Ulnar-artery access versus radial-artery access in coronary-artery angiography and interventions

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Introduction
The use of radial-artery access for percutaneous coronary angiography and interventions is recently adopted by many interventional cardiologists as their default access in coronary procedures. In some patients who have a weak radial pulse, or those who have used the radial artery as a bypass graft during coronary-artery bypass surgery, ulnar access may be a safe and convenient alternative to radial access that allows the operator to use forearm access and avoid crossing over to the femoral approach
Aim
In this study, we compared the safety and efficacy of ulnar access versus radial access for coronary angiography and interventions.
Patients and methods
This study was conducted on 100 patients who presented with chronic coronary syndromes and were referred for coronary angiography and percutaneous coronary intervention if needed. They were divided into two groups, group A consisted of 50 patients for which coronary angiography was done through transradial access, and group B consisted of 50 patients for which coronary angiography was done through transulnar access. The complication rate, crossover rate, and patient discomfort were compared in both groups.
Results
We found that hematoma formation and patient discomfort were found more significantly in the ulnar-access group. Access-artery occlusion was found more significantly in the radial-access group. There was no significant difference between both groups regarding access-artery spasm and crossover.
Conclusion
The transulnar approach proved to be noninferior to the transradial approach for coronary procedures.

Keywords:
coronary angiography, femoral access, percutaneous coronary interventions, radial access, ulnar access

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Introduction

The use of radial-artery access for percutaneous coronary angiography and interventions is adopted by many interventional cardiologists as their default access in coronary procedures. Radial access carries a lower risk of access-site bleeding. It is more convenient to patients and allows early hospital discharge compared with femoral access [1]. However, the use of radial-artery access may be difficult in patients with a weak radial pulse, radial-artery anatomical abnormalities, and those with severe radial-artery spasm [2]. In those patients, the use of ulnar-artery access may be convenient to avoid crossover to femoral access that may carry more risk for access-site complications and more hospital stay [3,4]. However, there are some potential complications for both forearm-access arteries (radial and ulnar) that do not occur when using the femoral access like access-artery spasm and access-artery occlusion that may limit the use of forearm-access vessels for coronary interventions [5,6].

Aim

In this study, we compared the safety and efficacy of ulnar access versus radial access for coronary angiography and interventions.

Patients and methods

The procedure was discussed in details and the access site was shown to all patients before obtaining the informed consent and the ethical commitee of the institute approved using both access sites. This study

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was conducted on 100 patients who presented to our hospital with chronic coronary syndromes and were resistant to medical treatment. All patients were scheduled for elective coronary angiography with possible percutaneous coronary intervention (PCI) if indicated, the study population was divided into two groups:

Group A consisted of 50 patients in whom coronary angiography was done by transradial route.

Group B consisted of 50 patients in whom coronary angiography was done by transulnar route.

All patients were subjected to:

Full history taking, including risk factors for atherosclerosis such as hypertension, diabetes, hyperlipidemia, cigarette smoking, and family history of atherosclerotic cardiovascular disease.

Physical examination with the measurement of blood pressure, auscultation of the heart and chest.

All patients had 12-lead ECG and transthoracic echo.

Laboratory tests for determination of lipid profile, blood glucose level, renal function, and virology.

After obtaining patient consent as per hospital protocol, coronary angiography was performed. Coronary arteries were viewed in the standard projections, major coronary arteries and their branches were considered separately. Left main coronary artery, left anterior descending, circumflex, right coronary artery, and the main secondary branches such as diagonal, obtuse marginal, and posterior-descending arteries. For the patients who underwent PCI, administration of an unfractionated heparin bolus at a dose of 70 UI/kg before the intervention was done to achieve anticoagulation. All patients had been pretreated with acetylsalicylic acid plus a loading dose of clopidogrel (300 mg) and were discharged on dual-antiplatelet therapy (Aspirin 75 mg once daily and Clopidogrel 75 mg once daily) and a Statin (atorvastatin 40 mg once daily or Rusovastatin 20 mg once daily) therapy for more than 12 months at the discretion of the operator and depending on the stent implanted.

Before the procedure, bilateral radial pulses had been evaluated by a physician for group A and bilateral ulnar artery for group B. For group-A patients, the transradial approach was used, after local anesthesia with 2% lidocaine, a 6 F sheath was advanced over a 0.022″ guidewire. In group-B patients, the transulnar approach was used after local anesthesia with 2% lidocaine; a 6 F sheath was advanced over a 0.022″ guidewire. In both groups, the radial artery and ulnar artery were cannulated with a 19-G needle. The use of a vasodilating medical cocktail containing 5 mg of verapamil and 50 μg of nitroglycerin was given. Hemostasis was achieved with external compression with the TR band. The patients were allowed to ambulate 1 h after intervention in both groups. After removal of the TR band and before hospital discharge, all patients were examined postprocedure for potential access-site complications, arterial occlusion was examined clinically and by reversed Barbeau test and by arterial ultrasound before hospital discharge and once again 1 week postprocedure. All results were tabulated and statistical analysis was performed using IBM-compatible PC and using statistical software package, namely SPSS (SPSS 21 Chicago Illinois , USA). The results were analyzed by suitable statistical methods, which include mean, SD, and Student's *t* test. Data were considered significant at a *P* value less than 0.05, highly significant at a *P* value less than 0.001, and not significant at a *P* value more than 0.05.

Results

The work was done on 100 patients, these patients were divided into two groups:

(1) Group A: included 50 patients in whom coronary angiography and intervention were done by conventional transradial route with mean age 55 ±7, 37 patients were males, 22 patients were hypertensive, 18 patients were diabetics, 16 patients were smokers, 16 patients were hyperlipidemic, and 12 patients with a positive family history of coronary-artery disease.
(2) Group B: included 50 patients in whom coronary angiography and intervention were done by transulnar route with mean age 57±6, 35 patients were males, 23 patients were hypertensives, 17 patients were diabetics, 17 patients were smokers, 17 patients were hyperlipidemic, and 11 patients with a positive family history of coronary-artery disease.

From the previous data shown in Table 1 and Fig. 1 on studying the demographic criteria among patients in the study, there was no significant difference between the two groups as regards mean age, sex distribution, hypertension, diabetes mellitus, cigarette smoking, hyperlipidemia, and positive family history of coronary-artery disease.

Angiographic characteristics among groups A and B

(1) Group A: among patients in group A we found, 10 patients with normal coronary arteries, 17 patients with one-vessel disease, 13 patients with two-vessel disease, and 10 patients with multivessel disease.
(2) Group B: among patients in group B we found, 12 patients with normal coronary arteries, 15 patients with one-vessel disease, 14 patients with two-vessel disease, and nine patients with multivessel disease.

From the previous data present in Table 2 and Fig. 2 on studying the angiographic characteristics of the patients in the study, we found no significant difference between the two groups as regards angiographic characteristics and severity of coronary-artery disease.

Comparison of procedural parameters between the two groups

(1) Group A: among patients in group A, the mean access time was 5.4 min, mean fluoroscopy time was 6.1 min, and mean procedural time was 26.7 min.
(2) Group B: among patients in group A, the mean access time was 5.7 min, mean fluoroscopy time was 6.3 min, and mean procedural time was 27.3 min.

From the previous data present in Table 3 and Fig. 3 on studying the procedural parameters in the study, we found no significant difference between the two groups as regards procedural parameters, namely the mean access time, the mean fluoroscopy time, and the mean procedural time.

Comparison of complications in-between the two study groups

(1) Group A: Among patients in group A, three patients had a hematoma, two patients had discomfort symptoms, seven patients had radial-artery spasm, five patients had crossover, and two patients had radial-artery occlusion.
(2) Group B: among patients in group B, eight patients had a hematoma, eight patients had discomfort symptoms, three patients had ulnar-

Table 1 The distribution of risk factors among group A and group B

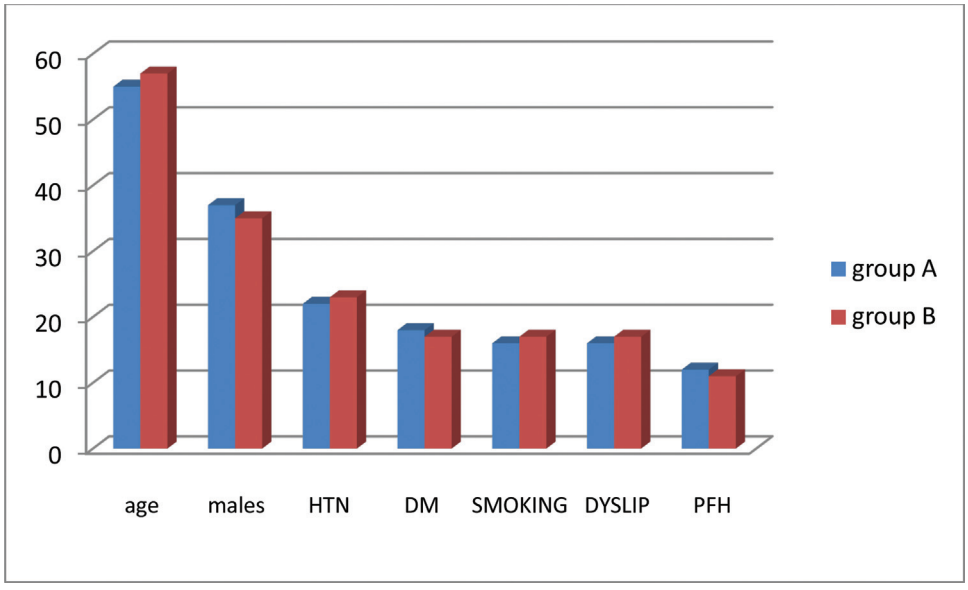
Items	Group A	Group B	*P* value	Significance
Age	55±7	57±6	0.372	Insignificant
Male sex	37	35	0.361	Insignificant
HTN	22	23	0.391	Insignificant
DM	18	17	0.387	Insignificant
Smokers	16	17	0.376	Insignificant
Hyperlipidemia	16	17	0.361	Insignificant
Positive family history	12	11	0.319	Insignificant

DM, diabetes mellitus; HTN, hypertension.

Table 2 Angiographic characteristics among group A and group B

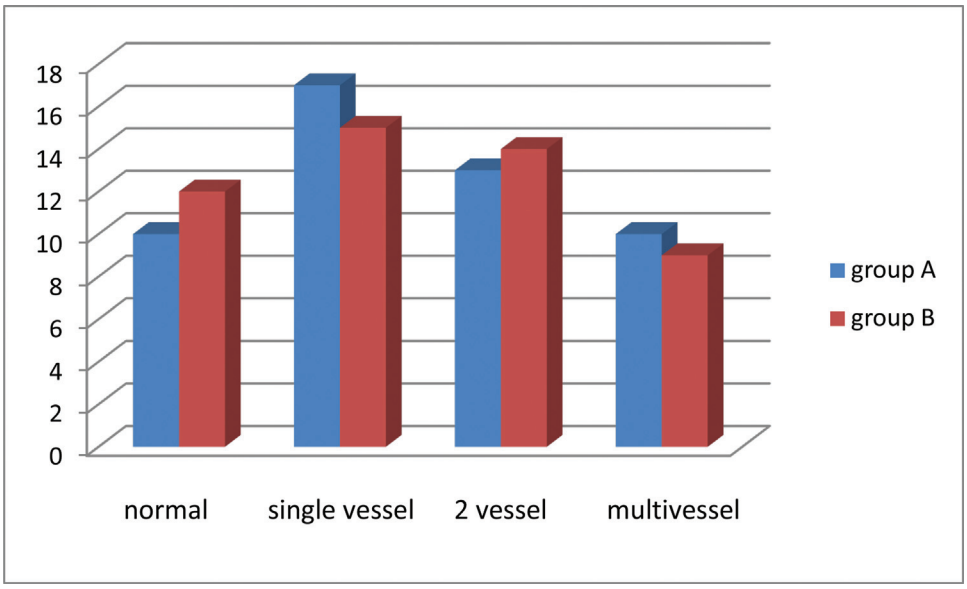
	Group A	Group B	*P* value	Significance
Normal coronaries	10	12	0.286	Insignificant
One-vessel disease	17	15	0.291	Insignificant
Two-vessel disease	13	14	0.419	Insignificant
Multivessel disease	10	9	0.411	Insignificant

Figure 1



Demographic criteria among group A and group B.

Figure 2



Angiographic characteristics among group A and group B.

Table 3 A comparison of procedural parameters between group A and group B

Items	Group A	Group B	*P* value	Significance
Access time (min)	5.4	5.7	0.193	Insignificant
Fluoroscopy time (min)	6.1	6.3	0.219	Insignificant
Procedural time (min)	26.7	27.3	0.221	Insignificant

artery spasm, eight patients had crossover, and 0 patients had ulnar-artery occlusion.

From the previous data present in Table 4 and Fig. 4 on studying the comparison between the two groups in the study, we found a significant difference between the two groups as regards hematoma and discomfort symptoms with a higher incidence in group B (transulnar group) and artery occlusion with a higher incidence in group A (transradial group) with no significant difference between the two groups as regards the incidence of arterial spasm and crossover.

Discussion

In this study, we found that transulnar access had a significantly lower rate of access-artery occlusion compared with transradial access.

On the other hand, ulnar access had more hematomas and symptoms of discomfort. In a similar study by Aptecar *et al*. [7], they also found that there was a lower rate of ulnar-artery occlusion, but in their study, they used smaller sheaths (4 F) in cardiac catheterization, in our study, we got the same results, despite we used 6 F sheaths.

In the PCVI-CUBA study, they had a nonsignificant higher ulnar-artery occlusion rate opposite to what we have found in our study [8].

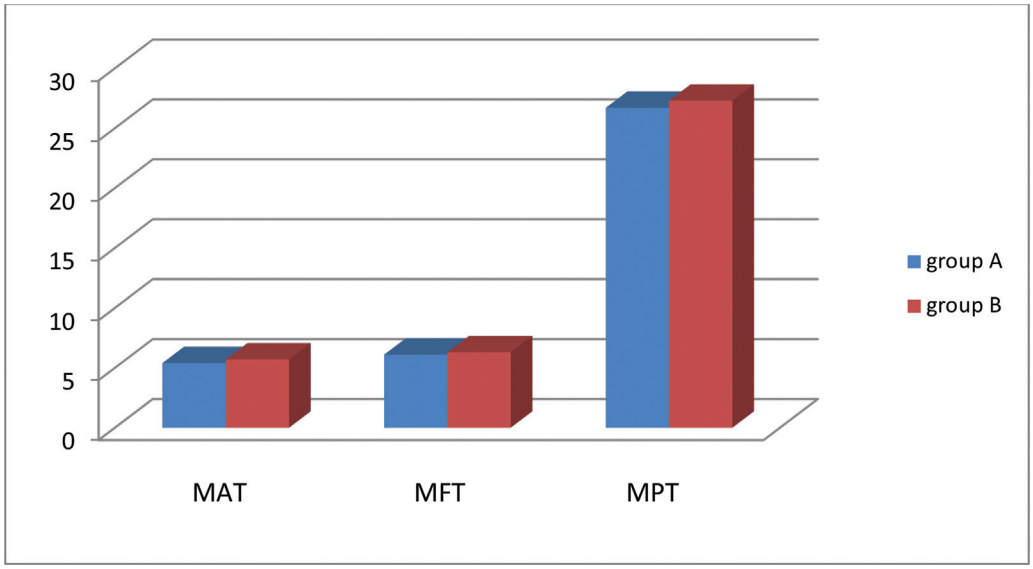
Kedev and colleagues had similar findings to our study, they did 240 ulnar-catheterization procedures in patients who had ipsilateral radial-artery occlusion, surprisingly, none of their patients suffered from symptoms of hand ischemia after a follow-up period that extended to 30 days, which reflects a low incidence of ulnar-artery occlusion and safety to use the ulnar access in cases of ipsilateral radial occlusion. This is because the anterior interosseous artery emerges around 2.5 cm below the origin of the ulnar artery, dividing into anterior and posterior branches, maintaining hand perfusion [9].

This proves that there are different anatomical features of the ulnar artery, which are different from the radial artery [10].

In research by Xile and colleagues, they compared the rate of complications between radial and ulnar approaches for coronary interventions. Their results were similar to our results, they found that the transulnar approach had a significantly lower rate of artery occlusion in comparison with the transradial approach, despite higher rates of discomfort and hematoma [11].

In a study by Doscher and colleagues, they found that the diameters of the radial and ulnar arteries at the wrist are approximately similar; however, peak systolic blood flow in the hand was greater via the ulnar artery

Figure 3



The comparison of procedural parameters between group A and group B, MAT (mean access time), MFT (mean fluoroscopy time), MPT (mean procedural time).

Table 4 The comparison of complications between group A and group B

Items	Group A	Group B	*P* value	Significance
Hematoma	3	8	0.004	Significant
Discomfort	2	8	0.009	Significant
Spasm	7	3	0.099	Insignificant
Crossover	5	8	0.091	Insignificant
Artery occlusion	2	0	0.019	Significant

compared with the radial artery [86.9 (49.5) vs. 72.2 (41.6) ml/min].

Flow (Q) is equal to the pressure divided by resistance. Given that the ulnar flow is greater than radial flow and the systemic pressure is equal, therefore, peripheral resistance of the ulnar artery in the hand should be significantly lower than that of the radial artery. This may be the cause for the different occlusion rates of the radial and ulnar arteries [12].

In a study by Hahalis and colleagues, they observed a higher incidence of ulnar-artery occlusion, which contradicts our study. Occlusion of both the radial and ulnar arteries is asymptomatic, this is attributed to the dual blood supply to the hand and the sufficient antegrade collaterals. In cases of radial-artery occlusion, the anterior interosseous artery supplies collaterals to the occluded radial artery [13].

It is worth mentioning that there is some increase in the size and the flow of the ulnar artery when the ipsilateral radial artery is occluded [14].

In our study, two patients with radial-artery spasms developed occlusion. In general, the ulnar artery has a lower risk of spasms compared with the radial artery. This may be because it is a more straight course and a thicker intima than the radial artery [15].

We found a lower rate of crossover in patients in the ulnar-artery group, who are less susceptible to spasms than the radial artery.

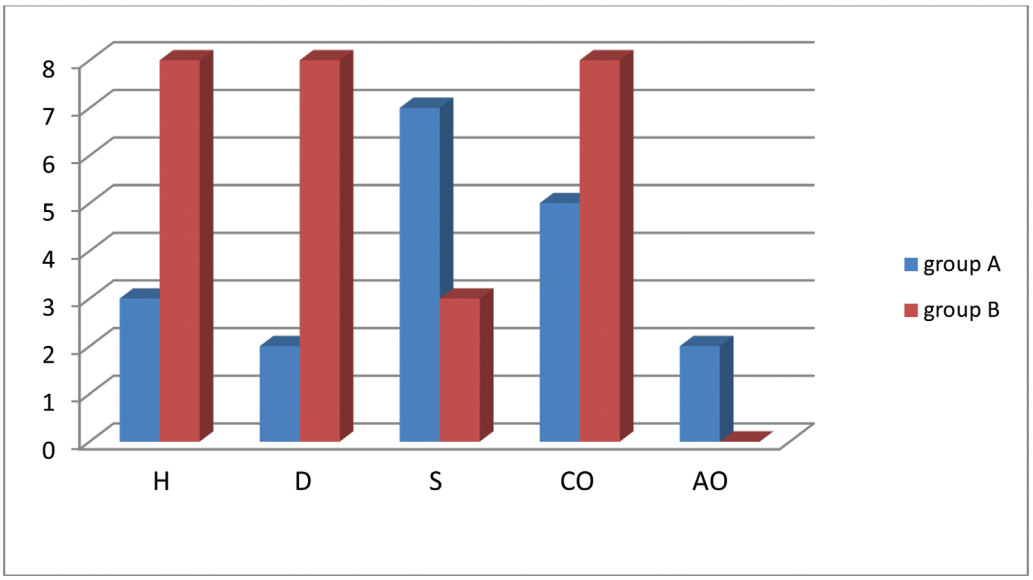
Until now, the radial artery is a more appealing arterial access for PCIs, this may be due to it being relatively superficial, and the pulse is easily palpated.

However, the ulnar access was inferior to the radial access regarding the number of hematomas and patient discomfort. Although the ulnar artery is deeper than the radial artery, it leads to a more difficult puncture. Being less spastic, the ulnar-artery access had a better success rate compared with the radial-artery access [16]. We found that successfully puncturing the ulnar artery was relatively difficult due to the deeper location of the ulnar artery compared with the radial artery, this also was the cause for the increased number of hematomas in the ulnar-access group. Increased symptoms of discomfort were associated with excitation of the ulnar nerve, although no major nerve damage was documented in our study.

Conclusions

Our study showed that transulnar access was associated with a lower rate of access-artery occlusion compared with transradial access. However, the disadvantage of

Figure 4



The comparison of complications between group A and group B, H (hematoma), D (discomfort), S (spasm), CO (crossover), AO (artery occlusion).

using the transulnar approach was an increase in the incidence of hematomas and symptoms of discomfort. In conclusion, the transulnar approach proved to be noninferior to the transradial approach for coronary procedures.

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Authors' contribution list

Ahmed K.A. Ghany Hassan: the idea for the research, collecting data, and coronary procedures. Khaled S. Ahmed: Collecting data, paper writing, and statistical work. The paper has been revised, approved by both authors, and both authors have participated equally in data collection and paper writing.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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