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Ultrasound guidance versus direct palpation for radial artery cannulation in adults undergoing cardiac surgery post transradial catheterization

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Abstract
Background: Arterial cannulation is a frequent and essential procedure for continuous blood pressure monitoring and arterial blood sampling. The radial artery is the most commonly used for arterial cannulation. Radial access for coronary angiogram & intervention is increasingly used worldwide. Patients undergoing repeated transradial cannulation in same arm, the rate of radial access site failure increased with successive procedure. Traditional placement of radial artery cannulation is performed by using anatomical knowledge and pulse palpation as a guide. Ultrasound can facilitate access to artery and is useful in patients with low perfusion, arrhythmias, obesity and previously unsuccessful attempts with palpation technique. Attempt is made to evaluate the better procedure among traditional direct palpation Radial artery cannulation and USG guided cannulation in this study.
Methodology: A total of 86 patients undergoing cardiac surgery post transradial catheterization were selected and randomized into ultrasound group and palpation group. It is a prospective, randomized, interventional study. Both the techniques were compared in terms of Total number of attempts, Time taken to cannulate, Complication related to procedure, Failure rate, Number of cannula used. Statistical analysis was performed by the software SPSS 22.0 version. Normality was checked by Shapiro Wilk test. To find the significant difference in means of two groups we used independent t-test and to find the association between categorical variables we used chi-square test or Fishers Exact test. p value <0.05 was considered as statistically significant.
Results: Out of the 86 patients, the initial randomized method was successful in 81 patients (42/43 in USG and 39/43 in DPG group). USG group had a mean cannulation time of 57.1 seconds while in DPG group mean time was 81.51 seconds with a standard deviation of 24.923 and 50.83 respectively with p value was 0.009. The mean number of attempts in USG group is 1.24 with standard deviation of.484, in DPG group mean was 1.59 and standard deviation was 0.91 with a p value of 0.036 which is statistically significant. Even though, number of cannulas used in ultrasound group was fewer compared to palpation group, it was not statistically significant. Ultrasound showed less failure rate but statistically not significant with p value of 0.167.
Conclusion: The use of ultrasound for radial artery cannulation in post transradial artery catheterized patients helps in faster insertion of cannula, requires less attempt for cannulation compared to traditional palpatory method. The complications were very low for both the methods, so ultrasound did not offer any advantage regarding reduction of complications following arterial cannulation.

Keywords: USG – Ultrasonography, DPG –Direct palpation group, cardiac surgery, post transradial artery catheterization

Introduction

Arterial cannulation is a frequent and essential procedure for continuous blood pressure monitoring and arterial blood sampling in many clinical settings, including the emergency department, intensive care unit, and operating room. The radial artery is the most commonly used for arterial cannulation for invasive blood pressure monitoring and arterial sampling in major surgical and critical conditions because of its anatomic accessibility, dual arterial supply, and low rate of complications [1, 2] Radial access for coronary angiogram & intervention is increasingly used worldwide [3]. Patients undergoing repeated transradial cannulation in same arm, the rate of radial access site failure increased with successive procedure.
Traditional placement of radial artery cannulation is performed by using anatomical knowledge and pulse palpation as a guide. However, the insertion of radial artery by palpatory method can be sometimes difficult, requiring multiple attempts which can cause

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patient discomfort and suffering. Radial access has some of its own limitation such as spasm & radial artery occlusion which although largely quiescent may limit further use of ipsilateral radial access.

The use of ultrasound imaging before or during vascular cannulation greatly improves first-pass success and reduces complications. Ultrasound can facilitate access to artery and is useful in patients with low perfusion, arrhythmias, obesity and previously unsuccessful attempts with palpation technique [6]. Ultrasound has been associated with reduction of complications and improved first-pass success rate in multiple studies.

Hence an attempt is made to evaluate the better procedure among traditional direct palpation Radial artery cannulation and USG guided cannulation in this study. Consequently, the purpose of this study was to test the hypothesis that ultrasound use may result in successful and faster insertion time with fewer complications in patients of post trans-radial catheterization undergoing cardiac surgery.

Materials and Methods
After institutional ethical committee clearance, the study was conducted.

Study Design
Prospective, randomized and interventional study.
Inclusion Criteria Adult patients undergoing elective cardiac surgery post transradial artery catheterization requiring continuous arterial pressure monitoring. Exclusion Criteria Local Infection. Coagulation Abnormalities. Cardiac Disorders Like atrial fibrillation. Refusal to participate. Pediatric patients. Traumatic injury in close proximity to the insertion site. Arterio venous fistula. Inadequate circulation to the extremity. Full thickness burns. Previous graft at the insertion site.

Method
After approval by the Research Ethics Committee of and after obtaining written informed consent from all patients who were scheduled to undergo cardiac surgery were included in this Prospective, randomized, interventional study. Complete pre anaesthetic evaluation was done in Pre Anaesthesia clinic and routine preoperative investigations was done like complete blood count, Coagulation profile, Renal function test, ECG, Chest X RAY, 2D-ECHO. Anaesthesia and analgesia were standardized for all patients as per our institutional practice. Patients were pre-medicated with oral pantoprazole 40mg night before surgery.
On the day of surgery, patients were randomly allocated to either direct palpation technique or real time ultrasound guidance group. Randomization was done using a computerized software "Random allocation". Randomization table was prepared by using Random allocation software. After preparing randomization tables, each patient was assigned according to the random numbers in each group.
All patients undergoing radial artery cannulation were subjected to Allen test using pulseoxymeter for detecting adequacy of ulnar artery flow. Patient's hand was placed in supine position with all the monitors connected namely ECG, SpO_2, Heart Rate, NIBP. After explaining the procedure, the patient's hand was secured in an arm board with dorsiflexion at wrist joint. Local anesthetic was infiltrated over the cannulation area after cleaning with

antiseptic solution. All the patients were sedated with 0.02mg/kg midazolam and 1 mcg/kg fentanyl.A single anaesthetist who was experienced in both the techniques performed the procedures in all cases of both groups to eliminate bias. In case of failure of primary technique (ultrasound/palpation), alternative technique (ultrasound/palpation) or alternative site will be used to secure arterial line.

Palpation Method
Radial artery was palpated and punctured at the site of maximal pulsation. Then a BD (Becton, Dickinson and Company, New Jersey, USA) 20G arterial cannula was advanced over the needle once flash of blood is seen in the hub of cannula.

Ultrasound-Guided Technique
After preparing the transducer with a sterile cover, the radial artery was identified using ultrasound with a linear transducer in short-axis view. Approximately 0.5 cm distal to the probe, a BD 20G arterial cannula was introduced and advanced at 15-300 to skin until tip of the needle is seen in contact with the anterior wall of artery. The needle is then advanced as the artery collapses and re-expands or blood appears as flash in the hub. Then the catheter is advanced over the needle.
Time to successful arterial cannulation will be measured, starting from when ultrasound probe made contact with the patient's skin or palpation started and concluded with complete and adequate catheter insertion of 20 G cannula. Number of attempts will be counted at each skin puncture or needle withdrawn from skin. If arterial cannulation is unsuccessful by initial randomization method within 10 minutes (600 Seconds), it was considered as failure. However, crossing over of technique (ultrasound/palpation) was attempted by provider as a rescue method. All patients eventually received an arterial line by using either an alternative technique or by inserting at alternative site.
The means by which successful arterial cannulation is achieved was recorded. Data was recorded by one of the research team who was not involved in management of the case. All of the adverse events except blockage of artery need to be monitored till decannulation.
Following observations were made:
- Time to cannulate.
- Attempts for successful cannulation.
- Was cannulation possible in 10 minutes/600 seconds.
- Number of cannulas used.
- Vitals before and after cannulation - Heart rate, non-invasive blood pressure, SpO_2.
- The insertion site and the hand are examined for the following adverse events till the day following decannulation.
- Haematoma.
- Infection (suggested by local swelling and tenderness).
- Ischemia distal to the insertion site/ distal discoloration.
- Blockage of the artery/ malfunction – will be monitored.

Standardized Anaesthesia and analgesia was used for all patients as per the institutional practice. Patients were pre-medicated with oral pantoprazole 40mg on the night before surgery. On the day of surgery patients were induced with midazolam 0.1mg/kg, fentanyl 5mics/kg, Etimodate

0.1mg/kg, and pancuronium 0.1mg/kg and patients were intubated with appropriate size tube and ventilated with volume controlled ventilation.

Anaesthesia was maintained with isoflurane, fentanyl and Pancuronium top up doses. ECG, ST segments, SPO2, EtCO2, Invasive BP, temperature, arterial blood gases, fiO2 and anesthetic gases were monitored.

After completing surgery patients were shifted to ICU and continued ventilation, analgesia was maintained with fentanyl infusion and extubated once they achieved extubation criteria.

Results

The study was conducted on 86 patients who were scheduled for surgery.

Group DPG (Direct Palpatory group) had 43 patients

Group USG (Ultrasound) had 43 patients after randomization.

The initial randomized method was successful in 81/86 patients (42/43 in USG and 39/43 in DPG group).

Crossover to other method resulted in additional one USG success and none palpation success.

Chi square tests and independent students t test was used for categorical and continuous variables.

SPSS v. 20 was used for analysis and determining statistical significance.

A p value of <0.05 was considered as statistically significant value

Table 1: Table showing mean demographic data and standard deviation of study population in USG and DPG groups.

	group	N	Mean	Standard Deviation	t	df	p-Value
Age	USG	42	54.83	9.815	-0.398	79	0.692
	DPG	39	55.67	8.983			
Weight	USG	42	69.38	11.113	1.136	79	0.26
	DPG	39	66.62	10.774			
Height	USG	42	164.19	8.594	-0.397	79	0.692
	DPG	39	164.95	8.572			
BMI	USG	42	25.68699	3.274984	1.456	79	0.149
	DPG	39	24.51243	3.970906			

Comparison of the AGE between the two groups shows that AGE was higher in DPG group with a t value of -0.398 and is statistically non-significant with a p value of 0.692.

Comparison of the WEIGHT between the two groups shows that WEIGHT is higher in USG group with a t value of 1.136 and is statistically non-significant with a p value of 0.26.

Comparison of the HEIGHT between the two groups shows that HEIGHT is higher in DPG group with a t value of -0.397 and is statistically non-significant with a p value of 0.692.

Comparison of the BMI between the two groups shows that BMI is higher in USG group with a t value of 1.456 and is statistically non-significant with a p value of 0.149.

Table 2: Table showing sex wise distribution in USG and DPG groups.

			Group		Total
			USG	DPG	
SEX	F	**Count**	**7**	**7**	**14**
		% within Group	16.7%	17.9%	17.3%
	M	Count	35	32	67
		% within Group	83.3%	82.1%	82.7%
Total		Count	42	39	81
		% within Group	100.0%	100.0%	100.0%

Comparison of the Sex Wise Distribution between the two groups shows that Male Patients ARE Higher IN USG and DPG group with a t value of 0.23 and is statistically non-significant with a p value of 0.879.

Table 3: Table showing mean ejection fraction percentage of USG and DPG groups.

	Group	N	Mean	Standard Deviation	t	df	p value
Ejection Fraction (%)	USG	42	0.49881	0.078467	0.8	79	0.38
	DPG	39	0.482051	0.092115	83		

Comparison of the Ejection Fraction (%) between the two groups shows that Ejection Fraction(%) is higher in USG group with a t value of 0.883 and is statistically non-significant with a p value of 0.38.

Table 4: Table showing mean and standard deviation of heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) and SPO2 before cannulation and after cannulation in USG group and DPG group.

	Group	N	Mean	Standard Deviation	t	df	p value
Hr Hemodynamics Before Cannulation	USG	42	76.83	12.806	0.206	79	0.837
	DPG	39	76.26	12.347			
Sbp Hemodynamics Before Cannulation	USG	42	140.57	18.491	0.343	79	0.733
	DPG	39	139.13	19.406			
Dbp Hemodynamics Before Cannulation	USG	42	81.9	6.928	-0.779	79	0.438
	DPG	39	83.28	8.926			
Spo2 Hemodynamics Before Cannulation	USG	42	98.36	0.618	1.889	53.304	0.064

	DPG	39	97.92	1.306			
Hr Hemodynamics After Cannulation	USG	42	77.07	12.574	-0.077	79	0.939
	DPG	39	77.28	12.031			
Sbp Hemodynamics After Cannulation	USG	42	140.52	18.363	0.111	79	0.912
	DPG	39	140.05	19.966			
Dbp Hemodynamics After Cannulation	USG	42	81.05	7.917	-0.995	79	0.323
	DPG	39	82.92	9.036			
Spo2 Hemodynamics After Cannulation	USG	42	100	<0.001a			
	DPG	39	100	<0.001a			

Comparison of the HR Hemodynamics before Cannulation between the two groups shows that HR HEMODYNAMICS Before Cannulation is higher in USG group with a t value of 0.206 and is statistically non-significant with a p value of 0.837.

Comparison of the SBP Hemodynamics before Cannulation between the two groups shows that SBP Hemodynamics BEFORE Cannulation is higher in USG group with a t value of 0.343 and is statistically non-significant with a p value of 0.733.

Comparison of the DBP Hemodynamics BEFORE Cannulation between the two groups shows that DBP Hemodynamics before Cannulation is higher in DPG group with a t value of -0.779 and is statistically non-significant with a p value of 0.438.

Comparison of the SPO2 Hemodynamics BEFORE Cannulation between the two groups shows that SPO2 Hemodynamics before Cannulation is higher in USG group with a t value of 1.889 and is statistically non-significant with a p value of 0.064.

Comparison of the HR Hemodynamics after Cannulation between the two groups shows that HR Hemodynamics after Cannulation is higher in DPG group with a t value of -0.077 and is statistically non-significant with a p value of 0.939.

Comparison of the SBP Hemodynamics after Cannulation between the two groups shows that SBP Hemodynamics after Cannulation is higher in USG group with a t value of 0.111 and is statistically non-significant with a p value of 0.912.

Comparison of the DBP Hemodynamics after Cannulation between the two groups shows that DBP Hemodynamics After Cannulation is higher in DPG group with a t value of -0.995 and is statistically non-significant with a p value of 0.323.

Table 5: Table showing time to cannulate between USG and DPG groups.

	Group	N	Mean	Standard Deviation	t	df	p value
Time To Cannulated (SECS)	USG	42	57.1	24.923	-2.712	54.35	0.009
	DPG	39	81.51	50.83			

Comparison of the TIME TO Cannulate (SECS) between the two groups shows that TIME TO Cannulate (SECS) is higher in DPG group with a t value of -2.712 and is statistically significant with a p value of 0.00

Table 7: Table showing catheters to success in USG and DPG group and total used.

			Group		Total
			USG	DPG	
NO. Of Catheters To Success	1	Count	42	37	79
		% within Group	100.0%	94.9%	97.5%
	2	Count	0	2	2
		% within Group	0.0%	5.1%	2.5%
Total		Count	42	39	81
		% within Group	100.0%	100.0%	100.0%

In USG group only one 20 G cannula was used individually for 42 patients, In DPG group 37 patients were cannulated with single cannula and for the remaining 2 patients 2cannulas were used and is statistically non-significant with p value of .137

Table 7: Table showing failure count and percentage among USG, DPG group and total number of study subjects.

Crosstab					
			Group		Total
			USG	DPG	
Failure	NO	Count	42	39	81
		% within Group	97.7%	90.7%	94.2%
	YES	Count	1	4	5
		% within Group	2.3%	9.3%	5.8%
Total		Count	43	43	86
		% within Group	100.0%	100.0%	100.0%

Comparison of failure between the two groups DPG group showed more failures (4/43) than USG group (1/43) which is statistically non-significant with a p value of .167.

Table 9: Table showing complications (haematoma) and percentage among USG, DPG group and total number of study subjects.

			Group		Total
			USG	DPG	
Haematoma	No	Count	41	38	79
		% within Group	97.6%	97.4%	97.5%
	Yes	Count	1	1	2
		% within Group	2.4%	2.6%	2.5%
Total		Count	42	39	81
		% within Group	100.0%	100.0%	100.0%

Comparison of complication (haematoma) between two groups showed equal number of complications (haematoma) which is statistically not significant with a p value of 0.958.

Discussion
Artery cannulation is a frequent and essential procedure for continuous blood pressure monitoring and arterial blood sampling in many clinical settings, including the emergency department, intensive care unit, and operating room. The radial artery is the most commonly used for artery cannulation because of its anatomic accessibility, dual arterial supply, and low rate of complications [1, 2] Traditional placement of radial artery cannulation is performed by using anatomical knowledge and pulse palpation as a guide. Numerous techniques have been described for insertion of catheters such as direct cannulation with an over the needle approach, modified Seldinger technique, the liquid stylet technique, pressure curve directed technique etc. [5] Ultrasound can facilitate access to artery and is useful in patients with low perfusion, arrhythmias, obesity and previously unsuccessful attempts with palpation technique [7]. Ultrasound has been associated with reduction of complications and improved first-pass success rate in multiple studies. Consequently, the purpose of our study was to test the hypothesis that ultrasound use may result in successful faster insertion time with fewer complications in patients of post transradial catheterization undergoing cardiac surgery. Our study included 86 patients were divided into two groups USG group (using ultrasound) containing 43 patient and DPG (palpatory method) group contained 43 patients.

Parameters like age, sex, weight, height, body mass index, ejection fraction were comparable in both groups. There was no significant statistical difference between the groups in any of theabove parameters as described in the result section in table 1.

In USG group out of 43 patients 42 patients were successfully cannulated and in DPG group 39 patients were successfully cannulated.

Conclusion
We conclude use of ultrasound for radial artery cannulation in post transradial catheterized patient's helps in faster insertion of cannula, catheter to success, requires fewer attempts for cannulation compared to traditional palpatory method. The complications were very low for both the methods, so ultrasound did not offer any advantage regarding reduction of complications following arterial cannulation.

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