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Original Research Article

Radial Artery - Caliber and Course Cardiologist's Perspective

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ABSTRACT

Background – Knowledge of radial artery anomalies and caliber is of importance for interventional cardiologists to plan their therapeutic procedures.
Materials & methods -To conduct a descriptive study on radial artery, in relation to level of origin, length and diameter at origin, midway point, wrist and anatomical snuff box.
Results – Average values- Right - distance of bifurcation below the line joining the two epicondyles of humerus-3.31±1.04cms, length -74±1.91cms, diameter at origin - 2.19±0.55mms, midway- 1.98±0.53mms, wrist-1.96±0.58mms, anatomical snuff box- 1.83±0.62mms with one anomalous high origin. Left - bifurcation- 2.88±1.13cms below, length- 22.69±2.02cms, diameter at origin-2.17±0.73mms, midway-1.99±0.83mms, wrist-1.99±0.82mms, anatomical snuff box -1.87±0.75mms.
Conclusion – There were significant differences with regard to diameter on right side at origin and anatomical snuff box and also in ethnicity.
Keywords- radial artery, bifurcation, transradial catheterization, diameter

INTRODUCTION

The radial artery is the most preferred method for transarterial catheterization procedures on the heart. Campeau [1] pioneered the transradial approach for coronary angiography in 1989, and Kiemeney [2] for coronary interventions. The radial artery arises as a terminal branch of brachial artery at the level of the neck of the radius. It then traverses the forearm on the radial side and reaches the anatomical snuff box on the dorsum of hand, where it passes between the first interossei muscle to enter the palm. The percutaneous coronary procedures, when done in radial artery, will be accessed at the wrist. During catheterization, it may not be as easy as it seems sometimes. The artery may be coiled or may have some congenital anomalies, which may hinder the smooth transit of the catheter. The diameter of the artery varies throughout its course, making the selection of the size of the catheter, an important factor in the successful manoeuvring of the catheter. T.S. Lo et.al, has reported an incidence of 13.8% in radial anomalies. According to him, high-bifurcating radial origin, full radial loop and tortuous radial artery are some of the anomalies that caused failure of procedures via radial artery.

OBJECTIVES

1. To ascertain the level of origin of radial artery, either above or below the line joining the epicondyles of humerus
2. To measure the exact level of origin in cms from the joining the epicondyles of humerus
3. To record the length of radial artery from its origin to the lower end of radius
4. To measure the diameter of radial artery at origin, midway in forearm, at wrist and in anatomical snuff box

MATERIALS AND METHODS

Source of Data

The descriptive study on radial artery was done on a total of 66 upper limbs (all of them satisfying the inclusion and exclusion criteria given below), out of which 33 were right and the other 33 were left limbs.

Inclusion Criteria

The upper limbs that were having an intact Axillary artery, brachial artery, Radial artery, ulnar artery and superficial palmar arch were alone taken for consideration.

Exclusion Criteria

The upper limbs with any discontinuity in the course of the above said arteries.

Statistical Analysis

Statistical analysis was done by unpaired t test, comparing the various results within the study. Analysis was done on values between the diameters at different levels, namely, at origin, midway, wrist and anatomical snuff box. The length and diameters of radial artery, on right and left sides were also subject to analysis, along with results from other studies.

TECHNIQUE

The limbs were meticulously dissected to trace the course of the radial artery from its origin from brachial artery to the anatomical snuff box. The branches of radial artery were also dissected and the anomalous branches were looked for. The level of origin, that is, either above or below the line joining the two epicondyles of humerus was recorded along with the distance from the same line. The whole length of radial artery was also measured from its origin to the lower end of radius. The diameters of radial artery at various levels, namely, at origin, at midlevel in its course in forearm, at wrist and at anatomical snuff box on the dorsum of the hand were measured using a Vernier caliper. The necessary statistical analysis has been done.

RESULTS

The results of the current study have been documented as Table 1 for right limbs and Table 2 for left limbs.

Table – 1. RESULTS ON RIGHT LIMBS

RIGHT						
S.NO	LEVEL 0F 0RIGIN –cms	LENGTH - cms	DIAMETER ORIGIN – mms	DIAMETER MIDWAY – mms	DIAMETER WRIST- mms	DIAMETER-ANAT SNUFF BOX – mms
1	6.3	23	1.5	1.5	1.5	1.27
2	3.5	23.5	1.7	1.8	1.05	1.12
3	4	24.5	1.86	1.2	1.2	1.25
4	1.7	23.5	1.85	1.56	1.57	1.82
5	3	22	2.25	2.15	2.28	2.2
6	3.8	21	2.2	1.82	1.98	1.99
7	3.4	21	1.32	0.8	0.75	0.6
8	2	24	2.5	2.2	2.3	2.22
9	2.3	23.4	1.8	1.95	1.75	1.44
10	1.5	19	2.3	2.2	1.8	1.5
11	1.7	24	1.7	1.5	1.56	1.9
12	3.5	21	2.61	2.13	2.35	2.18
13	3.7	21.2	2.1	1.78	2.4	1.78
14	4.2	21	2.76	2.6	2.6	2.5
15	4	22	1.76	1.35	1.8	1.9
16	2.2	23.3	2.4	1.9	1.8	1.38
17	2.1	21.5	2.54	1.9	1.9	1.1
18	3.5	21.4	2.2	1.77	1.84	1.64
19	4	21	1.9	1.64	1.17	0.92
20	3.5	26	2.94	2.27	2.36	1.73
21	3.5	21	1.55	1.46	2.1	2.4
22	3	20.2	1.05	1.5	0.9	0.8
23	4.3	28	2.18	2.27	2.3	2.13
24	4.5	25	3.31	2.67	2.9	2.9
25	4.8	23.2	2.8	2.7	2.6	2.6
26	3.8	24.5	2.47	2.44	2.47	2.9
27	3.4	21.3	2.7	2.7	2.69	2.2
28	1.8	23	1.87	1.78	1.8	1.78
29	2.8	26	2.96	2.66	2.92	2.9
30	3	22.2	2.65	2.82	1.98	1.8
31	3.2	23	1.5	1.4	1.4	1.3
32	4	23	3	3	2.78	2.65
33	15 - ABOVE	38	1.85	1.8	1.8	1.6

Table – 2. RESULTS ON LEFT LIMBS

LEFT						
S.NO	LEVEL 0F 0RIGIN –cms	LENGTH - cms	DIAMETER ORIGIN – mms	DIAMETER MIDWAY – mms	DIAMETER WRIST- mms	DIAMETER-ANAT SNUFF BOX – mms
1	2	23	1.59	1.11	1.39	1.2
2	4	22.3	0.92	0.7	0.86	1.06
3	0.5	23	1.52	0.88	0.99	0.68
4	2.5	25	2	1.95	1.14	1.2
5	2.6	25	2	1.95	1.14	1.2
6	2.8	22.8	1.06	1.08	0.94	1.13
7	4	20.5	1.98	1.89	1.91	1.79
8	3.8	20.4	1.84	1.69	1.6	1.54
9	3.5	24	1.43	0.94	1.06	1.31
10	3.5	21.2	1.54	1.6	1.5	1.08
11	4.5	21	1.16	0.94	0.96	0.91
12	3.2	21	1.4	1.45	1.61	1.62
13	3.3	21.4	1.43	0.85	0.67	0.8
14	3	22.4	2.71	1.78	1.93	1.38
15	2.8	19.4	1.24	1.02	1.34	0.99
16	3	26	2.24	2.02	2.4	2.12
17	4.5	20	2.12	1.78	2.1	2.1
18	0.5	22	2.5	2.5	2.37	2.3
19	2	27	3.2	2.9	2.9	2.4
20	2	25	2.6	2.2	2.2	2.1
21	2.2	19	1.46	1.4	1.5	1.5
22	2.5	24.4	3.4	3.4	3.4	3.2
23	2.5	23	3.03	3.1	3.1	2.7
24	5.8	22	3.08	3.11	3.1	3.08
25	2	24	2.43	2.45	2.71	2.52
26	3.5	23.8	2.89	2.44	2.74	2.29
27	2	25	2.39	2.58	2.58	2.4
28	2	20.5	3.1	3.08	3.05	2.8
29	1.8	26	2.05	2.29	2.3	2.58
30	4.8	22	3.44	4.1	3.58	3.4
31	2.2	21.2	3.2	2.4	2.7	2.5
32	3	22	2.4	2.12	2	2
33	2.9	23.5	2.45	2.12	2	1.9

On subjecting the above results to unpaired t test, there was not a significant difference between right and left sides. On analyzing by unpaired t test, the two-tailed p value was 0.0168, when done on the diameter of right radial artery at origin and at the anatomical snuff box, making the value highly significant. On comparing the radial artery mean diameter (Indian) with other non-Indian diameters, there is a difference which is very significant, as p value is 0.0001 in unpaired t test.

DISCUSSSION

Anomalous radial artery anatomy is relatively common and is a significant cause of procedural failure. [3] Within each specific anomalous pattern there is a differential procedural failure rate. This has implications for clinical practice and suggests a need for imaging of the radial artery after sheath insertion. Transradial procedures, though are commonly done, have a considerable failure rate (1%-5%) [4] in the presence of any significant anomalies. According to Zvonimiret al, [5] the incidence of anatomic variations in radial artery was 8.8%, when the tortuosities of radial artery was included, the incidence of failure shot up to12.7%. The most frequent anatomic variation was the higher origin of radial artery (5.1%), and radioulnar loops (2%) of cases. Regression analysis in the above study revealed that, age ($p<0.001$), female sex ($p=0.015$) and high origin ($p=0.034$) contributed to the development of tortuosity.

The radial artery is one the bifurcating terminal branches of the brachial artery. The intercondylar line of the humerus is taken as the referral site. The origin of the radial artery above this line is considered as a high bifurcation. The site of origin can be considered as first degree, when present within the lower one-third of the humerus, second degree, when present within the middle third of the humerus and third degree, when seen within the upper third of the humerus. Keeping in concurrence with the study done by Zvonimiret al, [5] this study too found a high

origin of radial artery, 15 cms above the line joining the two epicondyles of humerus. This variation was seen in a right arm and is of the third degree type of origin. Other than the high bifurcation of brachial artery, no other anomalies were seen. This records a percentage of 1.5% only as opposed to the 5.1% reported by Zvonimir et.al, [5] 2.4% by RoubinGS et.al [6] and 8.3% by Yang EH et al. [7] Rajani Singh et.al, [5] have described an anomalous bifurcation of medial radial artery and a lateral ulnar artery and at the level of the medial epicondyle, wherein the radial artery crossed to the lateral side and descended superficial and tortuous on the flexor muscles.

Many other anomalies of radial artery have been documented. The listing goes as follows: [6,7] Anomalous upper branching of radial artery - 3.2%, tortuous radial artery -4.2%, stenosis- 1.7%, hypoplasia of radial artery - 7.7%, retroesophageal subclavian artery course - 0.4% Marinos et.al, [9] has opined that radial artery loop is not a contraindication for transradial catheterization as >40% chances are there to overcome the loop and <15% chances are there to find a bilateral artery loop. In the same way, many of these anomalies can be overcome in experienced hands as the success rate of cardiac trans radial catheterization is as high as 83% to 96.7%, even in the presence of minor anatomic variations. But the awareness is of importance to overcome such anomalies. The one major problem, which can be named as even a contraindication is the lusoriasubclavian artery, where the success rate of procedures comes down as low as 60%. [10]

Apart from the anomalies of radial artery, the dimensions of the artery at various levels were also taken up in this study. On the right upper limb, the average distance of bifurcation below the line joining the two epicondyles of humerus was 3.31±1.04cms. The average length of the radial artery was 22.74±1.91cms. The average diameter at origin was 2.19±0.55mms, at midway length was 1.98±0.53mms, at wrist was 1.96±0.58mms and at the anatomical snuff box was 1.83±0.62mms. There was a single anomalous high origin, which was at 15cms above the lining joining the epicondyles of the humerus. On the left side, the bifurcation was 2.88±1.13cms below the epicondyle line, showing a slight degree of higher bifurcation as compared to the right. The average length of radial artery on the left side is 22.69±2.02cms. The diameter on an average at origin was 2.17±0.73mms, at midway distance from origin was 1.99±0.83mms, at wrist was 1.99±0.82mms and at the anatomical snuff box was 1.87±0.75mms.

On analyzing the different aspects of the study, the origin of radial artery on the left side was 2.88±1.13cms below the epicondyle line, showing a slight degree of higher bifurcation as compared to the right. In the same way, the diameter of radial artery on right and left sides were more or less the same at the different given levels, namely, origin, midway, wrist and the anatomical snuff box. But there was a significant difference when the diameter was compared on the same side at the origin and at the anatomical snuff box, that is, the proximal and the distal ends of the artery. This finding is of utmost importance as the right radial artery is the most preferred and commonly used for interventional procedures. On the other hand, the same was not true on the left, as the diameters were not statistically significant at origin and the anatomical snuff box. These findings should be taken into consideration when a transradial cardiac catheterization is considered. There are studies confirming that ultrasound examination prior to the procedure may be a useful tool to understand the anatomic variations in radial artery. [11]

The average radial artery diameter was 2.60±0.41 mm by two-dimensional ultrasound, as reported by Byung-SuYoo et.al. [12] On comparing this with our study, which is of Indian origin, there was a significant difference between the two

values. This is again of importance as the radial artery diameter may vary in different ethnic groups. This requires more analysis and study in different ethnic groups to confirm and authenticate further.

CONCLUSION

This study has stressed the importance of knowing the diameters of radial artery at various levels especially at wrist and anatomical snuff box levels which are important access sites for coronary interventions. This study has also emphasised significant differences in radial artery dimensions in south Indian population which is important in choosing correct catheter size. Prior knowledge of anatomical variations in radial arteries is also very important for safe access and smooth conduct of interventional procedures.

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