



Research Brief

Outcomes of transulnar and transradial percutaneous coronary intervention using ultrasound guided access in patients selected based on an ultrasound algorithm



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ABSTRACT

We performed a prospective observational study of 215 patients (58 ± 11 years) and compared the outcomes of ultrasound guided ulnar ($n = 98, 45.6\%$) vs. radial ($n = 117, 54.4\%$) cardiac catheterization and percutaneous coronary intervention (PCI) **in patients selected by an ultrasound based algorithm**. Primary endpoints included the number of access attempts and conversion to femoral access. Secondary endpoints included all-cause mortality, cardiac mortality, myocardial infarction, stroke, repeat revascularization, stent thrombosis, in-stent restenosis, and access site complications.

No significant difference was found in the primary endpoints between radial or ulnar. Ulnar access showed no significant hematomas. Therefore, ulnar PCI is a feasible alternative.

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1. Introduction

Cardiac Catheterization (CC) and percutaneous coronary intervention (PCI) is performed via the radial or femoral artery. Radial CC is favored secondary to diminished bleeding risk, vascular complications, and mortality.^{1–4} The ulnar artery is infrequently used secondary to the lack of experience and ease of the standard access routes. In patients with poorly palpable pulses, ultrasound visualization can be invaluable. Thus, **we sought to evaluate the outcomes of transulnar and transradial PCI using ultrasound guided access in patients selected based on an ultrasound algorithm**.

2. Methods

We conducted a prospective observational study (non-randomized) of 215 patients between October 2016 to May 2020 at a university hospital and compared the outcomes of ultrasound guided transulnar ($n = 98, 45.6\%$, median follow-up of 14 months) versus transradial ($n = 117, 54.4\%$, median follow-up of 13 months) CC and PCI in patients based on an ultrasound algorithm. The techniques and algorithm for selecting ulnar vs. radial access has been previously described by Kar,⁵ which we utilized for all of our procedures. All patients underwent Allen's, reverse Allen's, Barbeau, and/or reverse Barbeau testing prior to the procedure. Only patients with normal Allen's/reverse Allen's and/or Barbeau/reverse (Barbeau A and B) were selected. Afterwards, ulnar and radial artery ultrasound evaluation was performed to select the optimal vessel based on the algorithm reported by Kar.⁵ The standard method for radial artery compression using a transradial band was used for ulnar compression, except the band was reversed to occlude the ulnar artery to achieve patent hemostasis. Patent

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hemostasis was applied for 90 min post-PCI in ulnar and radial and 60 min for ulnar and radial CC.

The primary endpoints included the number of access attempts and conversion to femoral access. The secondary endpoints included all-cause mortality, cardiac mortality, acute myocardial infarction (AMI), stroke, repeat revascularization, stent thrombosis, in-stent restenosis, and access site complications such as major bleeding, arteriovenous fistula, pseudoaneurysm, vessel dissection/perforation, and/or compartment syndrome.

One operator performed all the cases using ultrasound access, except ST segment elevation myocardial infarction (STEMI) patients, who did not undergo ultrasound guided access. However, STEMI patients who underwent staged PCI for non-culprit vessels were included. The sole operator had experience with ultrasound use for CC and PCI. Patient follow-up was performed primarily in clinic. The institutional review board approved our clinical research study.

2.1. Statistical methods

Quantitative variables were summarized using mean and standard deviation or median and interquartile range. Categorical variables were summarized using frequency and percentages. Normally distributed quantitative variables were compared between the groups using a multinomial logistical regression analysis while compensating for a clustering effect. The data was considered statistically significant for $p < 0.05$. The statistical analyses were performed by the university statisticians using Stata version 15 (Stata Corp LLC).

3. Results

The primary endpoints were not significantly different between the ulnar or radial group (58 ± 11 years, median follow-up of 14 months, Interquartile Range [IQR] 6, 27). Patient characteristics are listed in Table 1. In the secondary endpoints, none occurred in the ulnar group. Of the 117 radial patients, 4 expired and 1 experienced a stroke post-PCI. Two patients expired from non-cardiac etiology (pulmonary embolism; post-operative complications after hepatic resection for metastatic colon cancer). Two expired from cardiac mortality (endomyocardial biopsy proven lymphocytic myocarditis with cardiogenic shock; AMI-cardiac arrest, cardiogenic shock, severely depressed ejection fraction on multiple vasopressors prior to PCI). Primary endpoints are listed in Table 2.

Due to severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2; novel coronavirus 2019, COVID-19), the quantity of procedures was reduced since outpatient, elective, and non-emergent cases were cancelled. A total of 123 patients (57.2%) had an AMI, of which, 87 (70.7%) had PCI. Fifty-seven patients in the ulnar group (58.2%) and 66 in the radial group (56.4%, $p = 0.851$) had an AMI with no significant difference between the number undergoing ulnar vs. radial PCI ($n = 37, 37.8\%$; $n = 50, 42.7\%$; $p = 0.434$). The most common coronary artery disease risk factors included: hypertension (81.8%, $n = 175$), hyperlipidemia (66.0%, $n = 142$), family history (63.3%, $n = 136$), history of coronary artery disease (57.7%, $n = 124$), diabetes (51.9%, $n = 110$), and smoking (48.6%, $n = 104$).

Table 1
Patient characteristics of the study groups.

Variables	Total	Radial	Ulnar	p-value
N	215	117 (54.4%)	98 (45.6%)	
Age, mean (standard deviation)	57.9 (10.6)	59.3 (10.5)	56.1 (10.6)	0.016
Follow-up, months (median [IQR])	14.0 (6.0, 27.0)	13.0 (5.0, 24.0)	14.0 (7.0, 28.0)	0.296
Smoking	104 (48.6%)	56 (48.3%)	48 (49.0%)	0.917
Hypertension	175 (81.8%)	96 (82.8%)	79 (80.6%)	0.685
Diabetes Mellitus	110 (51.9%)	59 (51.3%)	51 (52.6%)	0.849
Myocardial Infarction	78 (36.4%)	33 (28.4%)	45 (45.9%)	0.008
Coronary Artery Disease	124 (57.7%)	67 (57.3%)	57 (58.2%)	0.894
PCI	87 (40.5%)	50 (42.7%)	37 (37.8%)	0.434
Stroke	17 (7.9%)	13 (11.1%)	4 (4.1%)	0.067
STEMI	25 (11.6%)	12 (10.3%)	13 (13.3%)	0.481
NSTEMI	98 (45.6%)	54 (46.2%)	44 (44.9%)	0.851
STEMI and NSTEMI	123 (57.2%)	66 (56.4%)	57 (58.2%)	0.851
Peripheral Arterial Disease	6 (2.8%)	3 (2.6%)	3 (3.1%)	0.826
Atrial fibrillation	16 (7.4%)	11 (9.4%)	5 (5.1%)	0.209
Coronary Artery Bypass Grafts	14 (6.5%)	7 (6.0%)	7 (7.1%)	0.732
Atrial flutter	3 (1.4%)	2 (1.7%)	1 (1.0%)	0.672
Chronic Kidney Disease	21 (9.8%)	14 (12.0%)	7 (7.1%)	0.218
Hyperlipidemia	142 (66.0%)	73 (62.4%)	69 (70.4%)	0.214
Prior cardiac catheterization	58 (27.0%)	27 (23.1%)	31 (31.6%)	0.148
Family history	136 (63.3%)	78 (66.7%)	58 (59.2%)	0.251
Intravascular Ultrasound	30 (14.0%)	19 (16.2%)	11 (11.2%)	0.294
Fractional Flow Reserve	8 (3.7%)	6 (5.1%)	2 (2.0%)	0.251
Indications for Cardiac Catheterization or PCI				
STEMI	25 (11.6%)	12 (10.3%)	13 (13.3%)	0.481
NSTEMI	98 (45.6%)	54 (46.2%)	44 (44.9%)	0.851
Unstable Angina	22 (10.2%)	6 (5.1%)	16 (16.3%)	0.007
Abnormal stress test	61 (28.4%)	31 (26.5%)	30 (30.6%)	0.494
Congestive Heart Failure/Cardiomyopathy	27 (12.6%)	12 (10.3%)	15 (15.3%)	0.267
Pre-operative evaluation	6 (2.8%)	5 (4.3%)	1 (1.0%)	0.185

IQR* = Interquartile range; PCI† = Percutaneous Coronary Intervention; STEMI‡ = ST segment Myocardial Infarction; NSTEMI§ = Non ST segment Myocardial Infarction.

Table 2
List of the primary endpoints.

	Total	Radial	Ulnar	p-value
Primary endpoints: Number of access attempts				0.908
1	195 (90.7%)	106 (90.6%)	89 (90.8%)	
2	17 (7.9%)	9 (7.7%)	8 (8.2%)	
3	3 (1.4%)	2 (1.7%)	1 (1.0%)	
Primary endpoints: Conversion to femoral access	29 (13.5%)	19 (16.2%)	10 (10.2%)	0.381

4. Discussion

Ulnar PCI is seldom performed secondary to difficult access compared with radial and dearth of training. However, it is a suitable alternative access in select cases.⁶ A systematic review by Kar⁶ describes alternative access along with the techniques, considerations, complications, and ultrasound imaging.

Our study showed that ulnar CC and PCI was non-inferior to radial **in terms of bleeding risk**. None of the primary outcomes was significantly different between ulnar or radial. None of the secondary outcomes occurred in the ulnar group. No major bleeding or significant hematomas occurred in ulnar. We did not experience any access site related complications. Such complications may have been diminished due to ultrasound access **along with the ultrasound based algorithm and the pre-procedural evaluation of the vasculature**.

Therefore, ulnar access is feasible for CC and PCI. It can serve as an alternative route for patients who are not suitable for radial access or CC is unable to be performed via the radial artery. This can also avoid using femoral access, which is associated with increased risk of vascular complications.⁴

4.1. Limitations

Our study was performed in a single tertiary care university hospital with cardiovascular trainees. The utilization of ultrasound guided access along with ulnar CC and PCI was implemented by 1 operator. The primary and secondary endpoints did not include ulnar occlusion. Since ultrasound guided access was performed by a single operator (single center) in a selected population, the results may not be applicable to other operators and centers.

5. Conclusions

To our knowledge, this is the first study with a median 14-month follow-up of patients who underwent ulnar or radial ultrasound access for CC and PCI. Ulnar access is a feasible alternative

route for PCI. Conversion to femoral access or the number of access attempts was not significantly different between ulnar or radial.

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None.

Declaration of competing interest

The authors report no financial relationships or conflicts of interest regarding the content herein.

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