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Research Article

Comparative Study of Periarterial Infiltration of Nitroglycerine with Lignocaine vs Lignocaine Alone for Ultrasound Guided Radial Artery Cannulation in ICU Patients

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ABSTRACT

Background: Radial arterial cannulation is a commonly done procedure in ICU. Multiple cannulation attempts can lead to radial artery spasm resulting in low pulse volume, decreased pulse palpability and cannulation failure. This study evaluates the effects of periarterial nitroglycerine infiltration with lignocaine vs lignocaine alone in USG guided radial artery cannulation in ICU patients.

Methods: A total of 60 ICU patients in age group 18-65 years who required radial artery cannulation for ABG analysis and invasive blood pressure monitoring were enrolled. They were randomly allocated to Group LN (periarterial infiltration with 0.2ml nitroglycerine+0.8 ml lignocaine 2%) and Group L (periarterial infiltration with 1ml of lignocaine 2%) of 30 patient each. Both groups were compared with respect to radial artery dimensions before and after infiltration of drug, pulse palpability score, no of attempts, time of cannulation and failure rates.

Results: There was significantly greater increase in radial artery dimensions in group LN as compared to group L after intervention. Pulse palpability score was also better in group LN. Mean time required for cannulation, number of attempts and insertion failure were significantly lesser in group LN as compared to another group. No hemodynamic adverse effect was reported in either group.

Conclusion: Periarterial infiltration with lignocaine and nitroglycerine combination increase radial artery dimension with improved cannulation success rate.

Introduction

Arterial cannulation is an essential skill required for hemodynamic monitoring in critically ill ICU patients as well as those undergoing major surgeries commonly associated with large fluid shift and blood loss like cardiac surgery, vascular surgery, obstetric hemorrhage etc. The ease of arterial blood gas sampling from arterial catheter is beneficial to the intensive care management of the patients by anesthesiologists, emergency physician and intensivists.

Among various sites available for cannulation, radial artery is most commonly chosen due to its superficial location, presence of collateral blood supply and ability to be compressed for achieving hemostasis. But few issues are experienced when attempting to cannulate radial artery like inability to thread the wire, the creation of hematomas and arterial spasm [1-2].

Radial arterial spasm has been shown to be responsible for about 38 % of total trans radial procedure failure. The radial artery is more prone to arterial spasm because it has small diameter and large muscular media with high density of alpha-1 receptors which make it prone for

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vasoconstriction [3-4]. Spasm of radial artery with multiple attempts to cannulate leads to reduction in pulse volume or even complete loss of radial pulse and cannulating radial artery with feeble pulse is difficult even by an experienced anesthesiologist. This result in abandoning the procedure and switching over to other alternative arteries causing procedural delays and discomfort to the patients.

To overcome radial artery spasm various vasodilators are used like nitroglycerine (NTG), calcium channel blocker, papaverine and lignocaine. These vasodilators increase pulse palpability, decrease insertion time, treat radial artery spasm without causing hemodynamic change in blood pressure, heart rate and mean arterial pressure [5-6]. However, literature is inconclusive about superiority of one agent over other.

Previous studies proved that intravenous, topical and intra-arterial routes of nitroglycerine lead to vasodilation of radial artery [7-8]. Some studies have also tested the effect of subcutaneous injection of nitrate on access of radial artery but these studies have shortcoming such as subjective end point, small sample size and lack of randomization. These studies are mostly done on elderly cardiac patients scheduled for cardiac catheterization [9-11].

Following a thorough review of the literature, we found that there are relatively few studies comparing the effects of nitroglycerine and lignocaine in noncardiac patients admitted to the ICU. The goal of this study was to compare periarterial nitroglycerine infiltration with lignocaine vs lignocaine alone in USG guided radial artery cannulation in ICU patients.

Methods

The prospective, randomized and single blinded study was conducted in the intensive care unit of Department of Anesthesiology and Critical Care of a tertiary care hospital following approval from institutional ethical committee and CTRI registration (CTRI /2022/07/044209). ICU patients in age group 18-65 years who required frequent ABG analysis and invasive blood pressure monitoring were included in the study. Patient with positive modified Allen's test, coagulopathy INR ≥1.5, platelet count ≤70×103 /µl, patient with peripheral artery disease, hand deformities and burn at the site of injection were excluded.

The sample size was calculated by the comparison of two mean formula in reference to the study conducted by Candemir B et al. [12].

N=Size per group

SD-Standard deviation=70

δ = mean difference= 132-75 = 57

Zα/2= Z0.05/2= Z0.025 = 1.96 — From Z table at type I error of 5 Zβ= Z0.20 = 0.842 — at 80% power

$$N = \frac{2 \times (Za/2 + Z\beta)^2}{\delta\sigma^2} \times SD^2$$

= 2 (1.96+0.84)2 (70)2 / (57)2
= 15.68 * 4900 / 3249
= 76832 / 3249
= 23.64
= 30

Thirty patients per group were required with 95 percentage significance level and 80 percentage power.

The purpose and protocol of the study was explained to all enrolled patients and informed written consent was taken from patients or their relatives. The patients were accessed prior to radial artery cannulation and patients with negative Modified Allen's test were enrolled [11]. All 60 patients were allocated to one of two groups using computer generated randomization. In Group LN(n=30)- periarterial infiltration with 0.2ml (200microgms) nitroglycerine+0.8 ml lignocaine 2% and in Group L(n=30)- periarterial infiltration with 1ml of lignocaine 2% planned.

Demographic characteristics of enrolled patients were recorded. Patient's radial artery of either hand was assessed for course and quality of artery using USG. All images were taken using Son site M-turbo ultrasound machine with HFL (38×13-16) MHz 40 nm broadband linear artery probe. Aseptic preparation of distal forearm and ultrasound probe was done. Initially the probe was placed for transverse short axis view at wrist 1-2 cm proximal to styloid process of radial bone [13]. Transverse and vertical Radial artery diameter and cross-sectional area were recorded at baseline before study drug infiltration (Figure-1).

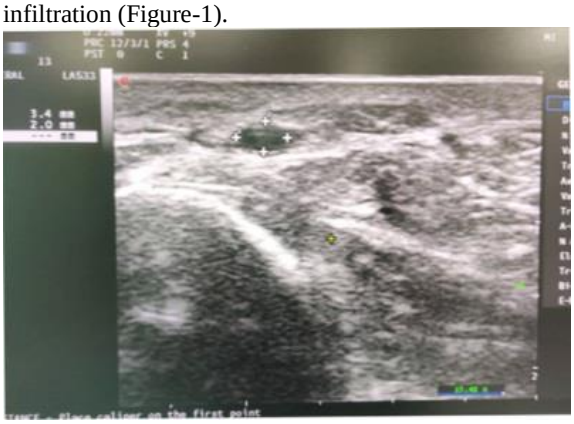

Figure 1- USG guided measurement of transverse and vertical diameter in our study after NTG infiltration

Later another anesthesiologist injected 1ml of study drug along the course of radial artery using 26 gauze hypodermic needles. This infiltration was performed as single slow injection at planned cannulation site subcutaneously as determined by USG guidance. Three minutes after infiltration, Radial artery diameters and cross-sectional area were recorded again. Pulse palpability was also assessed by using following scale-

(a). Grade 0: Radial pulse not palpable after the injection of study drug.

(b). Grade I: Radial pulse become feeble after the injection of study drug.

(c). Grade II: Palpability of radial pulse remained same after the injection of study drug.

(d). Grade III: Radial pulse become better palpable after the injection.

(e). Grade IV: Radial pulse become bounding after the injection.

After visualization of radial artery on USG screen (the 20G/1.10mm ×45mm BD) arterial cannula was inserted into skin at 350- 450 angle at point corresponding to midpoint ultrasonic probe. The entry of cannula into the artery was confirmed by visualizing the tip in cross sectioned area on USG screen and backflow of blood into arterial cannula. The angle of arterial cannula was lowered to 15° angle and cannula was pushed proximally to 2-3 mm. The stylet was withdrawn and cannula was advanced into radial artery. The arterial cannula was fixed and NIBP will be monitored with a connected pressure transducer.

Time required for cannulation was noted which was defined as time elapsed from skin puncture till catheter insertion. Number of attempts for cannulation were also noted. If cannulation was not successful after 3 attempts trial was considered as failed. Hemodynamic parameters like heart rate, SBP, DBP and mean BP were recorded before and after intervention.

Data analysis was done using licensed SPSS software version 21.0 (Chicago, Illinois). Univariate analyses were done initially and the results were presented with the help of tables, text and bar-diagrams. Descriptive statistics were used to calculate frequencies of categorical variables while measures of central tendencies and dispersion were used to describe continuous variables.

Bi-variate analyses were done using the Chi square test/Fisher's Exact test. To determine the association between categorical variables and for quantitative variable t- test or Mann-Whitney test was used. P <0.05 was considered as statistically significant.

Results

Total 60 patients were enrolled in the study. They were randomized and allocated in two groups, group L and group LN. The groups were compared with respect to age, gender, weight, height and BMI (Table 1).

Baseline transverse and vertical radial artery diameters were comparable. After 3 minutes of intervention, transverse and vertical radial artery diameters were increased in both group L and group LN. Though it increased in both groups but this difference was statistically significant in LN group. Cross sectional area was also significantly more increased in group LN as compared to group L (Figure 2) (Table 2).

Ease of cannulation was assessed by mean time required for cannulation, number of attempts, number of retractions, cannula insertion failure and pulse palpability score. Mean time required for cannulation and number of attempts were significantly less in group LN as compared to group L. Skin puncture was counted as retraction if needle was taken out of skin. There was no retraction in 43.3% patients in group L and 70.0% patients in group LN. So first attempt successful cannulation rate was 70% in group LN and 43.3% in group L which was a statistically significant difference. The failure of cannulation was lesser in group LN in comparison to group L, which was statistically significant (Table 3).

Pulse palpability score was also better in group LN in comparison to group L (Table 4).

Baseline hemodynamic parameters were comparable. Both groups showed no significant variation in hemodynamic parameters after intervention (Table 5).

Table 1- Demographic data

Demographic parameters	Group-L	Group-LN	P value
Age (mean± SD)	44.1±12.8 years	40.9±15.2years	0.387
Gender			
Males	86.7%	66.7%	0.067
Females	13.3%	33.3%	
Weight (mean± SD)	66.7±10.7 kg	63.07±10.973kg	0.203
Height (mean± SD)	2.13±2.7 meter	1.66±2.1 meter	0.340
BMI (mean± SD)	24.8±2.6 kg/m2	24.1±2.6 kg/m2	0.335

Table 2- Comparison of radial artery dimensions between both groups:

Dimensions	L (Mean ± SD)	LN (Mean ± SD)	P value
Baseline transverse diameter(mm)	2.870±.6433	2.977±.5525	0.494
3 min after Intervention	3.0033±.65468	3.6977±.57974	0.0001
Baseline vertical diameter(mm)	2.173±.4378	2.160±.4065	0.903
3 min after Intervention	2.3067±.45100	2.8340±.62648	0.0001
Baseline cross sectional area (mm2)	6.3543±2.19747	6.5253±2.10053	0.759
3 min after Intervention	6.9923±2.36688	10.5467±3.28256	0.0001

Table-3 Ease of cannulation

Parameters	Group L	GROUP LN	P value
Time required for cannulation	20.9 ± 5.1 (mean± SD)	10.1±2.2 (mean± SD)	0.0001
Number of attempts	2.40±1.59 (mean± SD)	1.63±1.13 (mean± SD)	0.035
Successful 1st attempt cannulation	43.3%	70%	
Failure of cannulation	13	4	0.010

Table 4- Comparison of pulse palpability score grade between both groups:

Grade	Group L		Group LN		P value
	Count	%	Count	%	
III	30	100%	2	6.7%	0.0001
IV	0	0%	28	93.3%	
Total	30	100%	30	40%	

Table 5- Comparison of hemodynamic changes between two groups

Hemodynamic parameters	Group L	Group LN	P value
Heart rate (beats/minute) Baseline	91.87±26.616	102.70±22.576	0.094
3 mins after intervention	91.87±26.448	103.00±22.597	0.085
Systolic BP (mmHg) Baseline	115.37±19.254	117.90±19.350	0.613
3 mins after intervention	115.43±18.807	117.83±19.501	0.629
Diastolic BP (mmHg) Baseline	77.07±13.075	75.87±10.315	0.695
3 mins after intervention	77.07±12.523	76.10±10.138	0.744
Mean BP (mmHg) Baseline	74.60±16.689	78.67±13.69	0.307
3 mins after intervention	73.97±15.725	78.60±13.531	0.226

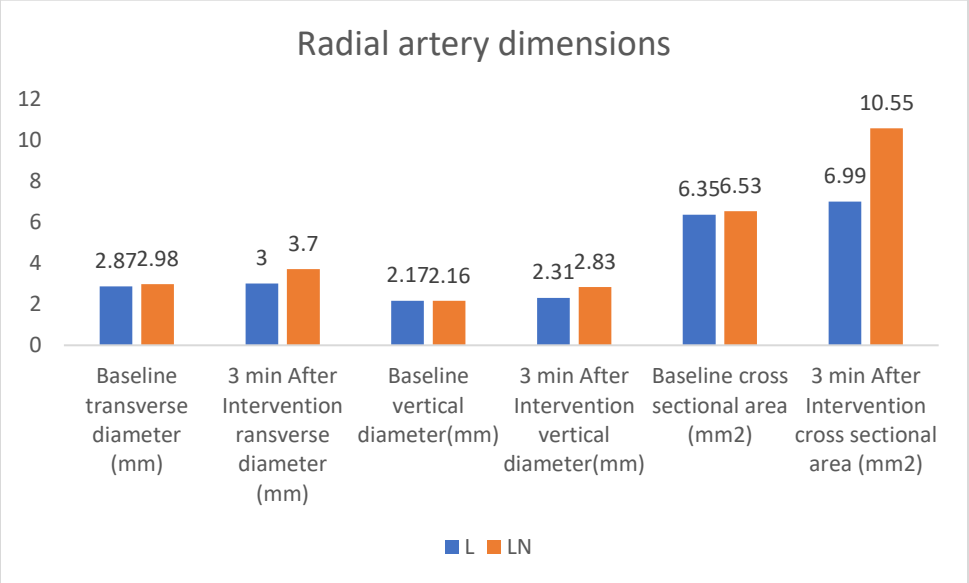

Figure 2- comparison of radial artery dimensions

Discussion

Radial artery cannulation is a commonly performed procedure in intensive care unit for analysis of arterial blood gases and invasive monitoring of blood pressure. Among various sites available for cannulation radial artery is most commonly chosen due to its superficial location and ability to be compressed for achieving hemostasis. Traditionally radial artery cannulation has been performed with aid of pulse palpation and anatomical knowledge. The location of the artery may be variable in up to 30% of patients, making it difficult to locate [2]. Furthermore, identifying the artery via palpation may be difficult or impossible in patients with severe hypotension, morbid obesity, arterial scarring, edema, and atherosclerosis. In this day and era of technological innovation, USG guided radial artery

cannulation is preferable because it has a higher first-attempt success rate, a shorter insertion time and a higher overall success rate, particularly in morbidly obese patients and neonates [14]. Hence, we chose USG guided radial arterial cannulation for our study. However, the learning curve for the techniques like ultrasound guided procedure is slow and in presence of radial artery spasm ultrasound alone cannot help.

Radial artery cannulation is sometimes encountered with difficulty due to small diameter and radial artery spasm. Radial artery spasm may occur prior to cannulation due to multiple painful punctures [16]. To overcome these problems different vasodilators like lignocaine, papaverine, nitroglycerine etc are used. These vasodilators increased pulse palpability, decrease insertion time and treat radial artery spasm.

Various routes such as intra-arterial, topical, subcutaneous and sublingual routes are used to administer nitroglycerin for radial artery dilation in adult patients. Topical nitroglycerin cream showed significant vasodilatory effects on the radial artery in healthy adult patients. Also, it has the advantage of being noninvasive. However, topical nitroglycerin should be applied on the skin for at least 30 min before radial artery cannulation. Additionally, transdermal absorption of topically applied nitroglycerin is unpredictable. Intra-arterial and sublingual routes have more systemic side effects. These side effects are not detected with subcutaneous route. Therefore, we chose to infiltrate nitroglycerin and lignocaine subcutaneously around radial artery. This route of administration allows localized effects without the possible systemic side effect [16-18].

The various parameters like demographic characteristics, radial artery dimensions, time required for cannulation and hemodynamic parameters were observed. This study included adult ICU patients with mean age 44.1±12.8 years and 40.9±15.2 years in group L and LN respectively. Mean age was higher in studies conducted by Pancholy et al, Candemir et al and Ezhumalai et al as they included the older patients undergoing coronary angioplasty for coronary artery disease which is generally a disease of old patients [9-11]. Mean age was lower in a study conducted by Jang et al as his study included pediatrics population less than 2 year [20]. Mean BMI in our study was 24.7673±2.61766 kg/m2 in group L and 24.1163±2.56922 kg/m2 in group LN respectively. As compared to this study mean BMI was higher in a similar study conducted by Quadhour et al as they noted a subgroup with a high-risk failure of radial access (i.e., female patients with BMI>27kg/m2) [16]. Hefnaway et al also observed higher BMI as this study included only morbidly obese patients [19]. In our study both groups were comparable in term of demographics like age (years), gender, height(m), weight (kg) and BMI (kg/m2).

We used 0.2ml nitroglycerine + 0.8ml lignocaine 2% for one group (Group LN) and 1ml of lignocaine 2% in another group (Group L). We used lesser volume of drugs as radial pulse may become feeble after subcutaneous infiltration of large amount of local anesthesia resulting in difficulty in puncture.

The primary finding of this study was that the periarterial infiltration of nitroglycerine with lignocaine before radial artery cannulation caused greater increase in first-attempt success rate by increasing the dimensions of the radial artery as compared to lignocaine alone. We also found that periarterial infiltration of nitroglycerine along with lignocaine caused more decreases in number of cannulations attempts and procedure time without significant changes in hemodynamics as compared to another group.

After subcutaneous injection of study drug baseline transverse radial artery diameter, vertical radial artery diameter and cross-sectional area were increased in both groups but there was statistically significant increase in group LN in comparison to group L. This increase in radial artery dimensions is consistent with the notion that nitroglycerin act as NO doner, which stimulates production of cGMP leading to relaxation of arterial vascular smooth muscle and vasodilatation [7].

Our results were consistent with the few studies. Ezhumalai et al study included patients taking anti-ischemic medications including nitrates [9]. They did not study the confounding effect of vasodilation produced by these medications. Candemir et al also have similar results but they compared prilocaine and nitroglycerine [12]. The total solution infiltrated (1 ml) was lesser in our study with similar results as compared to above studies. Chen et al also observed an increase in transverse radial artery diameter as they infiltrated NTG alone but it was a single blind study and they assessed radial artery diameter before and 24 hours after infiltration to assess radial artery occlusion post catheterization [10]. Transverse radial artery diameter was smaller in a study conducted by Jang et al as this study was on pediatric population [20]. Also, they have done assessment in anesthetized patients and general anesthetic agents can confound the vasodilatory effect of nitroglycerine.

Mean time for cannulation and number of attempts were less in group LN as compared to group L. Our results are in agreement with findings of previous studies [5,12,18]. Quadhour et al assessed only duration of puncture and no of attempts, no objective assessment done by USG [16].

First attempt successful cannulation rate was 70% in group LN and 43.3% in group L. Similarly, Hefnaway et al also observed that first attempt success rate was higher in LN group [19].

In present study, in group L all patient had pulse palpability score 3 while in LN group 28 patients had pulse palpability score 4 and 2 had pulse palpability score

3 which was found to be statistically significant (p=0.0001). Pancholy et al also observed better pulse palpability with both subcutaneous and sublingual NTG [15]. Candemir et al and Ezhumalai et al also found similar improvement in pulse palpability score [9,12].

In our study, no statistically significant difference in hemodynamic parameters was observed in both groups similar to other studies [10-11,20].

Conclusion

Thus, we find that, the use of both lignocaine as well as lignocaine plus nitroglycerine combination improve the radial artery diameter, cross-sectional area, pulse palpability score as observed by USG. This helps in reducing the time of cannulation, decreases the number of required attempts and improves the first attempt success rate while maintaining stable hemodynamics.

Our study also had a few limitations. It was a single blind study, including only adult ICU patients. Further studies with larger sample size including all age groups and wider variety of patients are recommended in future.

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