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Branching Pattern of Brachial Artery-A Morphological Study

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Abstract. *Brachial artery is the artery supplying the upper limb. It shows so many variations that later are considered a rule rather than exceptions. The present study was conducted on 50 upper limbs to find out the prevailing branching pattern of this important artery. It was seen that average length of this artery is 26.29 cm & it bifurcates into its terminal branches 2.99 cm distal to intercondylar line. Various variations depicted by brachial artery are explained ontogenically as well as their clinical implications are discussed.*

Key words *: Brachial artery, Superficial brachial artery, radial artery, ulnar artery, Arteria profunda brachii*

Introduction :

The brachial artery, a continuation of the axillary, begins at the distal (inferior) border of the tendon of teres major and ends about a centimeter distal to the elbow joint (at the level of the neck of the radius) by dividing into radial and ulnar arteries. At first it is medial to the humerus, but gradually spirals anterior to it until it lies midway between the humeral epicondyles. Its pulsation can be felt throughout *(Williams et al, 1999). Anson and Maddock (1952)* divide the course of brachial artery in 3 equal parts i.e. proximal 1/3, middle 1/3 and distal 1/3.

According to *Thorek, (1951)*, it lies successively on 3 muscles (from above downwards - long head of triceps, coracobrachialis and brachialis), is in contact with 3 important nerves (Radial, ulnar and median), associated with 3 veins (2 Venae comitans and 1 basilic vein) and gives 3 main branches (profunda, superior et inferior ulnar collaterals).

Branches of the brachial artery : These are as follows :

1. Arteria profunda brachii : It is also known as superior profunda *(Massie, 1944 and Spalteholz)* and deep brachial artery *(Anson, 1966)***.** It arises as a large branch from the posteromedial aspect of the brachial, distal to the teres major, follows the radial nerve closely, at first backwards between the long and medial heads of the triceps, then in the nerve's groove covered by the lateral head of triceps; here it divides into terminal branches. Apart from the muscular branches, it gives off the following branches :

(a) Nutrient artery : This enters the humerus posterior to the deltoid tuberosity.

(b) Deltoid (ascending) branch : Ascending between the lateral and long heads of triceps, it anastomoses with a descending branch of the posterior circumflex humeral artery.

(c) Middle collateral *(posterior descending) branch* : It is the largest terminal branch arising behind the humerus and descending in the medial head of the triceps to the elbow, anastomosing with the interosseous recurrent artery, behind the lateral epicondyle: it often has a small branch which accompanies the nerve to the anconeus.

(d) Radial collateral (anterior descending) : The other terminal branch, this is the artery's continuation. It accompanies the radial nerve through the lateral intermuscular septum, descending between the brachialis and brachioradialis anterior to the lateral epicondyle, anatomosing with the radial recurrent artery *(Williams et al, 1999)*.

(e) Articular branch : is given off from lower portion of the artery to the elbow joint.

(f) Cutaneous branch : accompanies dorsal cutaneous branch of radial nerve *(Huber, 1930)***.**

2. Nutrient artery of the humerus : This arises near the mid-level of the upper arm, and enters the nutrient canal near the attachment of coracobrachialis. *(Williams et al, 1999)***.**

3. Superior ulnar collateral artery : It is also known as inferior profunda *(Huber, 1930; Massie, 1944; Thorek, 1951; Anson and Maddok, 1952 and Spalteholz)***.** It arises a little distal to the upper arm's mid level, often as a branch from the arteria profunda brachii. It accompanies the ulnar nerve, piercing the medial intermuscular septum to descend between the medial epicondyle and

olecranon, ending deep to flexor carpi ulnaris by anastomosing with the posterior ulnar recurrent and inferior collateral arteries; sometimes a branch of it passing anterior to the medial epicondyle anastomoses with the anterior ulnar recurrent artery *(Williams et al, 1999)*.

4. Inferior ulnar collateral (supratrochlear artery) : It is also known as arteria anastomotica magna **(***Massie, 1944; Thorek, 1951 and Spalteholz***).** It begins about 5 cm proximal to the elbow (*Lockhard, 1959; Anson, 1966; Williams et al, 1999*) (4 cm above termination of brachial artery as described by *Huber, 1930*). Then it passes medially between the median nerve and brachialis and, piercing the medial intermuscular septum, curls round the humerus between the triceps and bone, forming, by its junction with the middle collateral branch of arteria profunda brachii, an arch proximal to the olecranon fossa. As it lies on brachialis it has branches descending anterior to the medial epicondyle to anastomose with the anterior ulnar recurrent artery. Behind the epicondyle a branch anastomoses with the superior ulnar collateral and posterior ulnar recurrent arteries. *(Williams et al, 1999)*.

Variations in Brachial Artery :—

Polanskaja (1932) pointed out that the smaller branches of brachial artery, especially those which anastomose around the elbow to form the collateral circulation, have no constant pattern. He further added that he was never able to find the same pattern even on the 2 sides of one body.

Some times brachial artery accompanies median nerve behind the supracondylar process of humerus from which a fibrous arch is most often thrown over the artery. This condition resembles the normal condition in some carnivores *(Huber, 1930; Romans, 1964 and Williams et al, 1999)***.** Occasionally brachial artery is crossed in some part of its course by muscular or tendinous slips derived from coracobrachialis, biceps, brachialis or pronator teres *(Williams et al, 1999)***.**

Hofer and Hofer (1910) described a case in which brachial artery passed between the heads of pronator teres instead of dividing above it but they were unable to find a similar case in literature.

The site of origin of anomalous arteries in the arm are determined with reference to intercondylar line of humerus. The bifurcation of brachial artery proximal to this line is considered a variation *(Karlsson and Niechajev, 1982)***.**

Text books of anatomy make a referece to 'Vas aberrans' in the main brachio antebrachial pattern *(Schafer & Thane, 1892; Huber, 1930; Treves and Rogers, 1947; Testut & Latarjet, 1981; Williams et al, 1999)* that these connect the brachial or the axillary artery with one or the other artery of forearm usually joining the radial *(Williams et al, 1999). Treves and Rogers (1947)* call superficial brachial artery, a common anomaly as a vas aberrans.

The superficial brachial artery arises from axillary artery or from proximal 1/3rd of brachial artery usually between contributions of medial and lateral cords of brachial plexus to median nerve. It is superficial to muscles of the arm under brachial fascia lying slightly more lateral than brachial artery and in the elbow region divides into radial and ulnar arteries *(Anson, 1966)*.

According to *Adachi (1928)* this superficial brchial artery is so called because it runs superficial to median nerve, whereas usually the brachial artery runs deep to median nerve. The superficial brachial artery may replace the main trunk or may be accompanied by equally important, less important or more important trunk running parallel and deep to median nerve in normal position. In these cases superficially placed vessels may continue as radial or more rarely ulnar artery.

Keen (1961) subdivides superficial brachial artery (found in 12.3% dissections) into 3 types :

(a) Those superficial brachial arteries which continue in cubital fossa and bifurcate as usual into radial and ulnar arteries (3.6%).

(b) Superficial brachial artery continues as radial artery and known as 'High origin of radial artery' (5.9%).

(c) Superficial brachial artery continues as ulnar artery and known as 'High origin of ulnar artery' (2.8%).

Both radial and ulnar arteries run a superficial course in forearm in such cases.

Singer (1933), Schwyzer and DeGaris (1935), Lippert and Pabst (1985), Fuss et al (1985) and Golan et al (1994) also consider the high origin of radial artery as a kind of persistent superficial brachial artery whereas *Compta (1991)* and *Icten and Tuncer (1996)* designate these to be separate entities.

Different series have reported varied prevalence of SBA (See Table I).

TABLE I

PREVALENCE OF SUPERFICIAL BRACHIAL ARTERY

Sr. No.	Name of the author	Year	%age
1.	Quains	1844	0.2
2.	Gruber	1848	0.4
3	Poirier	1886	6.0
4.	Muller	1903	1.0
5.	Linell	1921	6.0
6.	DeGaris and Swartley	1928	9.0
7.	Miller	1939	3.0
8.	Treves and Rogers	1947	15.0
9.	McCormack et al	1953	5.75
10.	Skopakoff	1959	19.7
11.	Lanz and Wachsmuth	1959	25.0
12.	Keen	1961	12.3
13.	Fuss et al	1985	17.0
14.	Lippert and Pabst	1985	22.0
15.	Baeza et al	1995	11.9
16.	Kapur et al (b)	2000	5.0
17.	Patnaik et al (Present study)	2002	6.0

Treves and Rogers (1947) described another type of variant i.e. presence of 2 arteries instead of one brachial artery. These 2 arteries may be (a) radial & ulnar, (b) 2nd branch may be interosseous which has originated high up from brachial, the later dividing into radial and ulnar arteries at normal position, (c) the 2 vessels may be normal brachial and a vas aberrans.

Vare and Bansal (1969) reported a similar type of case with high division of brachial artery - the superficial brachial artery giving rise to radial and ulnar artery while deep division continuing in the forearm as interosseous complex and giving a large median artery which in the palm formed superficial palmar arch with ulnar artery.

McCormack et al (1953) encountered a rare entity i.e. accessory brachial artery which arose from brachial artery 21 cm proximal to the intercondylar line. Throughout its course it lay medial to main brachial artery; however midway in the arm it passed deep to median nerve and 4 cm proximal to its termination crossed back over median nerve. It rejoined brachial artery in antecubital fossa 23 cms beyond its origin.

High origin of radial and ulnar artery forms the highest percentage of variations of brachial artery. A high origin radial artery occurring in 14.27% individuals (15% by *Anson, 1966; 7.7% by DeGaris & Swartley, 1928 and 3% by Miller, 1939)*, may arise as high as the axillary artery but most commonly it arises from the proximal one third of the arm (*Mc Cormack et al, 1953)*. In the arm, it lies anterior to median nerve and in the forearm it takes normal course *(Huber, 1930; McCormack et al, 1953 and Anson, 1966)*. Similar views are later expressed by *Karlsson & Niechajev (1982) and Compta (1991)* that a high origin of radial artery is the commonest vascular pattern variation of upper extremity.

Karlsson and Niechajev (1982) in angiographic observations, found high origin of radial artery in 10% patients, the parent trunk being axillary artery in 12.5%, proximal 1/3 of brachial in 62.5% and middle 1/3 of brachial in 25%. They could find high origin of ulnar artery in 1% cases only and compared it with similar reports by *Quains (1844), Jaschtaschinsky (1897), Muller (1903), Dubreuil & Chambardel (1926) and McCormack et al (1953)***.**

McCormack et al (1953) calling the high origin of ulnar artery as superficial ulnar artery points out that it may arise from axillary or brachial artery and usually lies superficial to brachial artery and median nerve. In the forearm it courses across the forearm flexors to medial side of the arm. They found it in 2.26% cases [(3.4% by *Coulouma et al (1934)*, 2.1% by *Gruber (1848)***,** 2% by *Muller (1903)***,** 1.7% by *Quains (1844)***,** 0.8% by *DeGaris and Swartley (1928)***,** 0.7% by *Adachi (1928)* and 0% by *Miller (1939)***].** Similar high origin of ulnar artery is also mentioned but without statistics by *Huber (1930)* and *Romanes (1964)*.

Fadel et al (1996) reported a case of bilateral superficial ulnar artery arising from 2nd part of axillary artery; running a superficial course in the arm; crossing elbow immediately subjacent to median cubital vein and continued in forearm in subcutaneous position. They further compared it with others saying that *Miller (1939)* could not find such anomaly in 480 bodies dissected by him.

The origin of arteria profunda brachii is quite variable. *Charles et al* (1931) specify 7 types of origins for this artery.

Type I : Branch of brachial artery in 54.7% cases (55% by *Anson, 1966*).

Type Ia: Origin of arteria profunda brachii by 2 separate branches (seen in 0.7% dissections).

Type Ib : Origin of arteria profunda brachii by 3 separate branches (seen in 0.3% dissections).

Type II: Arising as a common trunk with superior ulnar collateral in 22.3% cases (22% by *Anson, 1966*).

Type III: Arising at lower border of teres major so can be considered to be arising from axillary or brachial in 8% cases.

Type IV: Branch of 3rd part of axillary artery in 8.7% cases (16.0% by *Anson, 1966*).

Type V: Arising as a common trunk with posterior circumflex humeral in 4% cases (13% by *Keen, 1961* and 7% by *Anson, 1966*). (Former includes 6% before entry of posterior circumflex humeral into quadrangular space and 7% after its entry into quadrangular space).

Type VI: Arising as a common trunk with subscapular and both circumflex humerals from axillary artery in 0.7% cases.

Type VII: Absent arteria profunda brachii in 0.7% cases.

Brachial artery in its upper part may also give rise to subscapular and posterior circumflex humeral, normally branches of the axillary; in its lower part to the radial recurrent and at its bifurcation to the interosseous artery or to median artery which is usually a branch of interosseous artery. *(Huber, 1930)*.

Such a high prevelance of variations in branching pattern of this clinically so important artery was a stimulus to perform this composite study & to find out its branching pattern in the region.

Materials & Methods :

The present study was conducted on 50 upper limbs of 25 cadavers (19 Males & 6 Females) embalmed with an embalming fluid containing lead oxide to colour the arteries red & belonging to the Department of Anatomy, Govt. Medical College, Amritsar. These were labelled from 1-25 with letters R or L corresponding to right or left limbs respectively & letters 'M' or 'F' corresponding to male or female cadaver respectively. Brachial arteries were dissected & traced proximally to the continuity with axillary artery at the level of lower border of teres major. Distally in the cubital fossa the bicipital aponeurosis was divided and the brachial artery was traced upto its bifurcation. The following observations were made and noted :—

(1) Length of the brachial artery :

For measuring its length, the following 2 points were taken :

(a) The mid point of the width of the artery where it begins i.e. at lower border of teres major.

(b) At the point of termination of the artery.

First the distance between lower border of teres major and intercondylar line was measured along the artery (X) and then the distance between intercondylar line and termination of brachial artery was measured (Y). Then the length of the brachial artery was calculated by adding these two (X + Y) (If the brachial artery divided below the intercondylar line) or by subtracting 2nd distance from the Ist (X-Y) (If the brachial artery divided above the intercondylar line). The distance between 2 points was measured using authors' earlier reported work. (*Patnaik et al, 2000*)

(2) Branches of brachial artery :

The sites of origin of all the branches were noted and the distance between proximal point of

main trunk (lower border of teres major) and the origin of the branch was measured.

(3) Relations of the brachial artery specially at cubital fossa were studied.

Lateral head of triceps brachi was divided over the radial groove and arteria profunda brachii and its branches were exposed upto their destination.

TABLE II

VARIATIONS SHOWN BY BRACHIAL ARTERY

Sr. No.	Variation Observed	Limb no.	No. of limbs showing that variations	% age
1.	Superficial brachial artery encountered as			
	(a) Brachial artery crossed superficial to median nerve	17FR	1	2
	(b) Brachial artery in middle one third of arm divided into :- u Superficial branch – crossed median nerve superficially and divided in cubital fossa into radial and ulnar arteries. u Deep branch – passed deep to median nerve and continued in cubital fossa as common interosseous artery.	21MR	1	2
	(c) Axillary artery in third part divided into :- u Superficial branch continued as radial artery. u Deep branch continued as ulnar artery.	24ML	1	2
2.	Origin of profunda :			
	(a) Separate origin of anterior and posterior descending branches*.	12ML 18ML	2	4
	(b) Common trunk for anterior descending branch of profunda and superior ulnar collateral of brachial artery**	12ML	1	2
	(c) Arising from third part of axillary by way of a common trunk with subscapular and circumflex humerals	11MR	1	2
	(d) Arising from deep brachial artery .	24ML	1	2
3.	Origin of superior ulnar collateral			
	(a) Common trunk with anterior descending branch of profunda**.	12ML	1	2
	(b) Arising as a branch of arteria profunda brachii	11ML	1	2
4.	Absence of inferior ulnar collateral.	6MR 21MR	2	4
5.	Trifurcationof brachial artery.	5MR	1	2
	Total	9	12**	24

** Type Ia of Charles et al (1931)*

*** Variations described against Sr. No. 2(b) is reported as 3(a), so counted as one in the total.*

Observations & Discussion :

In 49 limbs, where classical text book description was true, the brachial artery was a continuation of axillary artery at lower border of teres major and bifurcating into radial and ulnar arteries at a mean distance of 2.99 cm (ranging from 1.0 to 4.5 cm) below intercondylar line, its total length being on an average 26.29 cm (ranging from 20.5 to 29.0 cm). In one case (limb no. 24 ML), axillary artery in its third part, 3. cm proximal to lower border of teres major bifurcated into superficial and deep branches which in the forearm continued as radial and ulnar arteries respectively. (*Patnaik et al 2001 b*) Here the distance between the lower border of teres major and intercondylar line was 23.2 cm while distance between point of bifurcation of axillary artey and intercondylar line was 26.2 cm.

In the present study, out of 50 brachial arteries dissected, 9 (18%) arteries showed a total of 11 types of variations in one form or the other (12-15% as reported by *Treves and Rogers, (1947)*. Details of these variations are shown in Table II and discussed in detail vide infra :-

1. Superficial brachial artery :

From Table II, it is evident that in 3 (6%) limbs, superficial brachial artery was encountered though its site and mode of origin was different in all those. Different prevalences of this variation as reported by earlier workers is shown in Table I.

Observations from the present study with respect to superficial brachial artery are in consonence with 4 out of 16 earlier reported works *(Poirier, 1886; Linell, 1921; McCormack et al, 1953; and Kapur et al, 2000)*. The other works show a very wide range from 0.2% to 25% with no concrete reasons firmly assigned. However *Skopakoff (1959)* inferring from his observations of 610 dissetions had included several instances of comparatively small branches of brachial which ran superficial to median nerve and resolved themselves into muscular branches without a downward continuation. This probably explains higher percentage frequency in his series.

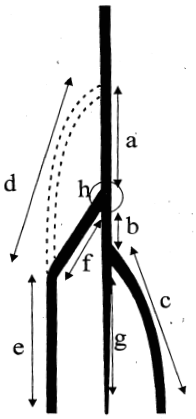
Superficial brachial artery was found in the following limbs :-

(A) Limb No. 17FR – In this limb brachial

Diagram No. 1

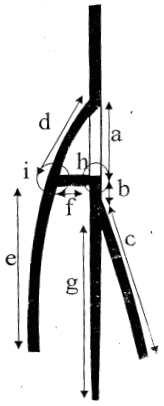
Development of human brachio - ante brachial system

Normal



(a) Part of axial artery which forms brachial artery
(b) Part of axial artery which forms proximal ulnar artery
(c) Trunk of origin of ulnar artery
(d) Part of superficial brachial artery which disappears
(e) Part of superficial brachial artery which forms radial artery
(f) Communicating branch between superficial brachial artery and brachial artery which forms proximal part of radial artery
(g) Terminal part of primitive axial artery
(h) Point of bifurcation of brachial artery

Limb No. 17 FR



(a) Part of axial artery which disappears
(b) Part of axial artery which forms middle part of ulnar artery
(c) Trunk of origin of ulnar artery
(d) Persistent superficial brachial artery
(e) Part of superficial brachial artery which forms radial artery
(f) Communicating branch between superficial brachial artery and brachial artery which forms proximal part of ulnar artery
(g) Terminal part of primitive axial artery
(h) Becomes part of ulnar artery
(i) Point of bifurcation of brachial artery

artery was found crossing superficial to median nerve from medial to lateral side in middle 1/3rd of arm. (Photograph I) It was called superficial brachial artery by *Adachi (1928)* as it runs superficial to median nerve and replaces the main trunk. *Miller (1939)* believed that superficial brachial artery is an atavistic condition, since a main brachial artery crossing superficial to median nerve is said to be the usual arrangement in the primates. However *Singer (1933)* reasoned it out to be a persisting embryonic vessel as follows (see Diagram-1)

During Singer stage V – *(For details of Singer staging see Patnaik et al, 2001 b)* after development of the communicating branch between superficial brachial artery and main brachial artery (f), instead of proximal part of superficial brachial artery (d), it is the proximal part of main brachial artery (a) which disappears, so proximal part of superficial brachial artery (which usually disappears) takes place of brachial artery. The communicating branch (f) which usually forms proximal part of radial artery now forms proximal part of ulnar artery, its middle part being formed by middle part of brachial (b) and terminal part by ulnar artery proper (c). The bifurcation of brachial artery which is usually seen at (h) is now seen at (i).

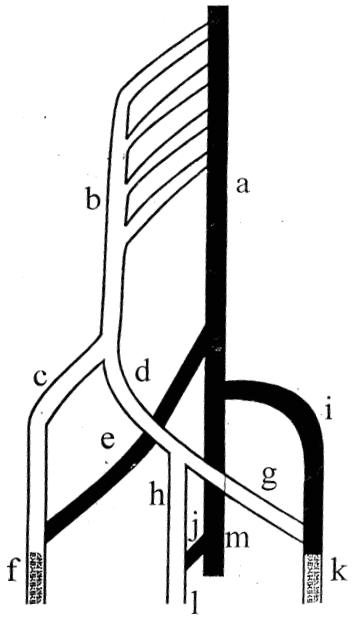
However, *Baeza et al (1995)* further suggest some changes in the understanding of normal formation of upper limb arteries (Diagram - 2).

1. The superficial brachial artery is a consistant embryonic vessel that plays an important role in the normal arterial morphogenesis of the upper limb.

2. The superficial brachial artery has two terminal branches *(Muller, 1903; Vancov, 1961)*; a medial one which is superficial antebrachial artery and lateral one which continues in the forearm as a part of the definitive radial artery.

3. The superficial antebrachial artery (medial brach of superficial brachial) divides into 2 terminal branches - Median and ulnar *(Muller, 1903; Lanz and Wachsmuth, 1959; Vancov, 1961)***.** Each of these branches anastomose with a corresponding branch of primitive axial artery which are trunks in origin of the medial and ulnar artery respectively. Gradually trunks of deep origin attain a haemodynamic

Diagram No. 2
Modification by Baeza et al (1995) in development of human brachio-antebrachial system



(a) Primitive axial artery
(b) Superficial brachial artery
(c) Lateral branch of superficial brachial artery
(d) Medial branch of superficial brachial artery (superficial ante-brachial artery)
(e) Trunk of deep origin of radial artery
(f) Radial artery
(g) Ulnar branch of superficial ante-brachial artery
(h) Median branch of superficial ante-brachial artery
(i) Trunk of deep origin of ulnar artery
(j) Trunk of deep origin of median artery
(k) Ulnar artery
(l) Median artery
(m) Common interosseous artery

predominance and superficial antebrachial artery together with the preanastomotic segment of its terminal branch regresses. Therefore, 2 segments can be distinguished in both the median and ulnar arteries; a proximal or deep one which corresponds to the trunk of origin in the primitive axial artery and another distal or superficial which represents postanastomotic segment of the terminal branch of superficial antebrachial artery.

4. The radial artery usually develops similarly (as median et ulnar artery.) Thus the lateral terminal branch of superficial brachial artery anatomoses with a trunk for the deep origin of the radial artery in the primitive axial artery. Deep haemodynamic

predominance determines regression of those superficial arterial segments located proximal to the anastomosis, while the distal segments persist as a part of the radial artery. This explanation is in line with that given by *Senior (1926) and Singer (1933)*. However, they defined the superficial branch of the anastomosis as the proper superficial brachial artery and not as its lateral terminal branch. This difference may be justified by the fact that once the anastomosis between the turnk for the deep origin of the radial artery and lateral branch of superficial brachial artery is made, the definitive patterns of the median and ulnar arteries have by then, already been established.

So according to *Baeza et al (1995)'s* above modifications (Diagram-2) in development of human brchio-antebrachial system, it was inferred that, in the present case, almost total primitive axial artery, failed to attain the hemodynamic predominance and so it disappeared i.e. the part between origin of superficial brachial artery to proximal segment of trunks of deep origin of radial and ulnar arteries proximal to their anastomosis with lateral and medial branches of superficial brachial artery.

(B) Limb No. 21MR – In this limb the brachial artery in the middle one third of arm divided into two branches, one superficial and other deep to the median nerve. The superficial branch after reaching the cubital fossa divided into radial and ulnar arteries, while deep branch continued as common interosseous artery (Photograph 2). This type of superficial brachial artery is describd by *Keen (1961)* in 3.6% dissections. Similar type is also reported by *Treves and Rogers (1947) and Vare & Bansal (1969)*, but they did not specify prevalence.

The ulnar artery in this case passed superficial to pronator teres and all flexor muscles except palmaris longus and reached the wrist in its normal position.

Schwyzer and DeGaris (1935) also reported 2 cases of superficial brachial artery dividing into radial and ulnar arteries in cubital fossa and then the ulnar artery going superficial to all flexor muscles of forearm in one case and all but palmaris longus in the other; the brachial artery continued in the arm as interosseous complex. One of their 2 cases is same as the specimen no. 21MR i.e. ulnar artery passing superficial to pronator teres and all flexor muscles except palmaris longus. They called this ulnar artery as arteria antebrachii superficialis ulnaris. Further quoting *Muller (1903)*, they have tried to explain this arrangement by radial artery losing its connection with deep channel and ulnar artery droping out the junction which it normally forms with common interosseous (axial) element. An alternative explanation was found in *Senior (1926)'s* work where radial artery is said to be tagged to an already existing superficial brachial artery which later continues as superficial ulnar artery.

Its ontogenic basis can be deduced referring to *Baeza et al (1995) (Diagram 2)* whereby, it is adduced that the trunk of deep origin failed to attain a hemodynamic predominance and superficial antebrachial artery continued to supply ulnar artery while proximal segment of trunk of deep origin of ulnar regressed. On the other hand proximal segment of trunk of deep origin of radial artery also failed to attain haemodynamic predominance, so the lateral branch of superficial brachial artery continued as radial artery. The trunks of deep origin of radial as well as ulnar regressed and disappeared and primitive axial artery continued to supply only interosseous complex.

The clinical significance of this anomaly can be explained, as was aptly put, by *Jurjus et al (1986)*, who reported a similar case calling superficial brachial artery and brachial artery as brchial artery I et II respectively with brachial artery I dividing in cubital fossa into radial and ulnar and II continuing as interosseous complex. They further related the clinical implications of this anomaly to both the presence of two brachial arteries and to superficial position of ulnar and radial arteries. The presence of a large common interosseous provides enough blood supply to the upper limb to prevent any ischaemia in event of occlusion of superficial brachial artery (brachial artery I in their case). The superficial position of ulnar and radial arteries not only makes them more vulnerable to trauma and thus to bleeding but also makes them more accessible to cannulation, if needed. Finally, by being superficial, ulnar artery may be mistaken for

a vein. If certain drugs are injected into this vessel, the results may be disastrous like gangrene or loss of hand.

(C) Limb NO. 24ML – The Variation shown by this limb has been already reported by the authors (*Patnaik et al 2001 b*).

2. Origin of arteria profunda brachii :

Its origin is extremely variable as reported by *Charles et al (1931)***.** They have described 7 types of origin of this artery. In the present study, it was seen arising in the following manner (Table III).

Table III

Sites and Modes of Origin of Arteria Profunda Brachii

Sr. No.	Site of Origin	Mode of Origin	Corresponding type of Charles et al (1931)	No. of limbs	%age
1.	Brachial artery	Directly	Type I	47**	94.00
2.	Brachial artery	Anterior and posterior descending branches of profunda arising separately	Type Ia*	1	2
3.	Brachial artery	Common trunk for profunda and superior ulnar collateral	Type II	1	2
4.	3rd part of axillary artery	Arising as common trunk with subscapular and both circumflex humerals	Type VI	1	2
5.	Total			50	100

** The figure provided by Charles et al (1931) shows type Ia to have the origin of arteria profunda brachii as 2 separate branches without a specific mention as to what those 2 were.*

*** This includes limb No. 24ML in which axillary artery in its 3rd part divided into superficial et deep brachial arteries; later giving of arteria profunda brachii directly.*

From Table III, it is evident that in majority of instances (94%), it was directly arising as a branch of brachial artery *(54.7% by Charles et al, 1931)*. Type Ia, (Photograph 3) II and VI were encountered in 2% dissections each (0.7% 22.3% and 0.7% respectively by *Charles et al, 1931***)**.

Keen (1961) found profunda arising from 3rd part of axillary artery in 26% of dissections in a mixed population of European and negroid specimens but in the present study, it was so only in 2% instances.

3. Origin of superior ulnar collateral :

In 2 of the specimens there was a departure from the usual origin of superior ulnar collateral artery i.e. not arising as a direct branch of brachial artery. In limb no. 11ML, it was an indirect branch as it arose from arteria profunda brachii and in limb no. 12ML, it was a branch of anterior descending branch of arteria profunda brachii.

4. Absence of inferior ulnar collateral artery

It was found to be absent in two limbs (limb No, 6MR and 21MR) out of 50 (4%).

In this context, it is apt to cite *Polanska (1932)'s* statement that ''the smaller branches of brachial artery specially those vessels that anastomose around the elbow to form collateral circulation, have no constant pattern''.

5. *Trifurcation of Brachial artery* - This variation has been already reported by the authors (*Patnaik et al, 2001 a*).

Summary & Conclusion :

On an average, brachial artery was 26.29 cm long and divided into its terminal branches 2.99 cm distal to intercondylar line. This artery showed variations in 26% of instances. These were seen in the form of presence of superficial brachial artery (in 6% limbs), different types of origin of arteria profunda brachii and superior et inferior ulnar collaterals. Only in one instance, brachial artery was trifurcating into radial, ulnar and radial recurrent arteries.

All these variations have been explained on basis of ontogenic stages in development of human brachio - antebrachial system, initially coined by *Singer (1933)* and later modified by *Baeza et al (1995)*. Clinical implications of these variations are also highlighted vide supra.

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Photograph 1

Superficial Brachial arter (SBA) crossing the median nerve (MN) superficially from medial to lateral side.

Photograph 2

Superficial brachial artery (SBA) dividing in cubital forsa into radial (R) ulnar (U) aa. Brachial artery (B) continuing as high origin of common interosseous artery. (C/A)

Photograph 3

Separate Origin of anterior (a) & posterior (P) descending bb of profunda (r-radial nerve; b-brachial artery)

brachial artery into PBA, ulnar and radial arteries (Fig. 1E). Two of the PBAs arose as a very short trunk that immediately bifurcated into two branches, one of which then trifurcated (Fig. 1F).In 6 cases (4.8%) the PBA trifurcated immediately after its origin into three terminal branches (Fig. 2A).Â 10. Patnaik WG, Kalsey G, Singla RK. 2002. Branching pattern of the brachial artery. A morphological study. J Anat Soc India 51: 176-186. 11. Standring S, Johnson D, Ellis H, Collins P. 2005. Morphological study of variation in branching pattern of brachial artery. Int J Basic Appl Med Sci. 2013; 3: 10â€“15.Â Patnaik V, Kalsey G. Singla Rajan K Branching pattern of brachial artery: a morphological study. J Anat Soc India. 2002; 51: 176â€“186. Rosenbaum RB, Ochoa J. Carpal Tunnel Syndrome and Other Disorders of the Median Nerve, 2e, 2 edition. Butterworth-Heinemann, Woburn, MA 2002. Singer E. Embryological pattern persisting in the arteries of the arm. Anat Rec. 1933; 55(4): 406â€“413.