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USG Guided Supraclavicular Verses Infraclavicular Approach for Left Sided Subclavian Vein Catheterization in Critical Care Settings: A Prospective Randomized Study

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Abstract

Background & Aims

Subclavian venous (SCV) access remains preferred choice for prolonged central venous catheterisation (CVC). Typically, right sided subclavian venouscatheterisation is preferred over left sided cannulation due to its anatomical complexity& complications strung. The purpose of this study was to compare supraclavicular (SC) & infraclavicular (IC) approaches for left sided subclavian vein CVC under ultrasound (USG) guidance.

Method

A total of 438critically ill patients were randomly allocated into two groups by computer generated sequentially numbered sealed envelope technique (SNOSE), namely group SC & IC(n=219). Left SCV was catheterised through supraclavicular approach in Group SC and through infraclavicular approach in Group IC under USG guidance. The primary outcome of this study was success rate with both approaches and secondary outcomes were mean access time, mean number of attempts and complications.

Results

The success rate was higher in SC group compared to IC group (94.5% vs 90% for SC& IC respectively, p = 0.00001).First attempt success ratemean no of attempts and mean access time was also sound with SC approach compared to IC approach. Complications were significantly lower in SC groups compared to IC approach. (p=0.03078)

Conclusion

Supraclavicular approach is superior when compared to infraclavicular approach to left subclavian vein catheterization in terms of its higher success rate, lesser access time and lesser complications.

Keywords

Subclavian vein, central vein catheterization, Ultrasonography

Introduction

Central venous catheter (CVC) insertion isone of the most commonly performed procedure in critical care settings and in some major surgeries. Subclavian vein (SCV) is achosensite for central venous cannulation owing to its lower risk of infection & thrombosis and increased patient comfort. [1,2]However, its close proximity to lungs pleura, neurovascular structures make it unsafe to attempt.[3,4]

CVC placement is more challenging on left side due to its anatomic complexity, higher dome of pleura and thoracic duct on left side.Pre-existing literature suggests higher success rate and less chance of catheter malposition with left side SCV cannulation.[5] US guided cannulation has added advantage of improved safety and reduced complications..[6]

To the best of our knowledge, none of the existing studies compared SC and IC approach of left SCV cannulation. Although there are few articles comparing both approaches on right side and suggested a higher success rate with SC approach because of its superficial course and position away from clavicle..[7-10]Hence, the present study was planned to compare SC and IC approach in terms of first attempt success rate of venous catheterization as primary outcome. Mean access time, mean number of attempts and complications were considered as secondary outcomes.

Materials and Methods

The present prospective randomized double - blinded study was carried out at tertiary centre teaching hospital after approval from Institutional Scientific and Ethics Committee. The study was conducted as per consort guidelines and followed ethical guidelines of the Declaration of Helsinki. This study included patients of 20 to 80 years age requiring left SVC catheterization in critical care unit. Those patients who had coagulopathies, distorted chest anatomy, superior vena cava syndrome, infection at site of cannulation, pregnancy, obvious source of infection, infective endocarditis, retroviral disease, previous lung & chest surgeries and on anticoagulants & immunosuppressive drugs were excluded from the study.

For the sample size calculation, a pilot study was conducted in 40 patients who were equally distributing among supraclavicular (SC) group and infraclavicular (IC) group due to the lack of previous study comparing these approaches for CVC in critical care. We observed 90% success rate in SC group compared to 80% in IC group. Taking these into consideration, with confidence level of 95% and

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power of 80%, minimum sample size of 219/group was required to compare the success rate of both approaches as calculated using Epitool, developed and maintained by AUSVET, Bruce ACT, Australia.

A total of 474 patients were assessed for eligibility and36 were excluded since not meeting the inclusion criteriaor tumbled in exclusion criteria. A consolidated standard of reporting trials flow diagram is depicted in Figure 1.Patients were randomly assigned by computer generated number into two groups (n=219); Group SC & Group IC according to the approach of left subclavian vein cannulation. Group SC was catheterised through supraclavicular approach and group IC was catheterised through infraclavicular approach into left SCV under USG guidance. The allocations were concealed in sequentially numbered, sealed, opaque envelopes.

Before the procedure, all the patients were evaluated & examined thoroughly with regards to history, physical examination and investigation. Hemodynamic parameters were observed throughout the procedure. Patient was placed supine with head in neutral position and arm by the side with 30^0 Trendelenburg tilt for left SCV catheterisation. The procedure was performed under proper sterile preparations using seldinger technique with the help of USG machine (Mindray 3C5s) by experienced anaesthesiologist who had experience of at least 50 successful US-guided SCV catheterizations. Size 18G CVC was used and lumens of the catheter were selected according to the patient's need.

Infraclavicular Approach

The subclavian and axillary veins were visualized by placing a high frequency linear probe (2-12MHz) in the infraclavicular fossa in order to obtain a short axis view of the subclavian vein and artery. After identification of the target vessel, the vein was positioned centrally on the screen and the probe was rotated, maintaining visualization of the vein, until a longitudinal view was obtained to visualize axillary vein and distal SCV, as well as the pleural lining below the vessel. Then, the transducer was tilted cephalad to visualize the subclavian artery in order to differentiate from vein by checking compressibility and venous pattern on pulse wave Doppler. An 18G introducer needle was inserted towards the midpoint of the small footprint of the transducer in an in-plane view. The needle was advanced slowly, while maintaining a view of the vessel and the needle throughout the procedure. Once needle had pierced the vessels and free aspirate of blood was obtained, the guide wire was inserted with the J-tip pointing caudad and the direction of travel visualized in real time.

Supraclavicular Approach

The subclavian and axillary veins were visualized by placing a high frequency linear probe (2-12MHz) in the infraclavicular fossa in order to obtain a short axis view of the subclavian vein and artery. After identification of the target vessel, the vein was positioned centrally on the screen and the probe was rotated, maintaining visualization of the vein, until a longitudinal view was obtained to visualize axillary vein and distal SCV, as well as the pleural lining below the vessel. Then, the transducer was tilted cephalad to visualize the subclavian artery in order to differentiate from vein by checking compressibility and venous pattern on pulse wave Doppler. An 18G introducer needle was inserted towards the midpoint of the small footprint of the transducer in an in-plane view. The needle was advanced slowly, while maintaining a view of the

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vessel and the needle throughout the procedure. Once needle had pierced the vessels and free aspirate of blood was obtained, the guide wire was inserted with the J-tip pointing caudad and the direction of travel visualized in real time.

Supraclavicular Approach

High frequency linear USG probe was kept on left side of neck and internal jugular vein (IJV) in short-axis view was traced down till IJV-SV junction in supraclavicular area. The probe was turned laterally to visualize the long-axis of SCV and the brachiocephalic vein and doppler profile checked. For obtaining the best longitudinal view of subclavian vein, the US probe was slightly rotated and tilted caudally with the subclavian artery in view. The needle was then introduced in plane under real time US guidance and advanced slowly considering lung pleura underneath the vessels. The needle tip was visualized till it entered the vein and a free aspirate of blood was obtained in the syringe. Then, the guide wire was inserted with the J-tip pointing caudad through the needle and the direction of travel in the subclavian vein entering the brachiocephalic vein was visualized in real time.[12]

Whenever needle visualization was lost, needle advancement was stopped, withdrawn slightly and re-visualized before proceeding. Catheterization was completed using Seldinger method. Catheter was sutured with 2.0 sterile silk. Sterile transparent dressing was applied.

Both groups were compared with respect to 1stattempt and overall success rate, mean access time (mean puncture time & mean catheter insertion time), mean number of attempts, and any procedure related complications. The puncture time was defined as the time from the initial skin puncture to the aspiration of blood from the SCV through the needle. The catheter insertion time was defined as the time from blood aspiration through the needle to free aspiration through the catheter. Procedural time/ mean access time was the sum of puncture time and catheter insertion time. The number of attempts was defined as the number required for each needle advance to puncture the vein and maximum 3 attempts were allowed in either approach. Complications, including arterial puncture, malposition, pneumothorax and infection were also recorded. All successful procedure was confirmed with radiographic check. In case of failure, internal jugular vein was catheterized.

Statistical Analyses

Statistical analyses were performed using SPSS 19.0 (SPSS, Inc., Chicago, IL, USA). Normality tests were performed using the Kolmogorov–Smirnov test. All data are expressed as the mean (SD) [range], number (%), or median [interquartile range (IQR)] as indicated. Data between the groups were compared using the x2 test, the Mann–Whitney U-test, and Student's t-test as appropriate. Statistical significance was defined as P=0.05.

Results

In this present study, demographic profile of both the groups were statistically comparable. (Table 1).

The first attempt success rate and the overall success rate of catheterisation via SC approach was significantly higher than IC approach. Mean access time as well as the mean no of attempts were significantly lesser in SC approach compared to IC approach. (Table 2)

The incidence of complications including pneumothorax, malposition and infection was lower in SC group compared to IC group, but it was

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statistically akin. The incidence of arterial puncture was also lower in SC group compared to IC group which was statistically significant(p= 0.03078). (Figure 2).

Discussion

The comparison on supraclavicular and infraclavicular approaches of left subclavian vein in critically ill adult patients was not done in any studies conducted so far. Establishing a safe and functional iv access is vital in critically ill patients. Due to advancements, expertise and courage to attempt the CVC made it a valuable part of critical care. It is a crucial intervention in critically ill patient for volume resuscitation, interventional monitoring, transvenous cardiac pacing, drawing blood and haemodialysis access. This not only provide patient comfort but also has lower infection rate compared to other routes of CVC. The right SCV route is more simple, short and straight compared to left. Left sided thoracic duct & increased risk of pneumothorax alsodefyan attempt of CVC on left side. A potential advantage of left sided access is the easier sweeping curve of left innominate vein that lead to SVC located in right mediastinum.

In our study, significantly higher success rate was observed in SC approach as compared to IC approach. Thakur A et al found a higher success rate in SC group compared to IC group though it was on right side (96.7% vs 90 %, respectively). But the values were higher when compared to our study could be attributed due to right sided approach and small sample size(n=60)in their study.

First attempt success was significantly higher in SC group (92.79⁄) as compared to IC group (88.28⁄) in our study. Also, the mean number of attempts were lower in SC group. This might be because of shorter distance from skin to subclavian vein insupraclavicular approach, straighter pathway to SCV, less chance of pleural and arterial puncture. The US guidance further facilitated success rate, efficiency, and reduced complications. Karthik K et aland Prasad R et al[4]observed a higher first attempt success rate in SC approach although it was statistically insignificant. This difference might be due to non-deployment of USG in their study. The first attempt success rate was 82.4% vs. 61% in SC and IC approach, respectively (p = 0.01), as reported by study conducted by Soudaka A et al and Kocum et al,which is similar to our study. [6, 7]

Mean access time was significantly lesser in SC approach compared to IC approach in our study. Thakur A et al also observed significantly lesser mean access time for SC approach (4.30±1.02 min) compared to IC approach (6.07±2.14 min)for right SCV catheterisation like our study. Similar findings were also seen in the study done by Kim J et al. [5]

Every invasive procedures under USG guidance increases the chance of accomplishment and decreases the prospects of complications. In our study, we documented a decrease in rate of complications like arterial puncture, pneumothorax, brachial plexus injury and hematoma formation by application of USG with both approaches of left SCV catheterisation. A study by Fragou M et al compared USG and landmark technique & found that time to obtain vascular access and numbers of attempts were significantly lower using real time US guidance (p< 0.05). [10]

There were no life-threatening complications observed in our study. The incidence of pneumothorax, arterial puncture, malposition and infections were lower when in SC approach compared to IC approachof our study, even though the results

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were not statistically significant. Although SC approach was technically difficult because of the little room availability for positioning the transducer while inserting the needle. The difference in ability to view and identify the needle tip varies with individuals which could be the reason for these complications even with the utilisation of USG. Apart from these difference in positional relationship of SCV to lungs, needle between two approaches also affect these parameters. Thakur A et al observed that arterial puncture in 3.3% of patients via infraclavicular approach & occurrence of hematoma at puncture site was 3.3% via supraclavicular approach.[9]Karthik K et al reported 10.3 % incidence of arterial puncture in compared to none in IC approach. Malposition was noted in 3.4% and 5.4% in SC and IC approach; respectively. Since their study was not with deployment of USG but blind approach the incidence of complications is expected to be high.

Limitations of our study was that we selected the population at convenience sample. This may lead to selection bias. However, every effort was made in patient selection was done with wide range of age and male-female distribution. USG is highly operator dependent technique. SCV was visualised using Mindray 3C5s guided machine which has its own limitations.

In future similar studies can be protracted for comparing the effectiveness with blind technique since ensuring availability of ultrasound in emergency situation would be a challenge especially in developing countries.

Conclusion

Ultrasound guided supraclavicular approach is found exceptional when compared to conventional infraclavicular approach to left subclavian vein catherization in terms of its higher success rate, lesser access time and lesser complications for critically ill patients. Hence, infraclavicular approach of left subclavian vein catherization can be used as an alternative to the traditional infraclavicular approach.

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Figures and Tables

Figure 1: Consort diagram

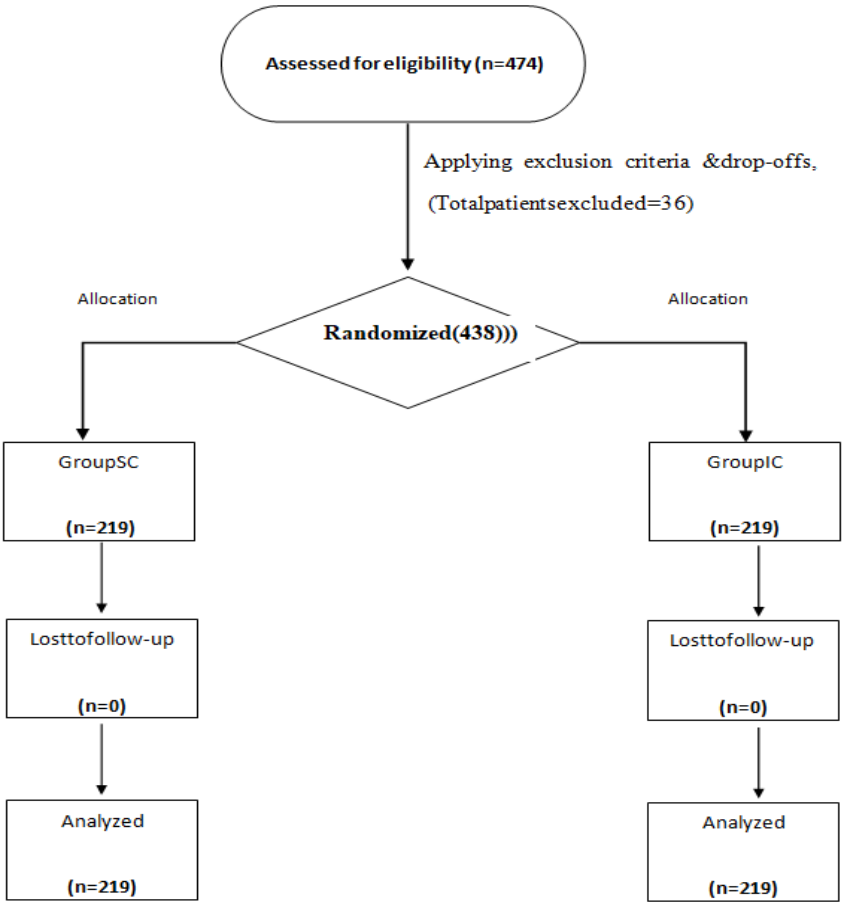

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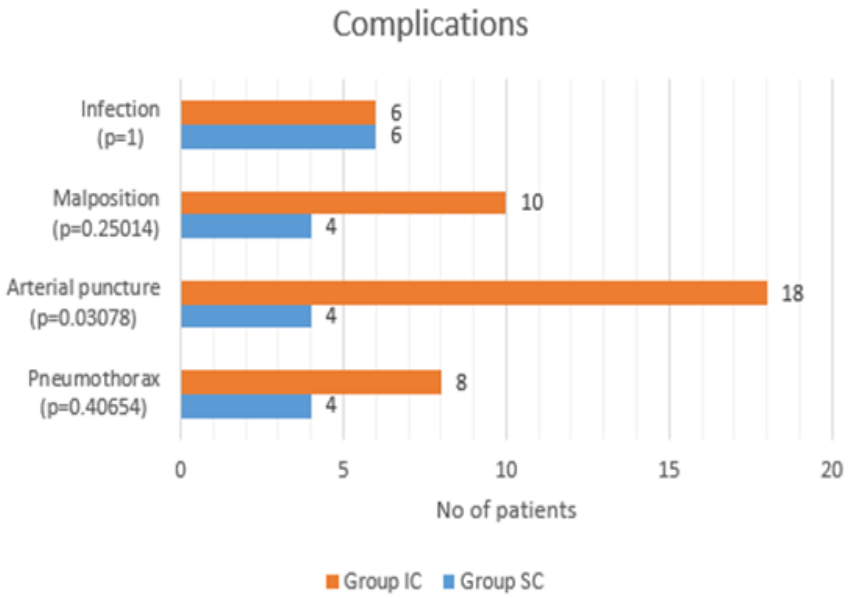
Table 1: Demographic profile

	Group SC	Group IC	p Value
Age (years) (Mean ± SD)	41.21 ± 7.64	42.22 ± 6.69	0.2959
Sex			0.2693
Male (%)	57.65%	65.76%	
Female (%)	42.34%	34.23%	

Table 2: First attempt success percentage, mean number of attempts, procedure success rate and Mean time of successful catheterization

	Group SC	Group IC	p value
First attempt success (%)	92.79	88.28	0.00001
Overall success rate (%)	94.5	90	0.00001
Mean no. of attempts	1.460±0.06899	1.713±0.08322	≤0.0001
Mean access time (min)	4.10±1.20	6.30±2.24	≤0.0001

Figure 2: Complications



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