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A Cross Sectional Study Of Superficial Palmar Arch In Human Cadavers In A North Eastern State , India.

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Abstract
Background – *Superficial Palmar Arch Is An Arterial Arcade Principally Formed By Ulnar Artery (UA), Completed On Lateral Side By The Superficial Branch Of Radial Artery(RA) Or Arteria Princeps Pollicis (APP) Or Arteria Radialis Indices (ARI) .Knowledge Of Variation In The Arterial Supply Of Hand Is Essential For Microvascular Surgery For Revascularization , Replantation & Composite Tissue Transfer.*
Objectives*: - To Study The Anatomical Variations Of Superficial Palmar Arch In Terms Of Its Shapes, Branches And Distributions.*
Materials And Methods*: - 50 No. Of Formalin Fixed Adult Cadaveric Hands Without Any External Trauma & Deformity Of Both Sexes Dissected At Department Of Anatomy At Agartala Government Medical College. We Observed For The Variations In The Pattern Of Superficial Palmar Arch On Right & Left Sides. Data Collected & Compared With The Previous Data Of Various Author's.*
Results*: - Out Of 50 Specimens , 41 Nos. Of Specimens Shows 82% Superficial Palmar Arch (SPA) Was Complete Arch & Of Classical Radio-Ulnar Type. Rest 9 Specimens 18% Variations Was Observed Incomplete Arch , Out Of 9 Specimens 5 Specimens Was Incompletely Formed By Ulnar Artery Alone, In One Specimen There Was Presence Of Persistent Median Artery Median Artery With Incomplete SPA, Others 3 Specimens SPA Was Incompletely Formed By Ulnar And Radial Artery. . All The Variations Found Unilaterally.*
Conclusion:*- The Finding Of Our Study Suggest That Majority Of Hands Showed Complete Arch Means That Collateral Circulation Is Present In Majority Of Cases . According To Coleman & Anson Complete Arch 78.5 % & Incomplete Arch 21.5%. In Our Study Complete Arch Is 82% & Incomplete Arch 18%. An Incomplete Type Of SPA Arterial Pattern Are Not Suited For Radial Artery Grafting In CABG , Because There Is No Collateral Circulation From The Ulnar Artery, May Lead To Necrosis & Gangrene Of The Fingers.*
Keywords *: Superficial Palmar Arch(SPA) , Ulnar Artery(UA), Radial Artery(RA), Median Artery(MA).*

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I. INTRODUCTION

Hand has derived its arterial supply, from two anastomotic arches , superficial and deep palmar arches which are formed between two main arteries of forearm i.e. radial, ulnar and their branches, in the palm .

The vascular patterns of the palmar arches and their interconnecting branches present a complex and challenging study . Many attempt have been made to classify these variations.[1]

The superficial palmar arch represents an important anastomosis between the ulnar and radial arteries along with the deep arch.[2]

The skin, superficial fascia, palmar aponeurosis, and thenar and hypothenar fasciae have been removed. The superficial palmar arch, located immediately deep to the fasciae ,is formed by the ulnar artery and completed by the superficial palmar branch of the radial artery.[1]

The superficial palmar arch is an anastomosis fed mainly by the ulnar artery. The latter enters the palm with the ulnar nerve , anterior to the flexor retinaculum and lateral to the pisiform . It passes medial to the hook of hamate , then curves laterally to form an arch that is convex distally and level with a transverse line through the distal border of the fully extended pollicial base . About a third of the superficial palmar arch are formed by the ulnar artery alone , a further third are completed by the arteria radialis indicis , a branch of either arteria princeps pollicis or the median artery. The superficial palmar arch is covered by palmaris brevis and the palmaris aponeurosis and it is superficial to flexor digiti minimi, branches of the median nerve and the long flexor tendons and lumbricals.

Superficial palmar arch(SPA) as a dominant vascular structure supplies a majority of the muscle of the palm of the hand . The main function of the SPA is to provide blood supply to the phalanges , metacarpophalangeal and interphalangeal joint of digit 2-4 and nutrient rami to the phalanges. [3]

Knowledge of the variations in the arterial supply of hand is essential in advent of microvascular surgery for revascularization , replantation and composite tissue transfers. [1]

Recent advance in microsurgical techniques for the reconstruction of hand and upper extremity and the latest choice of radial arterial graft during CABG have necessitated the understanding of vascular pattern in the palm. [4]

AIM AND OBJECTIVES

AIM :- To study the anatomical variations of superficial palmar arch of hand in human cadaver.

OBJECTIVES :- To study the anatomical variations of superficial palmar arch in terms of its shape, branches and distributions.

II. MATERIALS AND METHODS

A total of 25 cadavers(50 adult cadaveric hands) including male & female cadavers were fixed in 10% formalin solution .All specimens were dissected as per Cunningham's manual of practical anatomy during routine curriculum dissection classes during 2 Calender years duration(December 2020 to November 2022) in the Anatomy department of Agartala Government Medical College(A.G.M.C) ,Agartala ,Tripura. The upper limbs were devoid of any injury or deformity . The limbs were dissected from the level of the wrist joint on the palmar aspect till the web spaces, superficial branches of radial and ulnar arteries were identified and the branching pattern and course were traced. The morphology of SPA was studied and variations were noted. Observation were than tabulated according to Coleman and Anson[1] and Adachi [5] classification of SPA .This is a cross sectional descriptive study done after Institutional ethical committee permission.

Conflict of interest :- There was no conflict of interest or financial relationship to disclose.

III. RESULTS AND OBSERVATION

In our present study total of 50 cadaveric hands (adult cadaveric hands) embalmed with formaldehyde including male and female cadavers. All specimens were dissected during routine curriculum dissection classes in the Anatomy department of Agartala Government Medical College , agartala, Tripura, North east India. Any external trauma or pathology was absent among the chosen specimens. Palmar arches in them were dissected following classic incisions and dissection procedures of Cunningham's Manual of Practical Anatomy ,Volume -I and observations were then tabulated according to Adachi and Coleman and Anson classification of SPA .

Out of 50 specimens , variations were observed in 9 specimens present unilaterally. Out of 9 specimens in 5 specimens(male and female) SPA was formed alone by Ulnar Artery (Fig. 2) and incomplete SPA, others 3 specimens(male and female) SPA was incomplete formed by superficial palmar branches of Ulnar and Radial Artery(Fig .3) , in one specimen (female) there was presence of persistent median artery (Fig. 4) with incomplete arch. These variations were observed during the routine dissection classes .

In rest 41 specimens SPA was complete (Fig.1) , SPA was formed by ulnar artery completed on lateral side by the superficial branch of Radial artery (SPBRA) or Arteria Princeps Pollicis (APP) or Arteria Radialis Indices(ARI).

DUMMY TABLE -1
Present study

NO OF LIMBS (SPA)/ SAMPLE SIZE	NORMAL	VARIATIONS
50 Specimens	41 Specimens	9 Specimens

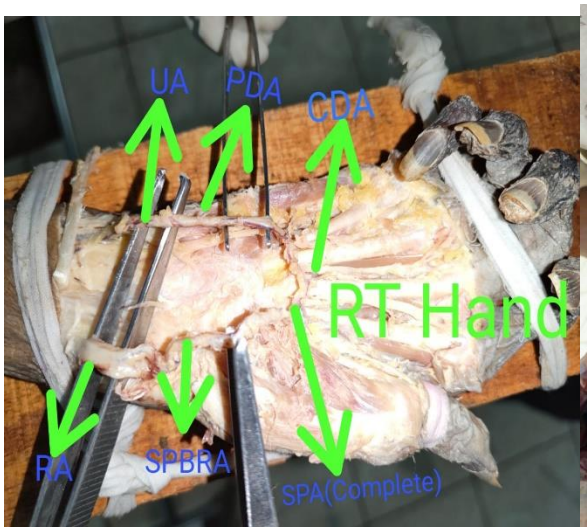

Fig . 1 : Showing Superficial palmar arch(SPA) was complete, formed by Ulnar Artery(UA) and Completed on lateral side by the superficial branch of Radial Artery(SPBRA) .
This is a complete (Group -I) SPA and Radio – Ulnar type SPA.

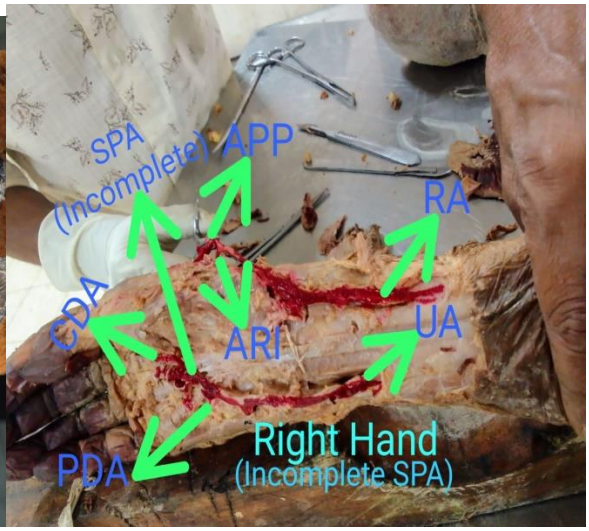

Fig . 2 : Right hand showing Incomplete superficial palmar arch(SPA) formed by Ulnar artery alone. this is Incomplete (Group - II) and Ulnar Type SPA.

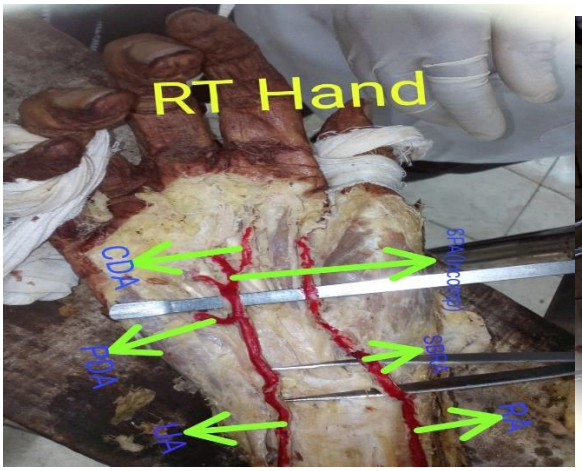

Fig.3 : Right hand showing superficial palmar Arch (SPA) formed by RA and UA . This was Incomplete(Group- II) and Ulnar Type SPA.

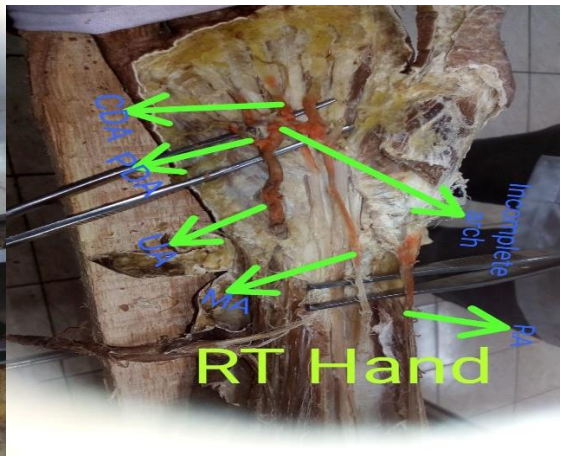

Fig.4 : Right hand showing superficial palmar arch(SPA) form between Ulnar Artery(UA) and Median Artery(MA).This Is Mediano ulnar Type of SPA.

Most common variation encountered was SPA formed by UA (Fig. 2).The UA entered the palm superficial to flexor retinaculum. At the distal border , it gave a deep branch and continued as SPA supplying palmar aspect of all the fingers . It gave a proper digital branch to medial side of little finger, three common digital branches to the medial four fingers by dividing into two digital branches. In one specimen (Fig.10.) there was only two common digital artery supply lateral side of little finger , both sides of ring finger and medial side of middle finger . Then it further continued to 1st web space and gave one more common digital artery which supplied the radial side of index finger and ulnar side of the thumb. The digital artery (branches of radial artery) thus divides into Arteria Princeps Pollicis (APP) and Arteria Radialis Indices (ARI) .The superficial branch of radial artery was small and terminated by nourishing the thenar muscles. The communication between the RA and UA was by completion of deep palmar arch through deep branch of UA, which maintains the collateral circulation of hand.

In three specimens (Male and Female hands) we found incomplete SPA in hand formed by superficial branches of RA and UA (Fig. 3). The superficial branches of UA and RA independently supplies the palm . UA entered the palm superficial to flexor retinaculum and its superficial branch gave off one proper digital

branch to the ulnar side of little finger and three common digital branches to supply adjacent sides of little , ring , middle and index fingers.

The superficial branch of radial artery entered the hand superficial to thenar muscles and then gave off one proper digital branch to the radial side of the thumb and one common digital branch to supply the ulnar side of thumb (APP) and radial side of index finger (ARI) .

On the right side in both cadavers SPA was complete as the traditional continuity between the superficial branches of UA and RA was maintained .

In one female cadaveric hand we found in right hand persistent Median artery participating in formation of SPA with UA (Fig .4) .UA entering the palm superficial to flexor retinaculum and gave off one proper digital branch to the ulnar side of the little finger, two common digital branches to supply the adjacent sides of index, middle, ring and little fingers.

In the same cadaver on left side SPA was formed by UA and completed on lateral side by the superficial palmar branch of radial artery (SBRA) .

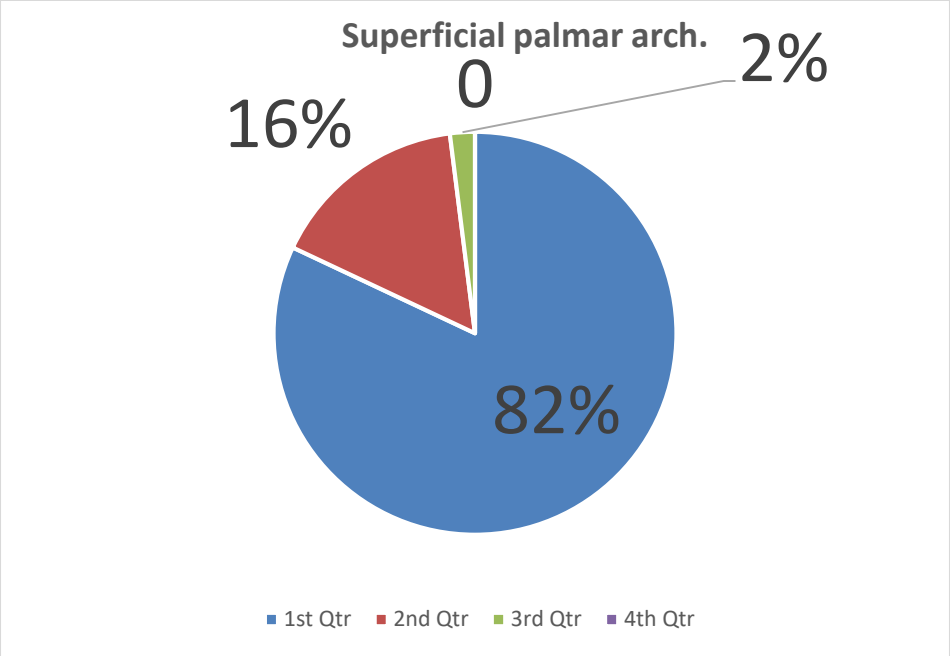

FIG.5 : This pie chart showing SPA as per Adachi 1928 classification , in which 1st Qtr indicate Radio –Ulnar type 82%, 2nd Qtr indicate Ulnar type 16% and 3rd Qtr indicate Mediano Ulnar type 2% in my study .

IV. DISCUSSION

The high rate of variations of the superficial palmar arch makes it an interesting area of study . A key guide to understanding the anatomy of the arterial distribution of the SPA is the classification into complete and incomplete arches. An arch is said to be complete , if an anastomosis is found between the vessels contributing to it . An incomplete arch has an absence of a communication or anastomosis between the vessels constituting the arch. This classification is currently in use and provides the simplest understanding of the anatomic distribution of the arches . [4]

Following this study we found total 41(82%) complete SPA and 9(18%) Incomplete SPA out of 50 specimens.

In present study in 41 specimens we found classical radio- ulnar arch belonging to complete palmar arch.

Out of 9 hands SPA variations in 5 hands, SPA found to be formed by UA alone and incomplete type.

In 3 specimens we found RA and UA independently supplying the palm belonging to variety of Incomplete palmar arch of Coleman and Anson's classification.

In one specimen we observed in right hand arch formed by ulnar artery with median artery , belonging to the variety of Incomplete palmar arch .

Silvia Regina Arruda de Maraes et al [6] found that ulnar type 23.34% ,Radio ulnar type 63.33% and Mediano ulnar type 13.33%.

Sheetal B Joshi et al [7] found that Ulnar type 66% ,Radio ulnar type 30%, Mediano ulnar type 4% .

In our study most commonly found pattern of SPA is complete Radio- ulnar 82% cases, Ulnar type 16% , Mediano ulnar type 2% .

Based on the study of Adachi [5] we found 8 ulnar types, 41 Radio- ulnar types, and 1 Mediano – ulnar type .

Presence of mediano – ulnar arch has been reported by many authors.

Coleman and Anson [1] reported incidence of PMA is 9.9% & Rodriguez – Niedenfuhr et al [8] reported 12%.

Ikeda et al 1988 [9] conducted a study on 220 hands & found mediano- ulnar type SPA in 0.9% subjects.

Patnaik et al [10] in their study found the following results. SPA was found to be single in 94% limbs (complete in 78 % , incomplete in 16%) .In 6% of specimens , double SPA was observed with proximal complete (radioulnar arch in 4% & medianoulnar arch in 2%) & distal incomplete types .

Singh et al in their study observed complete SPA in 92 % of specimens and incomplete type of SPA in remaining 8% of specimens . [11]

In my study Complete Arch SPA 82% and Incomplete type 18% as per Coleman and Anson classification.

In my study Ulnar Type - 16% ,Radio ulnar Type – 82% , Mediano - ulnar Type – 2% as per Adachi classification.

TABLE NO -2 .

Compares the Findings of Our Present Study with that of Previous Research Workers based on Coleman and Anson [1] classification 1961.

Name of the Author(s)	Complete arch Percentage Group-l	Incomplete arch Percentage. Group -ll
Coleman and Anson [**1]**	78.50%	21.50%
S. Singh [**11]**	92%	8%
Ikeda et al [9]	96.4%	3.6%
Patnaik et al **[10]**	78%	16%
Present study	82%	18%

TABLE NO- 3

Comparative study of SPA based on the study of Adachi(1928) [5]

SL no	SPA Types	Adachi [5]	Silvia [6]	Sheetal [7]	Present study
1	Ulnar type	59 %	23.34%	66%	16%
2	Radio – ulnar type	32%	63.33%	30%	82%
3	Mediano -ulnar	9%	13.33%	4%	2%

Soubhagya R Nayak et al [8] conducted a study on 84 upper limbs of embalmed human cadavers & found Persistent Median Artery(PMA) in 15.4%.Out of this 3.5%showed Incomplete SPA with PMA .

Ruengsakulrach et al [12] reported presence of PMA in 6% out of 50 cadaveric hands. One MA terminated at the wrist and one anastomosed with SPA. The 3rd MA terminated by giving off branches to index finger and thumb at the palmar side without anastomosing with UA or RA . Also found complete SPA in 66% & incomplete SPA in 34% subjects.

If the superficial palmar arch is complete , it appears safe to sacrifice the radial artery cannulation , radial artery forearm flap , and harvesting of radial artery to serve as bypass conduit in coronary artery disease . However , the decision to remove radial artery depends on factors like the type of complete SPA, the calibre of anastomosing vessels and their functionality , concomitant ulnar artery pathology etc .

The functionality of anastomoses can be assessed by performing angiography prior to surgical interventions .

Incomplete type for arterial pattern are not suited for radial artery grafting in cases of CABG, because there is no collateral circulation from the ulnar artery, which may lead to necrosis and gangrene of the fingers.

V. CONCLUSION

The present study observation shows that the usual and unusual patterns in the vascular architecture of SPA . The formation of superficial palmar arch is highly variable mainly in the radial artery contribution. The absence of the branches of the radial artery as its replacement by other arteries and the size of the arteries involved in the superficial palmar arch formation can cause the variations . This information is crucial in microsurgical procedure of hand and harversting the radial artery for coronary artery bypass graft . The awearness about such variations may help to prevent the possible complications in medical emergency . There variations can be detected by modified Allen's test [13], Doppler ultrasonography , pulse oximetry and arterial angiography before surgical interventions. The knowledge about variations in the SPA is essential to detect the collateral circulation in cases of arterial obstruction.

The radial artery is being frequently manipulated for several procedures. It is one of the common sites for introducing catheter for arterial pressure monitering , to create arterio - venous fistula and for elevating radial artery forearm flap. Hence, any variation in the collateral blood flow between the ulnar and radial arteries becomes surgically significant. [14]

Our study gives the necessary information to understand the vascular architecture and its common and rare variations in the hand .

The finding of our study suggest that majority of hand showed complete arch which implies that collateral circulation is present in majority of cases. This would result in least number of complications considering RA harvesting for coronary bypass graft .

Superficial palmar arch plays a principal role in microsurgeries following crush injuries of hand. It maintains the collateral circulation in case of obstruction of any of the arteries in hand. The plastic surgeons should be aware of these variations before attempting surgical procedure like vascular repair , graft application.

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