Original Research Article

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Mechanical Complications during Insertion of Central Venous Catheter in Subclavian Vein and Internal Jugular Vein: A Comparative Study

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Abstract

Background: Central venous catheters (CVC) are an essential component of modern critical care. They allow delivery of medications, intravenous fluids, parenteral nutrition, hemodialysis and monitoring of hemodynamic variables. Thus, percutaneous placement of a catheter into a central vein is a frequent procedure in many clinical settings.

Aims: To compare the ease of insertion between Internal jugular vein (IJV) and Subclavian vein (SCV) catheterisation, frequency of mechanical complications between the two routes like- Arterial puncture, Pneumothorax, Hemothorax/Hydrothorax, Subcutaneous hematoma, Misplacement of catheter.

Materials and Methods: 100 patients admitted to The Trauma Care Unit of our institution requiring CVC divided into two groups of 50 each. Group A Patients had CVC via IJV and Group B Patients had CVC via SCV. A prospective randomized double blinded clinical study has been conducted in patients of either sex fulfilling the inclusion and exclusion criteria after taking ethical committee approval and informed consent from the patients. The data was analysed using statistical methods like Chi square test, independent samples T test.

Results: The age, sex in the two groups were found to be comparable. Ijv catheterisation was significantly easier than scv (P value <0.05) and the mechanical complication like pneumothorax and misplacement of catheter was less in Ijv (P value <0.05) compared to scv although arterial puncture, subcutaneous hematoma more in scv (P value <0.05) than Ijv.

Conclusion: According to the observations and analysis of this study, catheterisation in IJV was significantly easier than SCV and has significantly lower risk of catheterisation related complications.

Keywords: Central Venous Catheters; Internal Jugular Vein (IJV); Subclavian Vein (SCV); Mechanical Complications.

Introduction

Central venous catheters (CVC) are an essential component of modern critical care. They allow delivery of medications, intravenous fluids, parenteral nutrition, hemodialysis and monitoring of hemodynamic variables [1]. Thus, percutaneous placement of a catheter into a central vein is a frequent procedure in many clinical settings. There has been an explosion of interest in the area of central venous catheterisation recently. The traditional use of catheters in anaesthesia, critical care, surgery and acute medicine continues and there is also a rapidly increasing requirement for medium or longer term central venous catheterisation for parenteral nutrition, cancer chemotherapy, prolonged antibiotics and other interventions. Recently Ultrasonography-guided catheterization has also made the procedure easy and less complicated [3]. A wide variety of different professionals are involved with the insertion, care and removal of such devices. The Inferior Vena Cava and Superior Vena Cava are generally too difficult to catheterize directly, unless imaging is

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used, because they lie deeply protected within the chest and abdomen. Therefore, they are usually catheterized more peripherally ('upstream') often with the help of a guide wire.

Four veins are commonly catheterized for percutaneous central venous access they are Subclavian, internal jugular, femoral, basilica veins [4]. The tip of most central catheters should lie in the central veins near the heart. The anatomy of these vessels is both variable and invisible to the naked eye. Therefore, a sound knowledge of the normal anatomy and common variants is an important aspect of competence for the clinician involved in the placement of such catheters. Though peripherally inserted central lines (through antecubital vein) can be done with fewer complications [7], it may not be possible in patients with severe dehydration or edema over limbs, which are commonly encountered in emergency and intensive units. The most frequently used anatomical sites for CVC insertion are the Internal Jugular and the Subclavian vein. This study is designed to compare the different mechanical complications arising during the insertion of CVC through Internal Jugular Vein and Subclavian Vein commonly used routes for central venous catherisation.

Aims and Objectives

To compare the ease of insertion between IJV and SCV catheterisation. To compare the frequency of mechanical complications between the two routes (Internal Jugular Vein and Subclavian Vein) of insertion like- Arterial puncture, Pneumothorax, Hemothorax/Hydrothorax, Subcutaneous hematoma, Misplacement of catheter.

Material and Methods

This study was conducted in Trauma care unit, Tertiary care Hospital after getting approval from Ethical Committee. Written informed consent was taken from all the patients in this study. 100 patients admitted to The Trauma Care Unit of our institution requiring Central Venous Catheterization (CVC) and fulfilling the inclusion criteria were included in the study.

Type of Study

A prospective randomized Double blinded interventional type of Hospital based controlled study.

Methods of Study

After ethical committee approval and informed consent, a clinical study has been carried out on 100 patients of either sex, aged 18 to 80 years, requiring Central Venous access. Hundred patients were randomly allotted in two groups containing fifty patients in each group.

Group A: Patients in group A had CVC via Internal Jugular Vein (IJV).

Group B: Patients in Group B had CVC via Subclavian Vein (SCV) The patients were monitored closely for any complications arising from the procedure.

Inclusion Criteria

1. Age 18 to 80 years
2. Either sex
3. Patients requiring Central Venous Access for any purpose.

Exclusion Criteria

1. Refusal of consent
2. Coagulation abnormalities
3. Infection at local site of insertion

Insertion in Internal jugular vein – Landmark Technique [8]

After applying monitors like electrocardiogram, pulse oxymetry, patient positioned with 10 degree head down (trendeleneburge position) to help distend the vein and reduce the risk of air embolism. The surface marking of the IJV was identified by placing the thumb on the mastoid process and the middle finger on the head of the clavicle. The index finger then falls on a point one-third of the way along this line, which is the approximate point of entry for the needle. The carotid artery was palpated with the non-dominant hand, adjusting the point of skin entry to be just lateral to the arterial pulse. The cannulation needle was angled downwards at about 30–40%. The needle was directed outwards towards the ipsilateral nipple, avoiding pointing it in a medial direction. Gentle suction was applied to the needle as it was slowly advanced. Recognition that a needle is in the vein was made by observing the dark colour of venous blood and non-pulsatile nature of the filling of the syringe. Guide wire passed through the vein then a dilator passed over guide wire for dilatation of the track, then catheter

was threaded over the guide wire. Once the CVC was inserted, it was sutured into place and covered with a sterile dressing. Catheter position was preliminarily confirmed by return of blood and free flow of fluid through all ports. All patients were observed for mechanical complications. The patients suspected clinically of having pneumothorax, hemothorax or misplacement of catheter tip were confirmed by bedside radiographs after procedure. All complications were managed as clinically indicated.

Insertion in Subclavian Vein (infraclavicular route) – Landmark Technique [9]

The patient was positioned supine and slightly head down. This distends the vein and reduces the risk of air embolus. A finger was inserted in the Subclavian groove and pressed medially until resistance was felt. This corresponds to the subclavius muscle. The needle was inserted below the clavicle at this point, which would be at the junction of the medial and middle thirds of the clavicle. The needle was passed towards the sternoclavicular joint and suprasternal notch. Aspiration with the syringe during passage of the needle ensured that puncture of the vein was recognized. As the vein could be transfixed with the needle, aspiration was continued on withdrawal of the needle. A wire was passed through the needle and thereafter a standard Seldinger technique was used.

The number of percutaneous punctures (needle traversing skin) was recorded. Catheterization by single percutaneous punctures by 1 operator at 1 site was considered as Easy insertion. Catheterization by multiple percutaneous punctures by 1 operator at 1 site was recorded as difficult insertion. If the puncture by one operator at one site was unsuccessful, then the site should change or the operator should cease, in which case the attempt was recorded as a Failure. A pulsatile bright red coloured blood flow through the needle was used as an indicator for arterial puncture. Other complications like pneumothorax, hemothorax, hydrothorax, subcutaneous hematoma and misplacement of catheters were diagnosed clinically and by radiographs.

Results

The age, sex in the two groups were found to be comparable. Ijv catheterisation was significantly easier than scv (P value <0.05) and the mechanical complication like pneumothorax and misplacement of catheter was less in Ijv (P value <0.05) compared to scv although arterial puncture, subcutaneous hematoma more in scv (P value <0.05) than Ijv.

Table 1: Demographic profile

	Group A (IJV); n=50	Group B (SCV); n=50	P value
Age in yrs	45.0 (mean) 16.7 (SD)	45.6(mean) 17.8(SD)	0.17
Gender	24:26	26:24	0.4

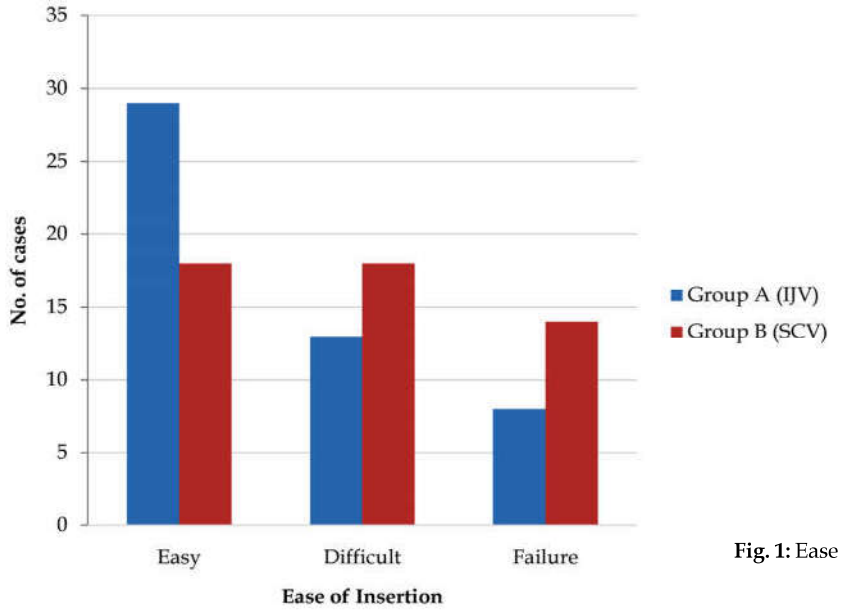

Fig. 1: Ease of Insertion

Table 2: Comparison of ease of insertion

Ease of Insertion	Group A (IJV); n=50	Group B (SCV); n=50	p value
Easy	29 (58%)	18 (36%)	0.02
Difficult	13 (26%)	18 (36%)	0.28
Failure	08 (16%)	14 (28%)	0.15
Total	50	50	

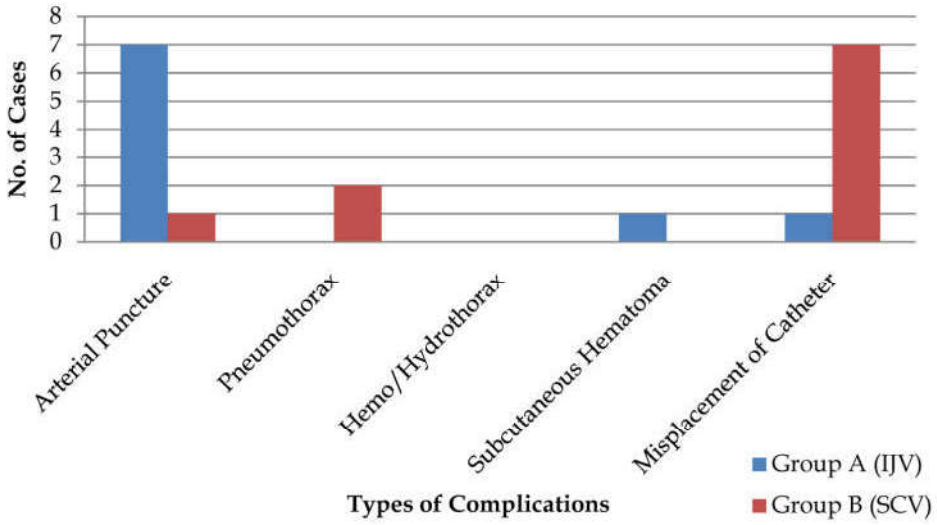

Table 3: Comparison of mechanical complications

Types of Complications	Group A (IJV); n=50	Group B (SCV); n=50	P value
Arterial Puncture	7 (14%)	1 (2%)	0.04
Pneumothorax	0	2 (4%)	0.15
Hemo/Hydrothorax	0	0	Na
Subcutaneous Hematoma	1 (2%)	0	0.69
Misplacement of Catheter	1 (2%)	7 (14%)	0.04
Total	9 (18%)	10 (20%)	0.8

Discussion

In many institution, the anatomical site of CVC insertion is chosen on the grounds of personal experience or local policies rather than on evidence-based guidelines. The aim of this study is to clarify some of the controversies that exist on the relative risk of internal jugular compared with Subclavian access [8,9]. If there is an evidence for an increased risk of specific complications with one approach, then clinicians may take advantage of that knowledge for insertion of a CVC in an individual patient.

The study design was random, 100 patients were randomly allotted in two groups containing 50 patients in each group. Procedures performed by experienced operators.

Group A: Contained patients who had CVC via Internal Jugular Vein.

Group B: Contained patients who had CVC via Subclavian Vein.

All patients underwent thorough pre-procedure assessment including detailed history, clinical examination and necessary investigations in both emergency and routine patients . All catheters were inserted after visualization of landmarks by Seldinger technique. The demographic data, number of percutaneous punctures (needle traversing skin) and the complications were recorded. In our study, success rate of single percutaneous puncture is significantly greater through Internal Jugular Vein (58%) than through Subclavian Vein (36%), with a P value of 0.02. Lewis A. Eisen et al [5] had also found that the internal jugular approach was more likely to require 1 skin puncture, but their difference was not found to be statistically significant ($p = 0.38$). Success rate of two or more percutaneous punctures is more in SCV (36%) as compared to IJV (26%); showing more 'Difficult' insertion in SCV.

Eisen et al [5] had found that more than two attempts are often required in SCV route as compared to IJV, but they had also included failures in this group. Overall rate of failure of catheter placement in our study has been found to be 22%, which is comparable to what Lewis A. Eisen et al [5] had found (22.3%). The failure of catheter placement is found to be 16% through IJV as compared to 28% through SCV. Eisen et al [5]. had found failure rate of 26.1% in SCV route and 25% in IJV route. It is quite evident from the above results that the Subclavian route has more number of failures than Internal Jugular route.

One of the most frequently reported complications of CVC insertion is arterial puncture. Based on the observations of this study, the rate of arterial puncture when internal jugular vein was chosen is 14% and when Subclavian approach was chosen is 2%. This result is statistically significant with a p value 0.03. This result is comparable to the results of Eisen et al [5] with 5% arterial puncture in IJV catheterization and 3.2% arterial puncture through SCV route. Sibylle Ruesch et al [6] had also found similar result i.e. significantly more arterial punctures with jugular catheters compared with Subclavian (3.0% vs. 0.5%, RR 4.70 [95%CI, 2.05–10.77]).

This apparently significant increased risk of arterial puncture with the jugular access, could be due to an under-reporting of arterial punctures with the Subclavian approach; as puncture of a carotid artery is usually easier to detect than puncture of a Subclavian artery. Although the puncture of a carotid artery seems to happen more often, effective haemostasis is much easier (manual compression). It is unlikely that clinicians will abandon the internal jugular access based on these risk data. Only 2 cases of Pneumothorax have occurred through SCV route and none through internal jugular route. This result is not statistically significant (p=0.15).

Eisen et al [5] had also found 5 cases of pneumothorax in SCV and none in IJV, but the difference was not significant. No cases of Hemothorax or hydrothorax have occurred in either groups. So, no difference between Subclavian route and Internal Jugular route could be elicited with respect to these complications.

These results are comparable to the study of Sibylle Ruesch et al [6] and Eisen et al [5]. It may be somewhat unexpected because many clinicians believe that the Subclavian access is more prone to these complications. Thus, the conclusion must be that, in experienced hands, both accesses have the same low risk of hemothorax, hydrothorax and pneumothorax. Only 1 case of Subcutaneous Hematoma has occurred in Internal Jugular Vein catheterization and none in Subclavian Vein catheterization. This difference is not significant. Eisen et al [5] also found such a low incidence of subcutaneous hematoma (0.5%). In their study, a single case was found through Subclavian route only. Internal Jugular vein lies quite superficial to Subclavian vein. This might explain the fact that subcutaneous hematoma can be easily diagnosed in neck. Moreover such low incidence in both the studies make no significant comparison between the two routes. The data on catheter malpositioning may have more impact on clinical decision making. Malpositioning has been observed in 8% of CVCs, happening significantly less often with the internal jugular access as compared to Subclavian access [2% v/s 14%; P = 0.04]. Eisen et al [5] had also found less catheter malpositioning in insertions though internal jugular vein as compared to Subclavian vein. [0% v/s 6.4%; p=0.004] Also, malposition of a Subclavian catheter may include entry into the opposite Subclavian vein or the neck veins, whereas many jugular catheters may simply be pulled back if the tip lies in the right atrium. This is yet another argument in favour of the jugular approach. The jugular access should be chosen if a fast and correct catheter tip placement is mandatory (e.g., hemodynamic monitoring in a patient in shock). Malpositioning of a CVC per se, independent of the access may lead to serious complications. The positioning of catheter tips within the cardiac silhouette is associated with an increased risk of cardiac tamponade. It can be seen that the choice of approach can be a complicated process. Other factors like infectious and thrombotic complications, convenience of access, patient factors, the indication for the device, the experience of the operator plus the competence of the operator at each site; also needs to be considered which are beyond the scope of this study. The choice of access site should be individualised for each patient dependent on their characteristics. The aim is to achieve satisfactory function whilst minimising the risks which vary between both patients and approaches.

Conclusion

According to the observations and analysis of this study, catheterisation in Internal Jugular Vein is significantly much easier than SCV and has significantly lower risk of catheter misplacement.

Pneumothorax is also less common in IJV catheterisation. However, even though the risk of arterial puncture is significantly more in IJV route than in SCV route, effective haemostasis is much easier (manual compression) in carotid artery which is more superficial than Subclavian artery. As far as mechanical complications and ease of access are considered, Internal Jugular Vein catheterisation is better than Subclavian catheterisation. More studies with larger sample sizes are needed to determine methods to decrease complications rates further.

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