

Comparative evaluation of ultrasound guided and direct palpation method for radial artery cannulation

¹Dr Dharam Singh Meena, Professor, Department of Anaesthesia and Intensive care, VMMC and Safdarjung Hospital, New Delhi.

²Dr Himanshu Gaur, Senior Resident, Department of Anaesthesia and Intensive care, VMMC and Safdarjung Hospital New Delhi

³Dr R P Singh, Professor and Consultant, Department of Anaesthesia and Intensive care, VMMC and Safdarjung Hospital New Delhi

⁴Dr Krishan Kumar, CMO, Department of Anaesthesia and Intensive care, VM MC and Safdarjung Hospital New Delhi.

⁵Dr Arushi Gupta, Associate Professor, Department of Anaesthesia and Intensive care VMMC and Safdarjung Hospital New Delhi.

⁶Dr Mamta Panwar, Associate professor, Department of Anaesthesia and Intensive care, VMMC and Safdarjung Hospital New Delhi.

Corresponding Author: Dr Himanshu Gaur, Senior resident, Department of Anaesthesia and Intensive Care, VMMC and Safdarjung Hospital New Delhi -110029

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Abstract

Background: Radial Artery cannulation is commonly indicated for continuous blood pressor monitoring and blood sampling in high risk patients, major surgical procedures, and in Intensive care unit. Successful cannulation of radial artery with traditional approach via palpation of pulse can be challenging sometimes, which is time consuming and may lead to several complications. Ultrasound guided radial artery cannulation has been shown with promising results.

AIIMS: This study was undertaken to compare the ultrasound guided versus direct palpation method for radial artery cannulation in terms of Success at first attempt, insertion time, number of attempts and complication if any.

Material and Method: This was a prospective randomised comparative study carried out in the

department of Anaesthesiology and Intensive care in VMMC and Safdarjung Hospital New Delhi. All Patients who fulfilled the inclusive criteria were enrolled and randomised equally into either of two groups. In Group DP (n=30) Radial Artery cannulated by direct palpation method while in Group UG (n=30) Radial artery cannulation was ultrasound guided. Success at first attempt, Number of attempts, total cannulation time, failure and any complications if occur were observed and noted. Data were analysis using SPSS version 21.0.

Results:-first attempt success rate in group UG 16/30 (53.33 %) and DP group 12/30(40%) p=0.496. Mean time for successful radial cannulation was 2.83+0.58min in UG group and 3.45+0.71 Min in DP group (P=.005). Fewer failure rate were observed in UG group 6.67% than DP group 26.67%. Complications

were also observed lesser in UG group 13/30 than 20/30 in DP group (P=0.069).

Conclusion: Ultrasound guided radial Artery cannulation is a useful alternative to direct palpation method.

Keywords: Ultrasound, Direct Palpation, Radial Artery cannulation.

Introduction

Radial artery cannulation for continuous blood pressure monitoring and blood sampling is an important monitoring technique in Intensive care units, major surgical procedures and high-risk patients¹

The traditional method for locating the radial artery is via palpation of the pulse in conjunction with the anatomical landmarks. However, the location of radial artery is variant in 30% of patients and may be difficult to find². Radial artery cannulation can be difficult sometimes, require multiple attempts, causing patient discomfort, suffering, spasm and haematoma formation. Doppler also has been employed for cannulation. However, it does not help much in increasing the success rate as compared to the palpation technique³.

Although severe complications are rare, successful radial artery cannulation can be technically challenging, particularly in hypotensive patients and those with vascular disease in which multiple unsuccessful attempts at arterial cannulation increases^{2,4}.

Radial artery although much smaller than central vein, can be easily identified by two-dimensional ultrasound (US) scanning. It is seen as a pulsating black circle on an otherwise static mainly white background. The use of ultrasound for radial artery cannulation has been reported to result in faster insertion time with higher first attempt success rate with fewer complications when compared with traditional direct palpation^{1,2,4,5,9,10,11,12,13}. On contrary, some studies

found that ultrasound guided radial artery catheterization does not affect the insertion time, the number of redirects, or the number of attempts when compared with the direct palpation technique when used by experienced cardiac anaesthesiologist.[6] However, ultrasound guided long axis (in plane) approach in radial artery cannulation shows higher first attempt success rate with less cannulation time as compared to short axis (out of plane)⁷. Also, several studies suggest that the bevel down approach of the needle during Ultrasound guided radial artery catheterisation exhibited a higher success with fewer complication compared to the bevel up approach^{8,14}.

Therefore, in the present study, we have attempted to determine the comparative efficacy of ultrasound guided (long axis) radial artery cannulation versus direct palpation technique in terms of insertion time, needle redirections, first attempt success rate when it is performed by the trainee anaesthesiologist after gaining training of radial arterial cannulation with ultrasound guided as well as direct palpation technique.

AIMS

To compare the Ultrasound guided versus direct palpation technique for radial artery cannulation in terms of Success at first attempt. Insertion time, Number of attempts made, and Complications if any like haematoma, bleeding, spasm and pain etc.

Materials and Methods

A prospective randomized comparative study was conducted in the department of Anaesthesia and Intensive Care, Vardhman Mahavir Medical college and Safdarjung Hospital, New Delhi. Approval obtained from the hospital ethics committee and written informed consent was taken from the Patients. Sixty patients who met inclusion criteria were enrolled in the

study and randomly allocated into 2 groups according to the computer randomization technique.

Group DP- In this group, radial artery was catheterized by direct palpation technique.

Group UG - In this group radial artery cannulation was Ultrasound guided

Inclusion Criteria

- a. Patients scheduled to undergo elective surgical procedure which require continuous arterial blood pressure monitoring.
- b. ASA grade I, II & III
- c. Adult patients 18-65 years of age of either sex.

Exclusion Criteria

- a. History of coagulopathy.
- b. BMI > 35 kg/m²
- c. Cutaneous infection at the site of insertion
- d. Known peripheral vascular disease.
- e. Negative Allen's test
- f. Severe hypotension, hypertension, hypovolemia.
- g. Patients with pregnancy.

All patients had undergone a detailed pre-anaesthetic check-up and kept fasting overnight and received oral tablet alprazolam 0.25 mg on the night before surgery.

RADIAL ARTERY CANNULATION PROCEDURE

A modified Allen's test [15] was performed. After recording the baseline vitals like pulse rate, non-invasive blood pressure, respiratory rate and pulse oximetry, intravenous (iv) line was secured and injection fentanyl 1mcg/kg body weight IV was given. The skin was cleaned with chlorhexidine 2% and draped. Then radial arterial cannulation was performed under all aseptic preparation after injecting lignocaine 2% subcutaneously with 26 G needle over the radial artery in both the groups.

The ultrasound guided technique will be performed as follows-

An ultrasound probe (linear probe 10 Mega Hertz, Kontron Medical) was placed over the radial artery perpendicular to its longitudinal axis to visualize the radial artery. Then the probe was rotated 90 degrees to achieve long axis approximately 5 mm proximal to the skin puncture site. With the bevel of the needle facing down, it was advanced to the skin until tip is seen inside the artery and blood appeared in the hub of needle. Then guide wire inserted into the needle. After removal of the needle, 20 G catheter (arterial leadercath VYGON France) was advanced over the guide wire using Seldinger's technique. Arterial pressure monitoring line flushed with heparinized saline was attached to the catheter and waveform observed.

The palpation technique will be performed as follows-

In palpation technique, the radial artery pulse was palpated with non-dominant fingers for cannulation. With the bevel of the needle pointing downwards, it was advanced towards the radial artery at an angle of approximately 30-45 degree till the flashback is seen at the hub of the needle. Then, after reducing the angle slightly, needle was advanced around 0.5 mm further. Then guide wire inserted into the needle. After removal of the needle, 20 G catheter was advanced using Seldinger's technique. Arterial pressure monitoring line flushed with heparinized saline was attached to the catheter and waveform observed.

In both the techniques, the success at the first attempt, number of the attempts made, insertion time, failure and any complication like haematoma, bleeding, spasm, pain etc. noted by the non-participant personnel.

Insertion time - Insertion time was considered from the puncture of the skin to the appearance of the arterial waveform on the monitor.

Attempts - Attempts of the needle puncture at skin.

Failure - when insertion time exceeds 5 minutes or need to change the site of arterial cannulation.

Statistical analysis: SPSS version 21.0 was used to analyse all statistical data.

In A study by M.A Hansen et al¹³ 2014, observed that first attempt success rate was significantly higher in the ultrasonography dynamic needle tip positioning group (23/40 vs 38/40). Taking these values as reference, the minimum required sample size with 90% power of study and 5% level of significance is 22 patients in each study group. So total sample size taken is 60 (30 patients per group). Categorical variables were presented in number and percentage (%) and continuous variables presented as mean+- SD. Quantitative variables were compared using Independent T test/Mann-whitney Test between the two groups. Qualitative variables were correlated using Chi-Square test/Fisher exact test. A p value less than 0.05 was considered statistically significant.

Results

The total number of patients were 60 in both the groups. The mean age, sex ratio, BMI and ASA grading of patients in both the groups were comparable (Table 1). The mean time for cannulation was 2.83+-0.58 in UG group in compare to 3.45+-0.71 in DP group (Table 3). Twelve patents in DP group and 16 patients in UG group were cannulated in the first attempt. Ten patients of were cannulated on second attempt in both the groups while 7 patients in DP group and 4 patients in UG group were cannulated on third attempt. Both groups were comparable in terms of number of attempts for successful cannulation p=0.496 [Table 3].The

failure of cannulation was observed in 2 patients in UG group while it was 8 in DP group, however it is statistically insignificant(p=0.08)[Table 4].Fifty percent patients had experienced pain during cannulation in DP group in comparison to 26.67% in UG group. Four patients had Radial artery spasm during cannulation in DP group while none had in UG group (P=0.112) Table 5.

Table 1. Demographic profile of patients of both groups

Parameters	DP	UG	
	N=30	N=30	p value
Mean Age (years)	39.5	38.4	0.679
Sex M/F	23/7	24/6	0.754
Mean BMI (Kg/M2)	22.54	25.85	0.07
ASA Grade (% of patients)			
1	53.3	30	0.151
2	13.33	13.33	
3	33.33	56.67	

Table 2 No of attempts for successful cannulation

	DP N=30	UG N=30	P value
First	2(40%)	16(53.33%)	0.496
Second	10 (33.33%)	10(33.33%)	
Third	7(23.33%)	4(13.33%)	
Fourth	1(3.33%)	----	

Table 3 Mean time for cannulation (min)

	DP n=30	UG n=30	P value
Mean time for cannulation (min)	3.45+-0.71	2.83+-0.58	0.005

Table 4 Failure rate

	DP n=30	UG n=30	P value
Failure rate	8(26.67%)	2(6.67%)	0.08

Table 5 Complications

	DP n=30	UG n=30	P value
Overall complications	66.67%	43.33%	0.069
pain	15(50%)	8(26.67%)	0.063
Spasm	4(13.33%)	NiL	0.112
hematoma	26.67%	13.33%	0.333

Discussion

Radial artery catheterisation is an important for beat to beat invasive blood pressure monitoring as well for frequent arterial blood sampling for gas analysis. Aim of our study was to comparatively evaluate the ease and success of radial artery cannulation in patients requiring invasive BP monitoring during elective surgeries. The ease of radial artery cannulation was compared in terms of success at first attempt, time taken for cannulation, number of attempts, and complications in all 60 patients.

The demographic profile of our study subjects in both the groups were comparable in terms of age, sex ,BMI and ASA grading (Table 1).

Peters et al (14) performed a study in 125 patients comparing success rate of radial artery cannulation via direct palpation method and ultrasound guidance. They found out that the first attempt success rate was 56.4% in DP group and 71.4% in the US group(p=0.10),while in present study it was 40% versus 53.33% in group DP vs UG .They also observed that no difference in the meantime taken for radial cannulation between DP and US guidance ,i.e. 104(76-212 sec) vs 104(68-270 sec.

respectively: (P=0.66). In the present study, the mean time taken for successful cannulation was 3.45+/- 0.71 min in DP and 2.83+/- 0.58 Min in UG group(p=.005), which is however, statistically insignificant. The difference between the results, probably due to the fact that in above study, arterial cannulation was performed by trained cardiac anaesthesiologist, who are probably well versed with direct palpation method.

Levin PD et al (1) conducted a similar study in 69 patients, in which it was observed that a shorter time required for catheter insertion in ultrasound group as compared to direct palpation method (55.5+/-63.8 vs 111.5+/-121.5 Sec, P=0.17), which was similar to our study. They also found that, a significant fewer attempts were required for catheter insertion using ultrasound as compared to palpation method (mean +/-SD, 1.6_/-1.0 vs 3.1+/-2.4; p=.003). In our study mean number of attempts were also higher in direct palpation group but statistically insignificant. The possible explanation is being that the ultrasound guided technique is more accurate in localizing an artery in comparison to the Palpatory Method.

Ueda et al ³ also observed in their study that ultrasound caused a smaller absolute increase success in cannulation rate on the first attempt (14%) than other techniques(P=0.002) which is statistically significant. Similarly, Gu et al ¹² also found in a meta -analysis, that the ultrasound guided radial artery catheterization was associated with an increased first attempt success rate. however, Ganesh et al ¹⁹ has observed in a prospective randomized study, that no significant difference found between the groups in respect to time for successful cannulation and total number of attempts.

Bhattacharjee et al ¹⁷ also found that radial artery cannulation by ultrasound guidance may increase the first attempt success rate but not the overall cannulation

success when compared to digital palpation technique. Present study also concluded that ultrasound increased the first attempt success rate but was statistically insignificant.

Anantasit et al¹⁸, performed a randomized trial for ultrasound versus traditional palpation to guide radial artery cannulation in critically ill 84 children. they observed that the total success and first attempt rates for the ultrasound guided group were significantly higher than those for palpation group. The median time to success for US group was significantly shorter than that for palpation group (3.3 versus 10.4 minutes; $p < .001$). Cannulation complication were lower in the ultrasound guided group than the palpation group (12.5% versus 53.3%) similarly less complication were observed in ultrasound group (Table 5).

The failure rate and hematoma formation rate in DP group 21% and 22.6%, respectively, compared with 12.7% and 11.1% was observed in a study of Peters et al (14). Theirs results difference were statistically insignificant which are similar to the observation of our study.

One of the limitations of our study was relatively small size of sample, so further comprehensive work with large sample size is suggested. We conducted our study in haemodynamically stable patients, ours results cannot be extrapolated in haemodynamically unstable and paediatric patients, where radial artery cannulation is challenging with direct palpation method.

Conclusion: the total time taken for radial artery cannulation was lesser in ultrasound guidance as compared with direct palpation. Ultrasound guided cannulation could improve the first attempt success rate with reducing complications.

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