Original article:

A Descriptive Comparison of Diameter of Radial and Ulnar Arteries Using Doppler Ultrasonography

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Abstract

Background: Radial artery is becoming the commonest artery after femoral artery used for cardiac procedures. The anatomical feasibility, patient comfort along with less chances of atherosclerosis in radial graft make it a preferred artery, but in certain clinical situations as need of second graft, blocked radial artery, difficulty in puncturing radial artery, where we require some other artery for cardiac procedures. Out of several factors the size of artery is the most vital factor for judging the suitability.

Methods: In this study of 117 subjects we measured the smallest internal diameter in each one-third segment of the radial and ulnar arteries at wrist, using L 11-3 probe.

Results: The mean diameter of right and left radial artery was 2.35 ± 0.49 mm and 2.29 ± 0.48 mm respectively (p value= 0.18). The mean diameter of right and left ulnar artery was 2.26 ± 0.44 mm and 2.22 ± 0.43 mm respectively (p value =0.18). On comparison of right Radial to right Ulnar and left Radial to Ulnar arteries diameter no significant difference was found.

Conclusion: The diameter of radial and ulnar arteries were almost equal without any significant difference. Knowing the size will guide the interventional cardiologist in using appropriate size sheaths and guide catheters. Cardiac surgeons can utilize ulnar artery for bypass grafting when it is deemed unsafe to harvest the radial artery.

Keywords: Radial & Ulnar artery diameter

Introduction:

Since the first use of radial artery as an alternative conduit for coronary artery bypass grafting in 1973 by Carpenter and colleagues[(1)] , many more had tried radial artery for cardiac interventions over time [(2,3,4)] . Radial artery is now increasingly being used as an alternative site of access for cardiac catheterization [(5)] . Recently ulnar artery was used as an alternative approach other than radial artery [(6)] . There are many factors which guide us to assess the suitability of any artery for cardiac interventions like diameter of artery, anatomical feasibility, patient comfort , less bleeding complications, chances of atherosclerosis in graft. There is no important nerve close to radial artery and no chances of atherosclerosis in radial graft along with anatomical feasibility, patient comfort and convenience, immediate ambulation, less chances of major bleeding, radial artery is becoming preferred site for cardiac interventions. But there are certain clinical situations like need of second graft, blocked radial artery, difficulty in puncturing radial artery, where we require some other artery for cardiac procedures. Rodriguez and Colleagues reported that radial arteries < 2mm and those with diffuse calcification or a negative Allen's test should be abandoned for coronary artery bypass grafting [(7)] . Size matching of conduits to native coronary artery vessels is also important as it can affect the long term

patency [8] . On the basis of anatomical studies, the ulnar artery has been considered the bigger artery of the forearm and hand [9] . However, in several studies the radial artery has been shown to have greater blood flow than the ulnar artery , but no difference in anatomical dimensions have been found at the wrist [10] . Because of conflicting findings in previous investigations, we designed the present study to evaluate the relative diameters of the radial and ulnar arteries at the wrist. Our objectives were to assess and compare the diameter of the radial and ulnar artery among patients reported for echocardiography at SMS Hospital, Jaipur.

Material and Methods:

Study design- hospital based observational, descriptive, comparative study.

Sample size- The Sample size calculated was 100 at 80% study power and 0.05 alpha error to detect the minimum difference in diameter of radial and ulnar arteries of 0.2mm (SD= 0.5 mm). We included 117 subjects for the current study.

Study duration : Between January 2013 to June 2013.

Inclusion criteria : 117 Consequitive eligible adult patients coming for echocardiography examination were included after taking informed consent.

Exclusion criteria:

Patients with harvested radial/ ulnar artery.

Intervention by radial route.

Trauma to upper extremity/ PAD of upper extremity.

Materials and Methods :

After taking written consent before the study, a detailed history, physical examination was done. Pre-existing risk factors for coronary artery disease at the time of echocardiography were recorded as gender, diabetes mellitus, hypertension, smoking, dyslipidemia and obesity. Height, weight, body surface area and body mass index were calculated. Height measurement was taken as; maximum distance from the floor to the highest point on the head when the subject is facing directly ahead in centimeters (cms). Weight was measured by making the patient stand on a weighing machine without shoes; in kilograms (kg). Body mass index (BMI) was measured by; the individual body weight divided by the square of his or her height i.e. mass (kg)/height (m2). Body surface area (BSA) was calculated by Mosteller formula.

Mosteller Formula

$$BSA(m^2) = \{\text{height in cms} \cdot \text{wt. in kg} / 3600\}^{1/2}$$

Radial and ulner arteries of both hands were considered hence there were 234 pairs of both areteris. The smallest internal diameter in each one-third segment of the radial and ulnar arteries was recorded after comparing the size in both; the longitudinal and transverse sections using L 11-3 probe, IE33-Philips.

Statistical Analysisn:

Continuous variables were expressed as mean ± SD and independent t-test was used to analyze the diameter in groups whereas discrete variables was expressed as percentages and analyzed by Chi-Square Test. Multiple logistic regression analysis was done to find out the effect of different variables on diameter of arteries. A p-value < 0.05 was considered as statistically significant. Calculations were performed with Microsoft excel statistical software.

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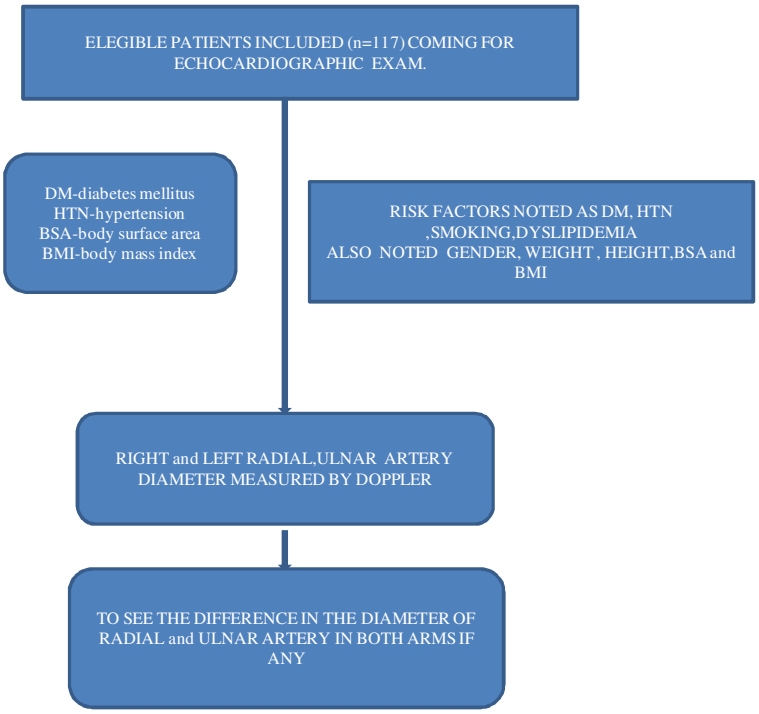
Flow Chart of Study Population



[Table 1: Demographics of 117 study patients]

Variables	No. of Patients	Percentage (%)
Male	96	82.05
Female	21	17.94
Hypertension	45	38.46
Diabetes Mellitus	18	15.38
Smoking	80	68.37
Dyslipidemia	40	34.18

[Table 2: Descriptive statistics of 117 patients]

Variables	Mean	SD	Median	Minimum	Maximum
Age	52.96	12.97	56	18	86
Weight	59.8	10.65	58	38	94
Height	163.1	8.444	163	135	182
BMI	22.38	3.372	22.4	15.8	32.8
BSA	1.636	0.1721	1.62	1.22	2.16

(BMI= Body mass index- kg/m2, BSA= Body surface area per m2.)

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[Table 3: Relative Internal Diameters of Radial and Ulnar Arteries at Wrist]

	Mean	Standard deviation	Median	Minimum	Maximum	Student's t test
Rt. Radial	2.352	0.4909	2.22	1.34	4	**P= 0.158**
Rt. Ulnar	2.265	0.4412	2.22	1.3	3.38	
Lt. Radial	2.291	0.4832	2.2 0	1.3	4.21	**P= 0.237**
Lt. ulnar	2.221	0.4326	2.18	1.28	3.28	

[Table 4: Interquartile range of radial and ulnar artery diameter]

Quartile	Rt. Rad.	Rt. Uln.	Lt. Rad.	Lt. uln.
0 [minimum]	1.34	1.3	1.3	1.28
1st	2.02	2	2	1.96
2nd [median]	2.22	2.22	2.2	2.18
3rd	2.66	2.5	2.54	2.48
4th [maximum]	4	3.8	4.21	3.28

[Table 5: Effects of Different Variables on Mean Radial Artery Diameter]

Variables		No.	Mean	SD	P value
Male		96	2.375	0.475	0.008
Female		21	2.075	0.418	
HTN	Yes	45	2.341	0.4478	0.731
	No	72	2.309	0.4984	
Smoking	Yes	80	2.368	0.4784	0.121
	No	37	2.221	0.4752	
DM	Yes	18	2.035	0.1819	0.005
	No	99	2.373	0.4967	
DYSL	Yes	40	2.29	0.3528	0.610
	No	77	2.338	0.5328	

(HTN=Hypertension, SMO= Smoking, DM= Diabetes Mellitus, DYS= Dyslipidemia)

Result:

The mean diameter of right and left radial artery was 2.35 ± 0.49 mm and 2.29 ± 0.48 mm respectively (p value 0.18). The mean diameter of right and left ulnar artery was 2.26 ± 0.44 mm and 2.22 ± 0.43 mm respectively (p value 0.18). On comparison of right Radial to right Ulnar and left Radial to Ulnar arteries diameter the p values were 0.15 and 0.23 respectively. ANOVA (Analysis of variance) test showed that there is no statistically significant difference in the mean diameter of all four arteries [F statistic = 1.72, (df= 3, 460) p=0.162] . Median, intequartile range for right Radial and left Radial artery were 2.22mm and 2.20 mm respectively. For

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right and left Ulnar arteries the median interquartile range were 2.22 mm versus 2.18 mm mm. The factors found to positively influence the size of radial artery included male sex (p value = 0.008). Diabetes mellitus has negative influence on the size of radial and ulnar arteries (p value = 0.005). There was no effect of hypertension (p value= 0.73), smoking (p value = 0.121), and dyslipidemia (p value= 0.61) on the size of radial and ulnar arteries found in this study. The logistic regression was done to find out the effect of different variables using age, sex, weight, height, BMI, BSA, status of HTN, DM, Dyslypedemia and smoking on the size of arteries and found that female sex has a negative change of 24.3% and DM brings a negative change of 35% on the diameter of radial and ulnar arteries, rest other variables were not significant.

Discussion:

According to Carpentier and colleagues [(1)] there was no risk of ischemia after removing the radial artery because of the many anastomoses from the ulnar artery. Acar and colleagues [(12)] and Dietl and Benoit [(13)] referred to the same anatomical study after which the forearm and hand are mainly vascularized by the ulnar artery and its collateral branches. However, in 1946 Debakey and simeone [(14)] had already reported a three time greater incidence of loss of the hand after the ligation of the radial artery compared with the ligation of the ulnar artery in battle injuries. Furthermore, in 1961 Keen [(15)] reported on the basis of cadaveric dissections that the ulnar artery was larger than the radial artery in the proximal forearm, but that the radial artery had a greater diameter at the wrist level. In 1983, Doscher and colleagues [(16)] found no difference in the diameters in Doppler ultrasound studies. Tonks and colleagues [(17)] dissected the radial and ulnar arteries at the wrist of 11 cadavers and found no difference in the diameters. In the present study the mean diameter of the radial and ulnar arteries in the right and left arm at wrist were 2.35 0.49 vs2.26 0.44 mm and 2.29 0.48 vs 2.22 0.43 mm respectively. In the present study, we found that there was no statistically significant difference in the diameters of radial and ulnar arteries at wrist.

As there is no difference between radial and ulnar artery size in our study and few other studies showing no difference between ulnar and redial procedural outcomes. Radial procedures have been shown to be cost-effective and more comfortable for patients than the femoral, and to result in shorter hospital stays.

The femoral approach has more vascular sequelae than does the radial approach, mainly in patients who need anticoagulants and full antiplatelet therapy. Transulnar cannulation has characteristics similar to those of the transradial approach. Because cardiovascular disease evolves chronically, many patients need more than 1 cardiac catheterization. About 5% will have a vascular occlusion after the transradial procedure,and the radial artery cannot be used thereafter as a bypass graft. The LIMA has proved to be the best vessel for use as a bypass conduit, the second conduit for use in CABG is radial artery. In addition, Kamya and co-authors showed that prior puncture of the radial artery was related to more intimal hyperplasia and reduced early graft patency. In consideration of the chronic nature of cardiovascular disease and of the radial artery's possible use as an alternative bypass graft, we suggest ulnar cannulation as a means of preserving the radial artery for future CABG. The ulnar artery has comparable diameter and fewer α-receptors than the radial artery, this results in a lower risk of

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vasospasm when transulnar access is compared with transradial access, since vasospasm is related to vessel size and is mediated by α-receptors' response to epinephrine.

Conclusion: We conclude that diameter of radial and ulnar arteries were almost equal without any significant difference, hence the diameter of ulnar artery seems to be no obstacle for use of ulnar artery for cardiac interventions. Knowing the size will guide the interventional cardiologist in using appropriate size sheaths and guide catheters. Cardiac surgeons can utilize ulnar artery for bypass grafting when it is deemed unsafe to harvest the radial artery. However further studies are required to assess other factors associated with ulnar artery to find out suitability of use of ulnar artery for cardiac interventions.

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