



## Original Article

# The initial experience of 2495 cases of the ulnar artery as default access for coronary diagnostic and interventional procedures at a single center: An observational study

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## ABSTRACT

**Introduction:** Upper limb arterial access is being increasingly used for coronary diagnostic and intervention procedures. Radial artery access is associated with reduced morbidity and mortality as compared to femoral artery access. However, access to the radial artery is not always successful with reported crossover rates to other routes between 3% and 8%. Ulnar artery access is emerging an attractive option both as upfront access and rescue access in case of failure to obtain radial artery access.

**Aims -:** To assess and document the feasibility and safety of ulnar access as a default strategy.

**Methods:** 2654 patients planned for coronary diagnostic and intervention procedures were assessed for inclusion. Inclusion criteria were, all patients planned for coronary angiography (CAG) or percutaneous coronary intervention (PCI) with palpable ulnar pulse. Exclusion criteria included reverse Barbeau test type D, previous procedure resulting in radial artery occlusion/excision, hemodialysis patients having ipsilateral AV fistula and severe forearm deformities.

**Results:** 2525 patients were found eligible, out of which 2495 (98.81%) were successfully cannulated. Procedure was completed in 2414 patients. Local site bleeding in 40 (1.6%) and acute loss of ulnar pulse noted in 33 (1.3%) out of 2495 patients. None of the patients had gangrene of access site, pseudoaneurysm, arteriovenous fistula or neurological deficit post procedure.

**Conclusion:** The Ulnar artery access as a default access is safe and feasible option for patient undergoing coronary diagnostic and interventional procedures.

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## 1. Introduction

Upper limb arterial access is being increasingly used for coronary diagnostic and interventional procedures. Radial artery access is associated with reduced morbidity like major bleeding, vascular complications and mortality as compared to femoral artery access.<sup>1,2,3,4</sup> Moreover, radial artery access is more cost effective due to reduction in number of complications and hospital stay.<sup>5</sup> This becomes even more important for a developing country like India where burgeoning burden of coronary artery disease (CAD) is already taking toll on its health care system. However, access to the

radial artery is not always successful, with reported crossover rates to other routes between 3% and 8%.<sup>6</sup> In a study 64% of radial artery access failure was related to failure of arterial puncture, spasm, dissection loop/tortuosity and stenosis.<sup>7</sup> Ulnar artery is emerging an attractive option both as upfront access and rescue access in case of failure to obtain radial artery access.<sup>8–13</sup> Meta-analysis performed by Dehal et al included 2744 patients from 5 RCTs and compared TUA and TRA routes in term of success rate of cannulations, efficacy and safety. They concluded that efficacy (comparable MACE rates), safety (comparable access site complications) and procedural times were similar in two routes while TUA results in higher access site failure and crossover rate.<sup>14</sup> However, recently feasibility of ulnar access is well acknowledged in terms of safety and efficacy across all age groups.<sup>15–17</sup>

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We planned an observational prospective study to investigate the safety and feasibility of ulnar artery access as an upfront technique for diagnostic and interventional coronary procedures.

## 2. Aims

The aim of this study was to assess and document the feasibility and safety of ulnar access as a default strategy. The primary outcome was success of Ulnar artery cannulation and Procedural success. The secondary outcome measures were procedure local site bleeding, ulnar pulse loss and other local site complications.

## 3. Methods

We assessed 2654 patients planned for coronary diagnostic and intervention procedures for right ulnar artery access as default strategy. All patients were included in the study after an informed consent. The study was approved by the hospital ethics committee and confirmed to the guidelines laid by the American Physiological Society.

### 3.1. Inclusion and exclusion criteria

Inclusion criteria included all patients planned for coronary angiography (CAG) or percutaneous coronary intervention (PCI) with palpable ulnar pulse. Exclusion criteria included reverse Barbeau test type D, previous procedure resulting in radial artery occlusion/excision, hemodialysis patients having ipsilateral AV fistula, severe forearm deformities. The ulnar artery cannulation was attempted by 10 operators, all of whom had experience of at least 50 Crossover from the ulnar to the radial/femoral (after ulnar cannulation) was done at the discretion of the operator and the cause for the same was documented.

### 3.2. Ulnar artery cannulation procedure

After cleaning and draping the puncture site hand was abducted and extended. Local anesthesia (2% xylocaine, 1–2 ml) was given lateral to the ulnar artery (to avoid ulnar nerve injury). Then Ulnar artery was punctured by anterior wall puncture technique 1–3 cm above distal flexor crease of wrist followed by hydrophilic sheath insertion. Radial sheaths size 5F and 6F (Terumo Corporation Japan) were used for CAG and PCI respectively. Allowed puncture time was kept <10 min. Spasmolytic cocktail comprising of nitroglycerine (100 µg), 2.5 mg diltiazem and heparin was given to all patients. 2500 IU and 7500 IU unfractionated heparin was used for CAG and PCI respectively. Local hemostasis post procedure was achieved with locally made compressive bandage applied for 4–6 h with use of additional splint on the dorsum of wrist to prevent post procedural mobility of the cannulation area. In case of vasospasm during the procedure, additional use of spasmolytic cocktail at the discretion of the operator was allowed. Patent hemostasis with T.R. band was not used. Indigenous tight pressure bandage with dynaplast was applied with use of pulse oximeter to assess adequacy of distal blood flow and monitoring for signs of ischemia if any.

Major and minor bleeding was classified according to the RIVAL trial.<sup>18</sup> Intractable vasospasm was defined as a condition where the operator had to change the access site. The maneuvers for improving the passage of the catheter including deep breathing, Valsalva maneuver, repeating the cocktail intra-arterially, talking to the patient to divert attention in an anxious patient, waiting for the spasm to improve, were all performed before the patient access site was changed.

### 3.3. Statistical analysis

Continuous variables are expressed as mean ± SD or median (inter-quartile range) for skewed data; categorical variables are described by frequency (percentage). Qualitative variables were analyzed using the paired *t* test while quantitative variables were analyzed using the unpaired *t* test. Complications encountered during the procedure were noted and their relative percentage was calculated. Comparisons were made in between the slabs themselves and an estimate of the changes in statistical outcomes was made. For all analyses, a 2-tailed *p* value < 0.05 was required to reject the null hypothesis. All required statistical analyses were done with SPSS software.

## 4. Results

Out of 2654 patients, 2525 patients were found eligible and right ulnar artery cannulation was attempted. Out of 2525 patients, 2495 (98.81%) patient had successful ulnar artery cannulation. In the remaining 30 patients, access site failure occurred due to severe calcification (Monckeberg calcification) and excessive tortuosity of target vessel, in these patients change over to other access site and procedure was completed by cannulation through radial (*n* = 28) and femoral route (*n* = 2).

The baseline and procedure related characteristics of the patients, who underwent transulnar intervention are given in Table 1. The mean cannulation time for CAG group and PCI group was 3.71 ± 0.3 and 3.81 ± 0.4 min respectively. Mean number of attempts were 1.2 ± 0.2 and 1.3 ± 0.23 respectively (Table 2). Out of total 2495 Patients, 81 (3.25%) patients needed switch over to other access depending on discretion of operator. Various causes of crossover and alternate sites after crossover are summarized in Table 3 and in Fig. 1 as bar diagram. Intractable vasospasm and lumps in arm and forearm remained the foremost reason for

**Table 1**  
Baseline characteristics of the patients attempted for Ulnar artery Cannulation.

	CAG	PCI
Male ( <i>n</i> = 1978)	1738	240
Female ( <i>n</i> = 547)	480	67
Mean age ± SD (Yrs)	59 ± 7.1 (M)	58 ± 6.3 (M)
	61 ± 8.0 (F)	61 ± 6.5 (F)
BMI Kg/M <sup>2</sup>		
<25	1597 (72%)	209 (68.07%)
25–29.9	621 (28%)	98 (31.93%)
≥30.0	nil	nil
Presentation		
STEMI	1330 (60%)	246 (80%)
NSTEMI/USA	665 (30%)	50 (16.28%)
CSA	223 (10%)	11 (3.72%)
Smokers ( <i>n</i> = 1010)	860 (39%)	150 (49%)
Hypertension ( <i>n</i> = 975)	878 (40%)	97 (32.33%)
Diabetes mellitus ( <i>n</i> = 792)	704 (32.1%)	88 (29.33%)
CKD ( <i>n</i> = 70)	65 (2.96%)	5 (1.66%)
Previous CABG ( <i>n</i> = 16)	16 (0.72%)	0
Previous PCI ( <i>n</i> = 144)	127 (5.78%)	17 (5.66%)

**Table 2**  
Procedural characteristics.

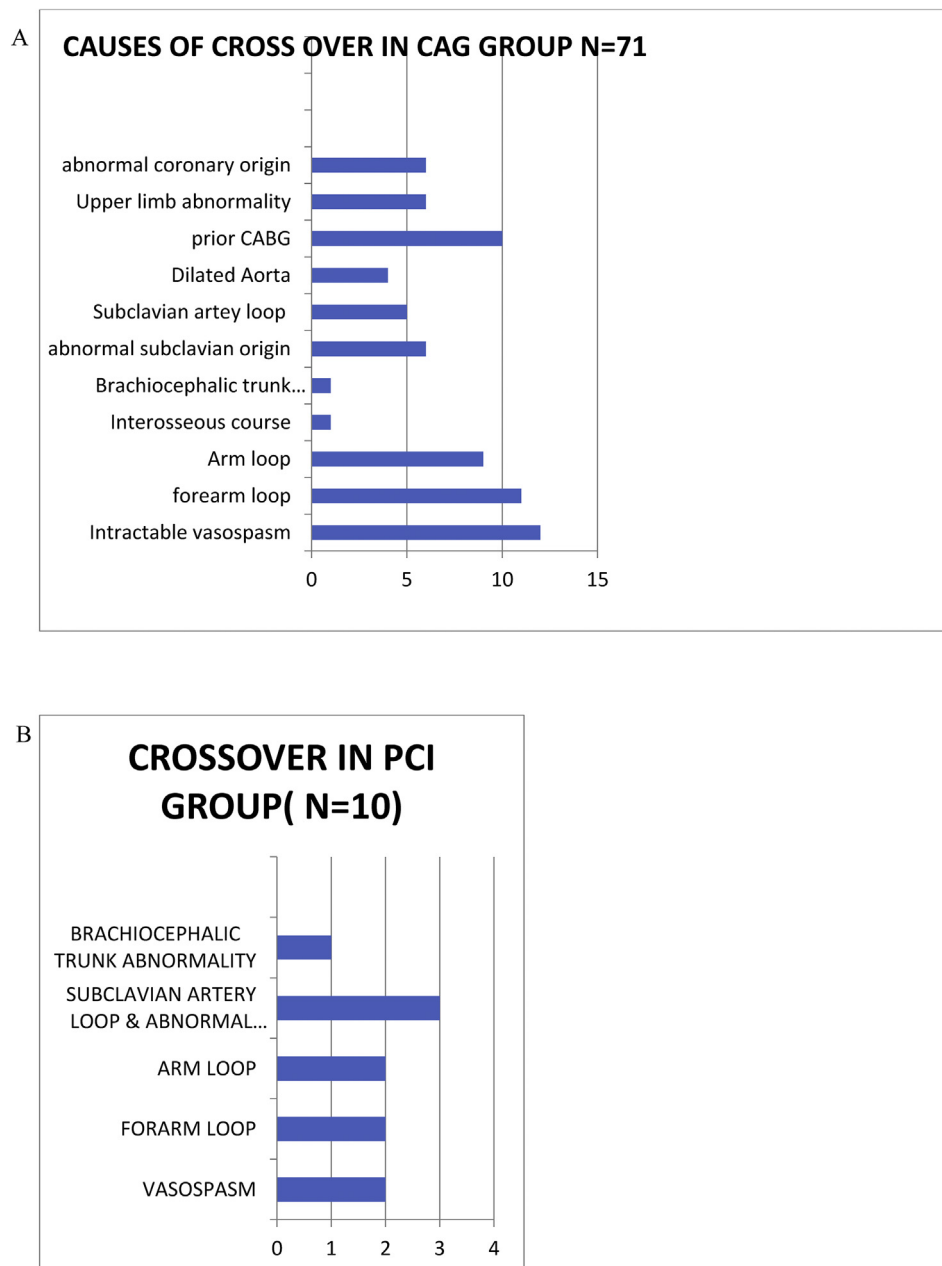
	CAG	PCI
Sheath size	5F	6F
Cannulation time (minute)	3.71 ± 0.3	3.81 ± 0.4
Mean number of attempts	1.2 ± 0.2	1.3 ± 0.23
Total procedure time (min)	3.5 ± 1.4	32 ± 17
Total fluoroscopy time (min)	2.2 ± 0.9	10.3 ± 0.4

**Table 3**  
Causes and alternate site of cross over after successful Ulnar artery cannulation.

	CAG	PCI
Access site crossover causes	71 (out of 2195)	10 (out of 300)
Fore arm loops	11	2
Loops in the arm	9	2
Interosseous course	1	0
Brachiocephalic trunk tortuosity	1	1
Abnormal subclavian origin	6	2
Tortuous subclavian artery/loop	5	1
Abnormal origin of coronary	6	0
Dilated aorta	4	0
Upper limb abnormalities	6	0
Prior CABG	10	0
Intractable vasospasm	12	2
<b>Crossover site</b>		
Alternate Upper Limb Access	52	9
Lower Limb Access	19	1

crossover across all age and sex groups. Vasospasm remained directly proportional to the experience of the operator and there was no way to measure the amount of vasospasm at which crossover had to be instituted which remained the prerogative of the operator. Out of 81 patients who needed crossover to other access, in 61 patients (75.3%) procedure was completed using alternate upper limb access.

The immediate post procedure complications were monitored and are summarized in Table 4. Out of total bleeding complications ( $n = 47,1.88\%$ ) bleeding complications – 1.6% ( $n = 40$ ) were local site bleeding. No major bleeding was noted in CAG group, while there were 3 major bleeds in PCI group none related to local site. Acute loss of Ulnar pulse was noted in 1.32% ( $n = 33$ ) patients. None of the patients had gangrene of access site, pseudo-aneurysm, arteriovenous fistula or neurological deficit post procedure.



**Fig. 1.** A bar diagram showing causes of crossover in CAG groups. B. Bar diagram showing causes of crossover IN PCI groups.

**Table 4**  
Post procedure complications in patients undergoing ulnar artery interventions.

	CAG (2195)	PCI (300)
Over all bleed, %	31 (1.41%)	16 (5.3%)
(a) Major bleed	0	3 (1.0%) (access site = 0)
(b) Minor bleed	31 (1.41%)	13 (4.33%)
<b>Site of bleed</b>		
Local	30	10
Intracerebral	0	1
Gastrointestinal	0	2
Genitourinary	1	2
Intrapericardial	0	1
Acute loss of ulnar pulse %	28 (1.27%)	5 (1.66%)
Gangrene of access site/palm %	0	0
Pseudo-aneurysm	0	0
Neurological deficit post procedure	0	0
Arteriovenous fistula at local site	0	0
Stroke	0	0

## 5. Discussion

To the best of our knowledge this is largest cohort of patients in whom Ulnar artery access is used as default strategy. In this observational study, all patients had ulnar artery as default access for coronary diagnostic and intervention procedures. The study was designed to investigate the safety and feasibility of Ulnar access for coronary diagnostic and intervention procedures.

When we compare our results to radial access cohort of RIVAL trial, ulnar artery cannulation was successful in around 98.8% in comparison to successful radial cannulation of 93% in later.<sup>18</sup> Rath et al<sup>19</sup> had cannulation success rate of 95%. AJULAR<sup>11</sup> study had cannulation success rate of 97.8%, while study by Li YZ<sup>20</sup> et al had cannulation success rate of 98.3%.

PCI success rate in our study is 96.7% (290 out of 300) which is comparable to 95.4% (2204 out of 2311) in RIVAL trial.<sup>18</sup>

Our study shows overall crossover rate of 4.4% (111 out of 2525 attempted for ulnar cannulation) to other access. In the AURA of ARTEMIS study, crossover of ulnar route was very high (32.3%) in comparison to radial route (5.9%).<sup>21</sup> The reason for this strikingly low rate of crossover in our study may be due to omission of non-palpable ulnar artery for ulnar cannulation (in previous studies attempts were made to cannulate even absent ulnar pulse). Other than this, a reason can be expertise of the ulnar operator at our center. Cannulation time, number of attempts to cannulate ulnar artery, total procedure time and total fluoroscopy time were less in our study when compared to study of AURA of ARTEMIS.<sup>21</sup> Li et al<sup>20</sup> observed crossover rates of 1.7% while AJULAR<sup>11</sup> study had crossover rate of 2.2%.

Earlier our AJULAR study concluded that transulnar cannulation if used as a default strategy is non-inferior to trans-radial approach, when performed by an experienced operator.<sup>10,11</sup> There is evidence to support safe use of the ulnar artery as an alternative to the radial artery for access for cardiac catheterization.<sup>11,22</sup> The ulnar artery has been reported to have less anatomical variations with fewer loops and tortuosity. It has also been shown to have fewer adrenergic receptors, therefore reducing the rates of arterial spasm.<sup>22,23</sup> Ulnar approach is even feasible when there is ipsilateral radial artery occlusion or radial artery access failure.<sup>24</sup> Meta-analysis by Fernandez et al which also had included our AJULAR study, showed no statistically significant differences in incidence of MACE between patients who underwent trans ulnar and trans radial artery catheterization, more access related complications (hematoma, pseudoaneurysm and arterio-venous fistula formation) in trans-ulnar group while no significant differences in arterial access time, fluoroscopy time and contrast load between the two groups.<sup>20,22</sup> Moreover, in case

of repeat interventions it can give an alternate access site reducing chances of crossover to femoral access. Despite good alternate to radial artery both as upfront or after radial access failure, ulnar artery access is underutilized. Ulnar artery is of larger size, has lesser chances of spasm and requires lesser horizontal fixity as it run between tendons of forearm muscle. Forearm ulnar loops were seen in distal half of forearm, most likely due to age related laxity and tortuosity of vessel which were easily tackled and didn't affect trans-ulnar procedures. Ulnar access has certain disadvantages like its deeper course, proximity of ulnar nerve and difficult direct compression for hemostasis in comparison to radial artery. Overall the transulnar approach is as safe as the radial, with fewer vascular complications and high success rates.<sup>25</sup>

### 5.1. Limitations

The limitations of our study includes (1) Ulnar occlusion data is only clinical as we could not document arterial patency by colour doppler study (2) lack of follow up of these patients to document late local site complications, ulnar nerve injury and ulnar artery occlusion.

## 6. Conclusion

The Ulnar artery access as a default access is safe and feasible option for patient undergoing coronary diagnostic and interventional procedures. It is an attractive option for an experienced operator. Procedural success and complication rate are comparable to radial artery access. Ulnar access also keeps radial artery spared for future graft use and gives another potential forearm access when obtaining radial artery access fails. Further studies are needed to document long term complications associated with ulnar artery access.

### Conflict of Interest

All authors have none to declare.

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