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Radial versus Ulnar Approach Regarding Vascular Complications and Hand Function after Cardiac Catheterization in Long Term Follow Up

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ABSTRACT

Background: The radial approach is replacing the femoral route as the preferred first-line method for coronary angiography (CA) and percutaneous coronary intervention (PCI).
Aim: to evaluate whether ulnar approach is non-inferior to radial approach as regards feasibility, safety and hand function preservation.
Patients and methods: This cohort study involved 140 patients with CAD who underwent coronary procedures and were divided equally into patients for radial approach (group I) and patients for ulnar approach (group II). Hand function and radial patency were followed up till 6 months.
Results: There was no statistically significant differences or association between both groups, in ulnar group 41 patients (58.6%) had acute coronary syndrome (ACS) and 29 patient had CCS (41.4%), while in radial group 39 patients had ACS (55.7%) and 31 patients had CCS (44.3%), (p=0.73). There was statistically significant difference in hand function in both groups as hand function significantly decreased at 1 day after the procedure in peak and mean then increased nearly to base level at six months in peak and mean.
Conclusion: ulnar approach is non-inferior to radial approach as regards feasibility, safety and hand function preservation.
Keywords: Ulnar Approach; Radial Approach; Cardiac Catheterization; Hand Function.

INTRODUCTION

Seldom is the ulnar artery (UA) used in the primary angiographic technique for cardiac intervention because it runs beneath the forearm tendons and is less perceptible than the radial Artery (RA). Cannulation of the UA therefore has a unique learning curve [1].

Even so, the ulnar access has advantages that may be worth considering. These advantages include the potential to prevent vascular trauma and ensure an intact radial artery for a later coronary artery bypass grafting (CABG); serving as a stand-in access artery for repeat angiographies, thereby minimizing the need for the femoral approach; and avoiding the femoral route and potential hand ischemia in patients with abnormal Allen test results; and providing ipsilateral cross-over access in certain situations following unsuccessful radial cannulation [2,3].

The most frequent side effect of the radial method is radial artery occlusion (RAO), which can occur in 3% to 30% of procedures using 6-F catheters [4]. Patients with abnormal findings from the Allen test had increased thumb capillary lactate, a sign of ischemia, after 30 minutes of radial occlusion. Patients with radial occlusion might occasionally experience symptoms, which can impair arm function. There are currently no data on hand function and strength in patients who have undergone percutaneous coronary procedures yet has persistent radial or ulnar occlusion [5].

Furthermore, it is unclear if short-term or long-term asymptomatic hand ischemia may have an impact on the hand's or fingers' ability to work both temporarily and permanently [6].

Therefore, this study aimed to determine whether the ulnar technique is safer, more feasible, and maintains hand function when compared to the radial approach.

PATIENTS AND METHODS

This is a prospective two center comparative study performed in collaboration of Cardiology Department at Zagazig University Hospital and Mataria Teaching Hospital for 140 patients with CAD who underwent CA and PCI. 70 patients were assigned to Group I, which used the radial method, and 70 patients were assigned to Group II, which used the ulnar approach.

Sample size

As finger print test before procedure 4.6 ±1.0 while after 4.1 ±1.1, at 80% power and 95% CI; the estimated sample were 140 subjects, 70 radial and 70 ulnar (open EPI).

Inclusion criteria

Patients with CAD whether chronic stable angina or in acute coronary syndrome (including unstable angina, NSTEMI and STEMI).

Exclusion criteria

Patients with non-palpable right radial or ulnar arteries, as well as negative or reverse Allen's test results (>10 seconds). Patients having a history of previous coronary artery bypass graft surgery, Raynaud's syndrome, aorto-arteritis, or a forearm vascular fistula for dialysis. The requirement for a big guide catheter. For this analysis, it was regarded a failure outcome if the designated artery could not be cannulated in the first three trials.

Ethical Consideration

Zagazig University Academic and Ethical Committee (IRB#3846/17-6-2017) granted approval

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for the study. Written informed permission was acquired from each participant. This work has been conducted in compliance with the Declaration of Helsinki, the World Medical Association's code of ethics for human subjects' research.

Pre-operative Assessment:

Complete history taking covered history of coronary artery disease, sex, and age. The criteria for dyslipidemia were 220 mg/dl of total cholesterol, 150 mg/dl of triglycerides, 40 mg/dl of high-density lipoprotein (HDL) cholesterol, or the use of an antihyperlipidemic drug at the time of diagnosis [7]**.** Both the use of antihypertensive medication by individuals with a history of hypertension and a systolic/diastolic blood pressure more than 140/90 mmHg were classified as hypertension [8]**.**

If a patient had a history of diabetes mellitus at the time of admission and had used oral anti-hyperglycemic full medicines or any extended-release insulin, their diagnosis of diabetes mellitus was verified as having DM if their laboratory HbA1c was greater than 6.5% at the time of admission [9]**.**

Having smoked more than 100 cigarettes in one's lifetime and keeping up the habit for the past six months was considered a positive smoking history. Conversely, ex-smokers were those who had smoked for at least 100 cigarettes and had abstained from smoking for a minimum of half a year [10]**.** Premature CAD was defined as a family history of fatal or non-fatal cardiac events in men under the age of 55 and women under the age of 60 [11].

Complete clinical examination focused on blood pressure, heart rate, respiration rate, complexion, JVP, and blood pressure. The heart was checked for aberrant murmurs, thrills, pulsations, cardiomegaly, and pulsations. Upon admission, every patient had a 12-lead surface electrocardiogram (ECG). At a paper speed of 25 mm/s and an amplification of 10 mm/mV, the ECG recordings were made. Laboratory investigations including serum urea, creatinine, CK, CK-MB and troponin, ESR, CRP HBsAg, HCVAb and AIDs.

Hand function was done one day before the procedure, one day after and follows up after six months. The hand grip strength was measured with the Jamar Plus dynamometer using the Southampton technique, which is based on guidelines from the American Society of Hand Therapists [12]. In brief, the patient was seated in a chair that had fixed arms. Every measurement has been taken using the same chair. The patient was told to rest their forearms on the armrest of the chair, keep their wrists neutral, and face their thumbs upward, and place their wrists slightly above the end of the chair's arm. Starting with the right hand, the observer encouraged the participant to squeeze as hard and as long as they could. Following that, measurements were taken with the left hand, and then each hand was measured again, switching sides so that a total of three readings were obtained for each side. The three metrics' mean value and highest score were applied.

2-D transthoracic echocardiography was used to determine the EF%. The LVEF was computed from the resting echocardiograms by dividing the end-diastolic volume by the end-systolic volume. Vascular Doppler VD-310 ***(Pioway Medical Lab Equipment Co., Ltd., China)*** was used to measure vascular patency the day before, the day after, and during the six-month follow-up. Multiple projections were used to accomplish right and left coronary angiography, and analysis was completed. The diagnostic criteria for angiographic coronary artery disease included > 50% luminal diameter stenosis of at least one major epicardial coronary artery.

Preparation of patients:

A vital component of patient positioning is an arm board that extends (usually) from the side of the catheterization table and is preferably hinged to allow lateral motion towards and away from the table. The patient was placed on the catheterization table in the usual way, with the right arm extended on the arm board, palm up, and the wrist stretched by placing a roll of gauze below it.

Radial artery puncture:

We used both the anterior puncture and counter puncture procedures in our investigation to gain access to the radial and ulnar arteries.

I. Anterior puncture technique:

The radial artery is punctured 2-3 cm above the styloid process; the site at which the artery is most noticeable using an open 21-gauge needle to create a pulsing blood flow. In a patient who had attempted to get access in the past without success, the second puncture was made one centimeter closer to the initial site. Shorter needles appear to be more preferable than longer ones since the operator cannot observe the "flash" of blood returning. Typically measuring 30 to 50 centimetres, the provided wires frequently feature a floppy tip and a more rigid shaft [13].

II. Counter-puncture technique:

Using a Teflon-sheathed needle, the technique involves puncturing the artery. The needle is advanced through the lumen and punctures the posterior wall once blood appears in the needle hub, indicating the puncture of the anterior wall. The inner stylet is then withdrawn once the needle has stabilised. After a continuous or pulsatile flow is observed, the guidewire is advanced and the needle is carefully removed from the artery lumen [14,15].

- **Ulnar Artery Puncture:**

The radial approach and the ulnar arterial access procedure are comparable. Following the infiltration of nitroglycerin (100µg) and local anesthetic, arterial puncture can be accomplished by palpating the point of maximal pulse prominence (wrist hyperextension frequently accentuates ulnar arterial pulsation). Since the ulnar nerve is situated directly medial to the ulnar artery, arterial puncture should start on the lateral side of the artery to minimize pain and spasm. The best place to puncture the ulnar artery is around 0.5 to 3 cm proximal to the flexor crease skin fold along the axis with the highest arterial pulse. In order to avoid the ulnar nerve, the needle should be inserted at an angle of 45° to 60° along the vessel axis and from lateral to medial.

A hydrophilic guidewire measuring 0.021 inches is threaded through the needle using the Seldinger technique. After removing the needle, the guidewire is covered with a 6 French hydrophilic sheath. Vasodilators, including verapamil and nitroglycerin, and heparin (50–70 IU/kg, up to 5,000 units), are then given intra-arterially. Following this, cardiac catheterization can begin. After the cardiac catheterization is finished, the sheath is taken out, and a compressive device is used to accomplish hemostasis.

I. Distal puncture of the ulnar artery:

It is safe to puncture the ulnar artery more distantly, at the level of skin folds (over the carpal bones), in situations when the ulnar artery pulsations are palpable but weak at the distal wrist. When the ulnar artery is punctured close to the skin folds on the wrist, the chance of a post-procedural hematoma is reduced [(1)].

II. High puncture of the ulnar artery:

As long as the pulsations are detectable, puncturing the ulnar artery can occur up to the mid-forearm, albeit the optimal location is between 0.5 and 3 cm proximal to the pisiform bone. When performing coronary or endovascular operations that call for larger-bore devices, an experienced operator may find this method helpful. To prevent unintentional nerve damage, the operator must be extremely cautious and precise during the puncture because the ulnar nerve and ulnar artery are so near together in that area. Exchanging and upgrading sheaths of different diameters, as well as using specialized sheathless guiding catheters, require extra caution to prevent local bleeding issues from the sized devices [(1)].

Adjunctive Pharmacologic Treatment:

Given the spasm propensity of the ulnar and radial arteries, we employed a spasmolytic cocktail in addition to heparin (50–70 IU/kg, up to 5,000 units). Mixed combinations (2.5 mg of verapamil and 100 mic nitroglycerin) were used.

Vascular access site hemostasis:

Percutaneous intervention was followed by the removal of the arterial access sheath. By using a compressive band (TR band) for either radial or ulnar compression, hemostasis was achieved.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS version 20.0) was used. Quantitative data were expressed as a mean ± SD group, and qualitative data were expressed as a number and percentage. To compare and connect qualitative variables, the chi square test was employed (X^2). The t test and ANOVA test were used to assess differences between quantitative independent groups. P value was set at <0.001 for highly significant results and <0.05 for significant results.

RESULTS

The present study showed no statistically significant differences between both groups regarding their age, body mass index, gender, and smoking **(Table 1)**.

Table 1. Demographic data distribution between studied groups

			Ulnar Group (N=70)	Radial Group (N=70)	*t/ X^2*	*P*
Age (Years)			54.94±8.91	54.82±9.82	0.072	0.943
Body mass index (%)			27.70±3.46	28.14±4.38	1.509	0.138
Sex	Female	**N**	24	22		
		%	34.3%	31.4%		
	Male	**N**	46	48	0.13	0.719
		%	65.7%	68.6%		
Smoking	No	**N**	33	30		
		%	47.1%	42.9%		
	Smoker	**N**	37	40	0.26	0.61
		%	52.9%	57.1%		

Data are presented as mean± standard deviation or as number (%)

There were no statistically significant differences between both groups regarding their risk factors distribution; dyslipidemia, hypertension, diabetes, history of IHD, family history of IHD**.** There were also no statistically significant differences between both groups regarding laboratory results **(Table 2)**.

Table 2. Risk factors and Laboratory distribution between studied groups

			Group		X^2/t	P
			Ulnar Group(N=70)	Radial Group(n=70)		
Hypertension	-VE	N	39	35		
		%	55.7%	50.0%		
	+VE	N	31	35	0.46	0.50
		%	44.3%	50.0%		
Diabetes mellitus	-VE	N	46	46		
		%	65.7%	65.7%		
	+VE	N	24	24	0.0	1.0
		%	34.3%	34.3%		
Dyslipidemia	-VE	N	45	44		
		%	64.3%	62.9%		
	+VE	N	25	26	0.031	0.86
		%	35.7%	37.1%		
History of IHD	-VE	N	45	50		
		%	64.3%	71.4%		
	+VE	N	25	20	0.82	0.37
		%	35.7%	28.6%		
Family history of IHD	-VE	N	52	52		
		%	74.3%	74.3%	0.0	1.0
	+VE	N	18	18		
		%	25.7%	25.7%		
Laboratory test						
Creatinine			1.09±0.24	1.11±0.27	0.463	0.644
ESR			14.42±4.6	13.81±4.04	1.774	0.095
CRP			1.19±0.38	1.13±0.32	0.694	0.489

IHD: ischemic heart disease, ESR: erythrocyte sedemintation rate, CRP: C-reactive protein, Data are presented as mean±standard deviation or as number (%)

There was no statistically significant difference between both groups regarding type of procedure **(Figure 1)**.

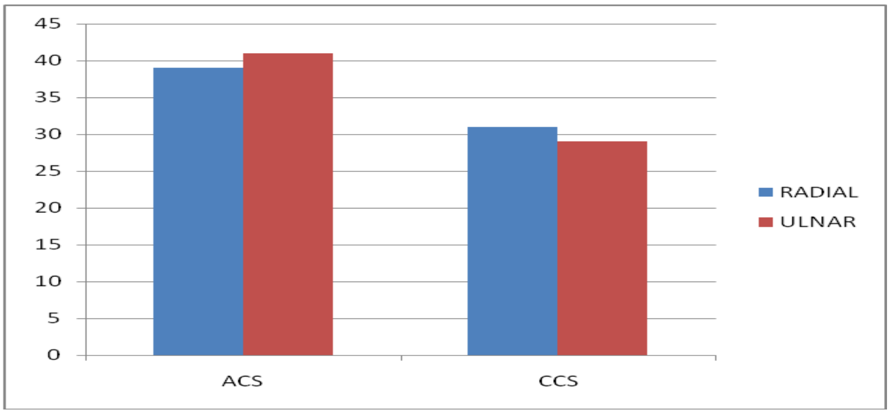

Figure 1. Type of procedure (elective and emergency) distribution among both groups

There was no statistically significant difference between both groups regarding the fluoroscopy time of CA and PCI of the studied groups. The mean fluoroscopy time regarding ulnar group was (4.23 ± 0.95) minutes in CA and (13.84 ± 4.21) minutes in PCI, compared to (4.36 ± 0.897) minutes in CA and (15.2 ± 4.36) minutes in PCI in radial group. However, the procedure time of CA and PCI of the ulnar group was significantly higher than that of the radial group (*p*-value=0.009 and 0.002, respectively). The mean procedure time regarding ulnar group was (26.04± 5.74) minutes in CA and (29.6 ± 7.6) minutes in PCI compared to (22.28 ± 6.33) minutes in CA and (26.01 ± 6.25) minutes in PCI in radial groups. The access time regarding ulnar group was significantly higher than that of the radial group (*p* value=0.009). It was (4.6 ± 0.9) minutes in ulnar and (4.3 ± 1.2) minutes in radial group, while time of compression was (2.81 ± 0.47) in ulnar group and (2.82 ± 0.56) in radial group which is significant (*p*=0.029) **(Table 3)**.

Table 3. Timing distribution between studied groups at different times

	Ulnar Group(N=70)	Radial Group(N=70)	*T*	*P*
Time of Fluoroscopy	10.40±5.37	11.36±3.56	0.950	0.344
Hours of compression	2.81±0.47	2.82±0.56	0.081	0.936
Procedural time	27.98±6.96	24.72±7.28	2.823	0.007*
Access time	5.71±0.93	4.25±1.29	2.318	0.029*

Data are presented as mean± standard deviation, *: Significant

There was no statistically significant difference between both groups regarding all types of complications except spasm, as it was significantly higher in the radial group **(Table 4)**.

Table 4. Complication distribution between studied groups at different times

Complication		Group		X^2	*p*
		Ulnar Group(N=70)	Radial Group(N=70)		
Hematoma	N	8	5	0.76	0.38
	%	11.3%	7.1%		
Spasm	N	3	11	5.08	0.02*
	%	4.2%	15.7%		
Occlusion	N	3	5	0.53	0.47
	%	4.28%	7.1%		
Dissection	N	1	1	------	1
	%	1.4%	1.4%		
Hematemesis	N	1	0	1.01	0.32
	%	1.4%	0.0%		
Ulnar nerve injury	N	1	0	1.01	0.32
	%	1.4%	0.0%		
MACE	N	0	1	1.01	0.32
	%	0.0%	1.4%		

*: Significant

Concerning hand function, there was no statistically significant differences between both groups regarding hand function at one day before, one day after and 6 months after procedure but there was statistically significant difference in hand function in both groups as hand function significantly decreased at 1 day after the procedure in peak and mean then increased nearly to base level at six months in peak and mean **(Table 5)**.

Table 5. Hand function distribution between studied groups at different times

	Ulnar Group (n=70)	Radial Group (n=70)	*T*	*P*
Hand Function (P) 1 day before	34.51±7.65	34.72±6.44	0.417	0.632
Hand Function (M) 1 day before	33.54±7.76	34.81±6.40	0.757	0.421
Hand Function (P) 1 day after	27.60±7.07*	28.75±6.33*	1.019	0.310
Hand Function (M) 1 day after	25.81±6.90*	26.87±6.32*	0.944	0.347
Hand Function (P) 6 months after	34.30±7.91	34.40±6.76	1.206	0.230
Hand Function (M) 6 months after	33.28±7.79	34.20±6.98	1.131	0.260
p value (difference among different times in peak hand function)	0.002*	0.003*		
p value (difference among different times in mean hand function)	0.001**	0.001**		

Data are presented as mean± standard deviation, *: Significant, **: Highly significant

Concerning predictors of occlusion, body mass index was found lower in the occlusion group versus non occlusion group. Also, time fluoroscopy and compression time were higher in occlusion group versus non occlusion group. Also, hemodynamic compromise was significant independent predictor for occlusion **(Table 6 and 7).**

Table 6: Univariate analysis to find predictors for occlusion

			Non occluded (N=133)	Occluded (N=7)	*t/ X^2*	*P*
Age			54.54±9.07	61.28±12.78	1.875	0.063
Body mass index			30.42±2.99	27.3+_14.1	2.075	0.048*
Time of Fluoroscopy			10.59±3.22	16.28±4.15	2.489	0.014*
Access time			2.81±0.52	2.85±0.37	0.204	0.838
Procedural time			25.58±8.12	31.0±10.81	1.192	0.235
Number of trials			1.97±0.68	2.0±0.57	0.082	0.935
Hours of compression			4.44±1.10	5.32±1.45	2.094	0.044*
Sex	F	N	45	1		
		%	33.8%	14.3%	1.61	0.20
	M	N	88	6		
		%	66.2%	85.7%		
Hypertension	No	N	71	3		
		%	53.4%	42.9%	0.30	0.59
	Yes	N	62	4		
		%	46.6%	57.1%		
DM	No	N	89	3		
		%	66.9%	42.9%		
	Yes	N	44	4	1.71	0.19
		%	33.1%	57.1%		
Dyslipidemia	No	N	85	4		
		%	63.9%	57.1%		
	Yes	N	48	3	0.13	0.72
		%	36.1%	42.9%		
History of IHD	No	N	92	3		
		%	69.2%	42.9%		
	Yes	N	41	4	2.11	0.15
		%	30.8%	57.1%		
Family history of IHD	No	N	101	3		
		%	75.9%	42.9%		
	Yes	N	32	4	3.81	0.051
		%	24.1%	57.1%		
Smoking	No	N	69	4		
		%	51.9%	57.1%		
	Yes	N	64	3	0.07	0.79
		%	48.1%	42.9%		
ACS or CCS	ACS	N	76	4		
		%	57.1%	57.1%	0.0	1.0
	CCS	N	57	3		
		%	42.9%	42.9%		
Hemodynamic compromise	-VE	N	131	6		
		%	98.5%	85.7%		
	+VE	N	2	1	5.18	0.02*
		%	1.5%	14.3%		

Data are presented as mean± standard deviation or as number (%), *: Significant

Table7: Multivariate logistic regression for independent predictors for occlusion

	Wald	P	OR	95% C.I	
				Lower	Upper
Body mass index	**1.145**	**0.308**	**1.100**	**0.912**	**1.854**
Time of Fluoroscopy	**2.396**	**0.122**	**1.105**	**0.974**	**1.285**
Hours of compression	**1.678**	**0.197**	**1.533**	**0.875**	**2.932**
Hemodynamic compromise	**3.963**	**0.021***	**6.923**	**1.521**	**11.321**

CASE 1

In ulnar group, female patient, 59 years old, diabetic and hypertensive presented with acute chest pain started 2 hours before admission. ECG showed ST elevation I, AVL, CATH lab activated ulnar access tried first but without success due to ulnar A stenosis then femoral route used and CA revealed proximal large D1 tight lesion then primary PCI to first diagonal was done successfully **(Figure 2)**.

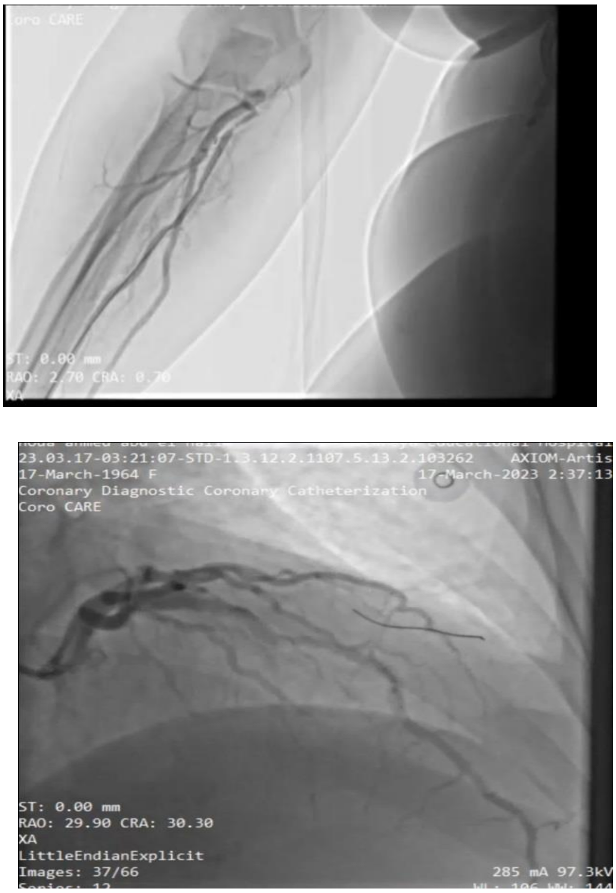

Figure (2): Angiographic image shows ulnar tight lesion (on the right) and wire in totally occluded diagonal (on the left picture).

CASE 2

In radial group, female patient, 52 years old, diabetic and hypertensive came for elective CA. Radial access was tried first but without success due to brachial artery dissection then femoral route was used and CA revealed normal coronary angiography **(Figure 3)**.

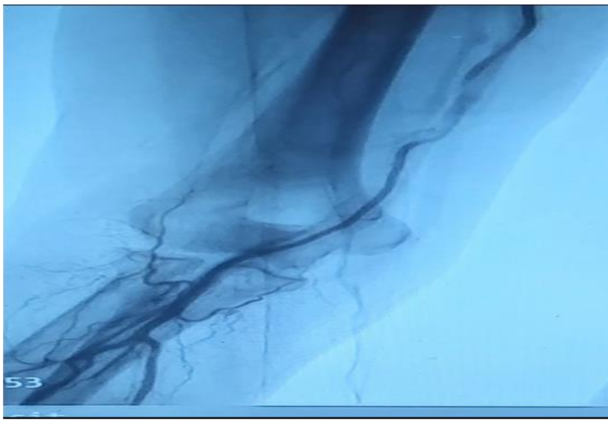

Figure (3): Brachial artery dissection while using radial access for CA.

DISCUSSION AND CONCLUSIONS

Because vascular problems are less common with the transradial approach, which is currently frequently used in coronary angiography and intervention, it may be preferable to the femoral access. When a patient is not a good candidate for the transradial technique, the transulnar route was suggested for elective treatments [(6)]. This work aimed to evaluate whether ulnar approach is non-inferior to radial approach as regards feasibility, safety and hand function preservation.

Our study showed that the majority of the study population were males (66%) in ulnar group and (69%) in radial group, the mean age was 54.94±8.91 years in ulnar group and 54.82±9.82 years in radial group, smoking was the predominant risk factor (52%) and (57%) in ulnar and radial group respectively, followed by hypertension (44%) and (50%), then dyslipidemia (35%) and (37%), then diabetes (34%) in both ulnar and radial groups, then history of IHD (35.7%) in ulnar and (28.6%) in radial group, and finally family history of IHD (25.7%) in ulnar and same in radial group.

This agreed with **Hahalis *et al.*** **[(16)]** who involved 902 patients qualified for both percutaneous coronary intervention and diagnostic coronary angiography. Patients were randomized in a 1:1 ratio to either transradial approach or transulnar approach in which the majority of the study population were males (78.4%) in ulnar group and (78%) in radial group; the mean age was (64.3 ± 10.8) in ulnar group and (64.6±11.9) in radial group. Also, in the study of **Roghani-Dehkordi *et al.*** **[(17)]**, six months of observation and follow-up were conducted on 216 patients who underwent CA and/or angioplasty via radial (111 cases) or ulnar artery (105 cases). The majority of patients (60% in the ulnar group and 62.1 in the radial group) were males, with mean ages of 60.3 ± 9) years in the Ulnar group and 59.5 ± 10.3) in the radial group.

The procedural success rate in our study was high (93% versus 91.6%) for both the radial and ulnar groups. The ulnar method was linked to a higher crossover rate than the transradial group, but there were no statistically significant differences.

This order is consistent with the RURU technique, which used the right ulnar artery as the default entry point for coronary procedures when the right radial artery failed. The left radial artery was then used, followed by the left ulnar, or "RURU"[18].

In our study, 6 cases had failed out of 70 cases (8.4%) compared to 5 cases in transradial group (7%). In the ulnar group we had to cross over to homolateral radial access in three patients and to femoral access in three also. Causes of crossover in ulnar group were failure of puncture in 2 cases, subclavian artery tortuosity in 1 case, dissection in 1 case, ulnar artery stenosis in 1 case and sheath kink in one case. Regarding third case in which tortuosity of subclavian artery, Terumo wire (0.35 inch) was used trying to overcome this resistance but without success so the operator decided to shift to femoral artery with final success.

In relation to the radial group, we were forced to switch to homolateral ulnar access in two patients and femoral access in three cases. The reason for crossover in two cases was due to radial artery spasm that persisted despite the vasodilatory cocktail being repeated. In one case of radial group cross over to femoral access occurred due to dissection in brachial artery after canulation of radial artery and doing RCA angiography while introduction of JL3.5 to do angiography to left system. In 2 patients, sheath kink was the reason.

This goes in agreement with **Fernandez *et al*.** [19] review when spasm, tortuosity, or perforation in the radial artery prevents catheterization, the homolateral ulnar artery can be reached, which avoids the requirement for contralateral radial artery or femoral artery access. There is no evidence to suggest that hand ischemia occurs more frequently when the homolateral ulnar artery is accessed after the radial artery cannot be accessed, as the hand's blood supply varies greatly and is supplied by a number of arteries, including the interosseous and median arteries.

This also agreed with **Moorthy *et al.*** [20] in which uncrossable radial artery loop was noted in 8 patients (5%) of cases, after gaining access to the Ulnar artery, the radial sheath (6F Terumo) was left in place and the sheath was placed. Six of the cases had angioplasty after the diagnostic coronary angiography was completed successfully in all of them. Following the removal of both sheaths, appropriate hemostasis was achieved. The procedure was a success, and there were no procedural problems, such as hemorrhage, ischemia, or bleeding.

Due to the artery's deep seating under the muscles, weak pulses in the ulnar group were a contributing factor in puncture failure. But in a small number of patients who had weak ulnar pulses, we were able to successfully perform the coronary surgery and puncture the artery with ease. However, we were unable to access the artery in other individuals even though we could feel a strong palpable ulnar pulse in them.

Our study agreed with **Sallam *et al.*** [21] who revealed that the main reason for ulnar access failure was inability to puncture (17.7%). Also, **Paulo *et al.*** [22] included 535 patients who were randomized to receive either the transulnar approach or the transradial method; 91.5% of patients in the transulnar approach group and 95.1% of patients in the transradial approach group successfully had their objective artery punctured.

In terms of procedure duration, the ulnar group's mean procedure times were (26.04 ± 74 min) for CA and (29.63 ± 7.63 min) for PCI in our study. In the radial group, the values were (26.01 ± 6.25) in PCI and (22.28 ± 6.33) in CA. The ulnar group's procedure time for CA was significantly longer than the radial group's (P=0.009), while both groups' procedural times for PCI demonstrated a statistically significant difference (p= 0.002). The ulnar group in our study had a mean procedure time of 27.98 ± 6.96 min, while the radial group had a mean procedure time of 24.72 ± 7.28 min. There was a statistically significant difference (p value = 0.007) in the mean procedure time between the two groups.

Regarding fluoroscopy time, the mean fluoroscopy time in our study was (10.4 ±5.4) minutes in ulnar group, while in radial group it was (11.3 ±3.6) minutes. The difference was not significant.

Our results agreed with **Roghani-Dehkordi *et al.*** [17] who found that transulnar approaches had a mean procedure time of (21 ± 11) minutes, which was somewhat longer than transradial methods (20 ± 8) minutes. The same steps were done at the follow-up and the day after the operation. At follow-up, patients were divided into two groups according to whether they had occlusion (group 2) or radial patency (group 1). Of the 99 individuals in the study, 90 patients (group 1) had a patent radial artery and nine (9.1%) had an occluded artery. At baseline, the hand grip test revealed no statistically significant differences between the two groups. Both groups' hand grip test results were significantly below the baseline values after the surgery. During the follow-up, the hand grip test findings eventually returned to baseline levels for both groups.

Therefore, it is conceivable that the patients' clinical conditions had an impact on the initial evaluation of hand grip strength in our study, which could explain the gradual increase in hand grip strength over time. This matches with **Valgimigli *et al.*** [23] who studied patients with different clinical settings (at least 30% of patients with acute myocardial infarction).

According to our research, the occlusion group's body mass index was shown to be lower than that of the non-occlusion group (p value=0.048). Additionally, there was a significant difference in compression time between occlusion and non-occlusion situations.

This matches with **Sadaka *et al.*** [24] that studied 164 patients for PCI via transradial approach and showed that prolonged compression leads to a complete cessation of blood flow and eventually to thrombus formation.

In our study hypotension during procedure (hemodynamic compromise) was significant predictor for occlusion (*p* value =0.02).

This is matched with **Sadaka *et al.*** [24] that assumed hemodynamic compromise is a predictor of occlusion. In these situations, the patients' low blood pressure, which may be caused by vagally mediated causes or arrhythmia, which results in blood stasis and RA intimal injury provides an ideal environment for the activation of the coagulation cascade, which in turn causes thrombosis.

CONCLUSION

We concluded that ulnar approach is non-inferior to radial approach as regards feasibility, safety and hand function preservation.

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