If there is a defect in the seventh cervical intersegmental artery it may lead to variation in the initial plexus of capillaries in the limb bud and subsequently, variation in the course of arteries.

Upper limb vascular variation is generally seen to be present, due to either involution or ingrowth of limb bud during embryonic development<sup>11-16</sup>, resulting in defects in the origins or course of upper limb vessels<sup>17</sup>. Upper limb vascular variation ranges from 9 – 18.5%<sup>18</sup>.

According to Waseem Bader, it was found that ulnar artery variation is more common in males than in females<sup>19</sup>.

Understanding the anatomical variation in today's scenario, is the key to minimize the complications. Variation is important to be known, to avoid injury to ulnar artery as it can lead to iatrogenic distal limb ischaemia during various surgical procedures and interventions. Ulnar artery is most commonly injured in carpal tunnel release surgeries, if the ulnar artery lies beneath the flexor retinaculum, the chances of injury are much more higher. So, to avoid complication understanding variation of ulnar artery by the health care workers is of utmost importance.

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