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Original Research Article

A clinical study on immediate complications of central venous catheter insertion in surgical patients in a tertiary care hospital

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ABSTRACT

Background: Central venous access is a common procedure performed in management of the critical patients. Central venous catheters (CVC's) are used for delivery of intravenous fluids, medications, parenteral nutrition and monitoring of hemodynamic variables. However, placement of the central lines is not without risks, and there are complications associated with their placement which could be serious and sometimes can be life threatening. Complications can present in an immediate or delayed manner and they may vary based on the type of central venous access.
Methods: This prospective, observational study was conducted from 1st November 2017 till 31st April 2019 on patients admitted under the department of surgery at Christian medical college and hospital, Ludhiana.
Results: Complications were seen in 16.67% of the patients. Arterial puncture was noticed in 13.33%, bleeding 5.33%, hematoma 4.67% and malposition of central line in 2%. Bleeding was found to be more in internal jugular vein (IJV) access 5.71% compared to subclavian vein (SCV) 4.44%, hematoma 4.76% in IJV compared to SCV 4.44%. Coiling of the central line was noted to be more in IJV 2.86% compared to SCV 0.00%. The incidence of immediate complications was noticed to be more with IJV than subclavian approach and when more than 2 attempts were made.
Conclusions: This study concluded that incidence of immediate complications was noticed to be more with IJV than subclavian approach and when more than 2 attempts were made.

Keywords: Central venous catheters, Immediate complications, Surgical patients

INTRODUCTION

Central venous catheters (CVC's) play an important role in the management of critically ill patients. However, the placement of CVC's is not free from risks and could be associated with complications which could be mechanical, infectious and thromboembolic complications. Immediate complications occur at the time of catheter insertion and include vascular, cardiac, pulmonary complications. Delayed complications include infection and device dysfunction.[1]

Factors which determine risk of complications related to placement of central lines can be: Patient related factors (local anatomy, nature of underlying disease, comorbidities, thrombocytopenia). Catheter related factors (type of catheter, material of CVC, how CVC is used). Site of CVC insertion (internal jugular vein (IJV), femoral, SCV. Catheter care and its usage by medical and nursing staff.

Mechanical complications associated with insertion of central lines include arterial puncture, hematoma,

pneumothorax, hemothorax, misplacement of catheter tip, air embolism. Mechanical complications have been reported to occur in 5 to 19 percent of patients.[2,3] Use of ultrasound has significantly reduced incidence of immediate complications from 11.8 to 4 to 7%.[4-7] Delayed complications include infection, thrombosis and occlusion. Infectious complications are reported to occur in 5% to 26% and thrombotic complications in 2% to 26% of patients.[2,3]

The objective of the study was to identify, prevent and manage the adverse outcomes of central venous catheter insertion that can occur during or immediately after the procedure. Minimize the patient morbidity and mortality and to improve the clinical outcomes in critically ill patients.

METHODS

Study design

This was a prospective, observational study conducted on patients admitted under the department of surgery at Christian medical college and hospital, Ludhiana.

Study duration

The study was conducted from 1st November 2017 till 31st April 2019.

Inclusion criteria

Patients who required CVC in emergency, surgical ward, operation theatre or intensive care unit and age more than 18 years were included.

Exclusion criteria

Patients admitted with CVC's already inserted from outside medical facility were excluded.

Ethical approval

The study was initiated after obtaining approval by the institutional ethics committee.

Data collection

A written informed consent was taken prior to CVC insertion. CVC was either inserted by a consultant or a postgraduate resident into the IJV or SCV in an absolutely sterile condition via the Seldinger technique. The catheter used was Certofix Trio V715 which is 18 gauge, 15cm long catheter. Once the CVC was inserted it was covered with a sterile transparent dressing. Date, side and site of cannulation and number of punctures required for successful cannulation as well as complications, if any, were noted. Chest Xray was done on all patients post procedure to verify the position of tip of the CVC.

Sample size and statistics

Prospective analysis of 150 patients who underwent central venous catheter insertion in the IJV/SCV were included in this study. The presentation of the categorical variables was done in the form of percentages (%). The data entry was done in the Microsoft excel spreadsheet and the final analysis was done using SPSS version 21.0. Descriptive analysis was done and statistical test used was Pearson's chi square test, Fischer exact test. $P<0.05$ was considered statistically significant

RESULTS

Total of 150 patients requiring CVC in the SCV or IJV were included. Central venous cannulation was either done by the consultant or the residents. Patients in the age group of 18-70 years were included. Majority of central lines were inserted on the right side 32.67% compared to the left side 18.67%. However, the side of insertion of the line had no significant correlation with the immediate complications ($p=0.061$). Higher incidence of complications was seen females (25.76%) in comparison to males (9.52%) ($p=0.008$).

Complications were seen in 16.67% of the patients. Table 1 shows arterial puncture was noticed in 13.33%, bleeding 5.33%, hematoma 4.67% and malposition of central line in 2%. Table 2 shows bleeding was found to be more in IJV 5.71% compared to SCV 4.44%. Hematoma was seen more in IJV 4.76% compared to SCV 4.44%. Coiling of the central line was noted to be more in IJV 2.86% compared to SCV 0.00%. The incidence of immediate complications was noticed to be more with IJV than subclavian approach. However, the p value obtained was not statistically significant for each complication with the site of insertion.

Majority of lines were inserted by residents in 119 patients (79.33%) and by consultants in 31 patients (20.67%). Complications were more in residents compared to when inserted by the consultants.

Figure 1 shows that 59.33% of cannulations were done in 1st attempt. 24.00% required 2 attempts and 16.67% required >2 attempts. CVC's requiring 2 attempts had complication rate of 27.78% and those requiring >2 attempts 60.00%. No complication was noted in patients where central line was inserted in 1 attempt. The p value obtained was significant ($p<0.0001$). Figure 2 shows out of 150 central lines, there was failed insertion of the central line in the IJV in 5 patients (3.33%) and thereby the line put in the SCV.

Majority of lines were inserted in ICU. Maximum percentage of immediate complications were noted when the line was inserted in the Ward 26.09% and when inserted in emergency 25.00% compared to when inserted in ICU and OT. However, p value obtained was not statistically significant.

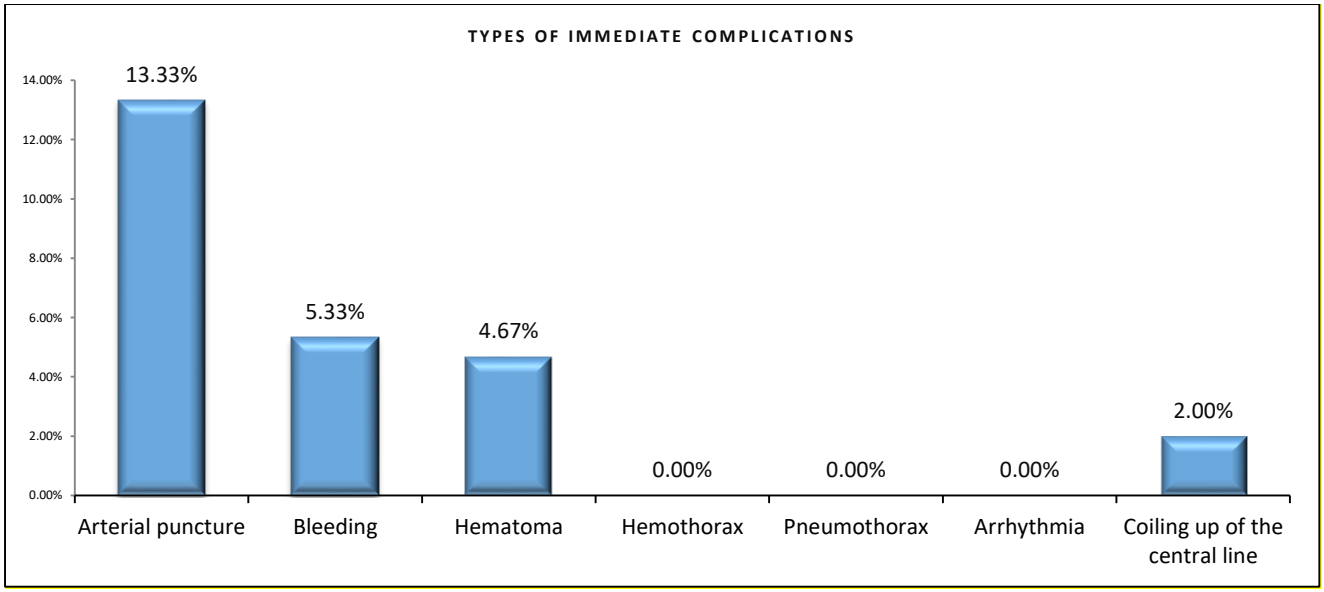

Figure 1: Immediate complications in central venous catheter insertion.

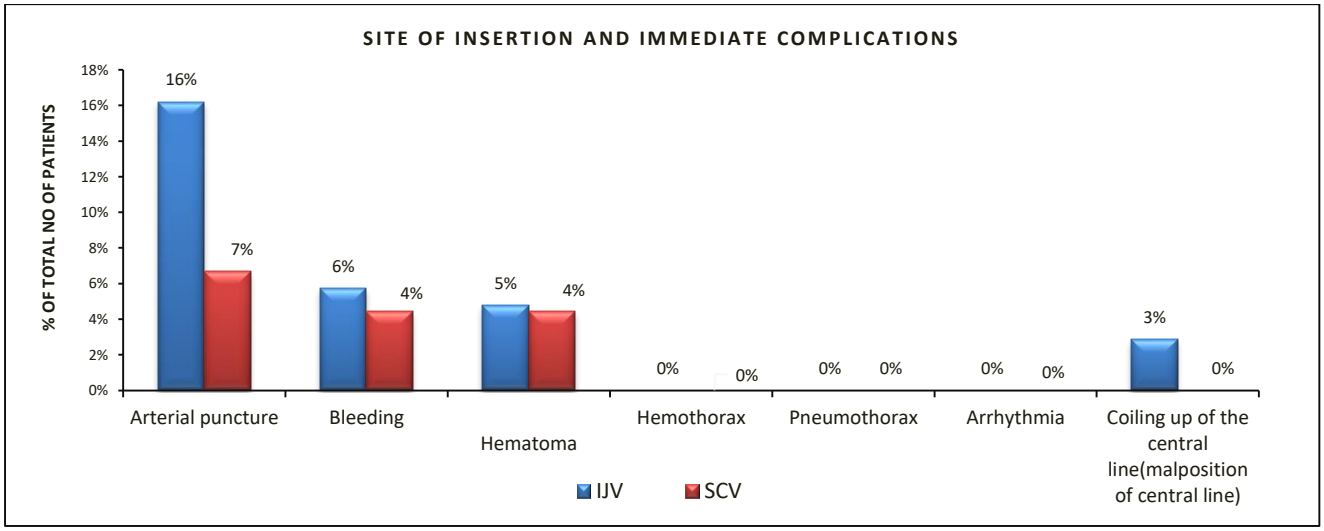

Figure 2: Complications with the site of insertion (IJV and SCV).

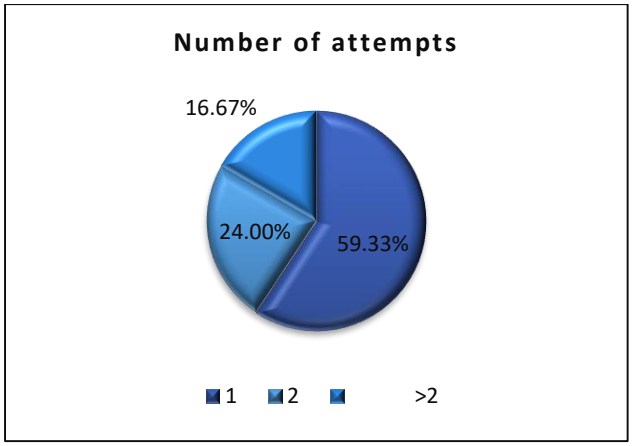

Figure 3: Number of attempts required in cannulation.

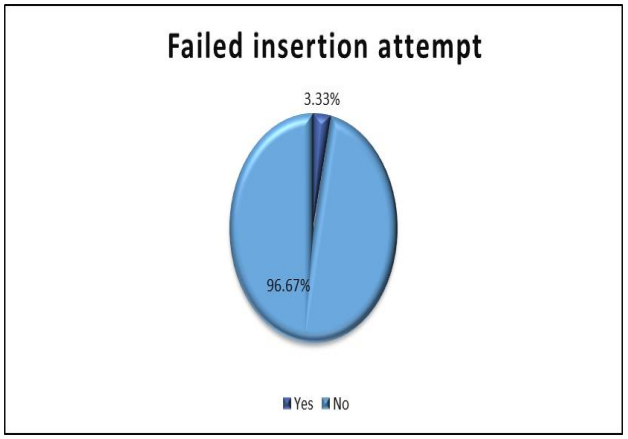

Figure 4: Failed attempts in CVC insertion.

Table 1: Demographic profile and insertion characteristics.

Variables	Patients, N (%)	P value
Total CVCs		
IJV	101 (67.3)	
SCV	49 (32.6)	
Mean age (in years)	55	0.195
Gender		
Male	84 (56)	0.008
Female	66 (44)	
Side of insertion		
Right	122 (81.33)	0.061
Left	28 (18.67)	
Number of attempts		
1 attempt	89 (59.33)	
2 attempts	36 (24)	<0.0001
>2 attempts	25 (16.67)	
Failed attempts		
Yes	5 (3.33)	<0.0001
No	145 (96.67)	
Level of experience		
Residents	119 (79.33)	0.292
Consultants	31 (20.67)	

Table 2: Immediate complications associated with CVC insertion.

Variables	Site of insertion (%)		Total, N (%)	P value
	IJV	SCV		
Arterial puncture	16	7	20 (13.33)	0.188
Bleeding	6	4	8 (5.33)	1
Hematoma	5	4	7 (4.67)	1
Hemothorax	0	0	0 (00.00)	-
Pneumothorax	0	0	0 (00.00)	-
Arrhythmia	0	0	0 (00.00)	-
Malposition of line	3	0	3 (2)	0.554

DISCUSSION

Central venous cannulation is an important tool in the management of critically ill patients. Three common sites of cannulation are IJV, subclavian and femoral vein. The ideal site of catheterization would be the one that has least mechanical complications, less rate of infection and thrombosis. SCV has lower infection rate as compared to the other sites. Despite their utility placement of CVCs is associated with mechanical, infection and thromboembolic events, increase in the hospital stay and increase in the cost of the management of these complications.[8]

In this study majority of CVCs were inserted in males 84 patients (56%) and females 66 patients (44%). Higher incidence of complications was noted in females (25.76%). The p value obtained was statistically significant. Mansfield et al had similar findings in their study for the higher frequency of complications in females. The reason is unclear but could be related to the anatomical differences.[9]

Majority of central lines were inserted in the IJV i.e. in 101 patients (67.33%), the reason may be residents are more familiar with the IJV cannulation. Comparatively lesser number of central lines were inserted in the SCV i.e., in 49 patients (32.67%). In study done by Akmal et al 464 CVCs (35.1%) in the IJV and 276 (20.9%) in the SCV. Incidence of immediate complications were noted to be higher in IJV compared to SVC.[10] Majority of lines were inserted on the right side i.e. 122 patients (81.33%) compared to left side 28 patients (18.67%). In the study by Ishizuka et al it was reported that the vertical and horizontal diameters of the right IJV were significantly larger than those of left IJV. The right IJV runs more superficially than the left. Thus, the right sided approach is more acceptable than the left sided CVC insertion.[11] Anatomically the right jugular vein is more commonly used because the right jugular vein drains immediately into the superior vena cava, however the left does not. The apex of the left lung is located at higher level than the right lung. So, the left jugular central line has a higher chance of developing pneumothorax.[12]

Maximum number of central lines were inserted by the PG residents i.e. in 119 patients (79.33%) and by consultants in 31 patients (20.67%). Complications were more when inserted by 2nd year residents 20.29% and by the 3rd year residents 17.39% compared to when inserted by consultants 9.68%. Complications were also more in the resident's group 37.68% than the consultants 9.68%. Sznajder et al have reported complication rate of 5.4% for experienced and 11% for unexperienced group.[5]

The 59.33% of cannulations were done in 1st attempt. 24.00% required 2 attempts and 16.67% >2 attempts. CVC's requiring 2 attempts had complication rate of 27.78% and those requiring >2 attempts 60.00%. Study done by Eisen et al CVCs requiring 2 punctures had a complication rate of 28% and those requiring more than 2 punctures had a complication rate of 54%. Operators with lower level of experience required more punctures.[12] Mansfield et al described how rate of complications increases with more than 2 needle insertion and that more than 2 attempts by same medical person should be discouraged when catheterization is elective.[9]

Maximum percentage of complications were noted when the line was inserted in the ward 26.09% than when inserted in emergency 25.00%. Least complications were noted in the ICU 14.13%. Reason could be faster insertion required in the emergency to save the life of the patient. Use of ultrasound for cannulations in ICU's has significantly reduced the incidence of the immediate complications.[4]

Incidence of hematoma was 4.67% and arterial puncture 13.33%. Incidence was more when placed in the emergency when time is limited to save the life of the patient, where the patient is hemodynamically unstable. The cause of bleeding could be that the patients who come to emergency are on anticoagulants and CVC would be a requirement in patients with shock.[13] Most hematomas formed during central line insertions are benign but some can become sources of infection in patients and lead to abscess formation. Blood can collect in the thorax or mediastinum and can require treatment with CT guided drainage.[15] However in this study hematoma resolved by applying pressure and no serious complications occurred.

Immediate complications were more with the IJV route of cannulation, and when more than 2 attempts were made. The cause of bleeding could be that during insertion the guide wire gets trapped against the vessel wall and subsequent insertion of the dilator or catheter can lead to injury of the vessel wall.[15] In the study done by Merrer et al and Reusch et al they reported similar results that arterial puncture and hematoma were more common with IJV compared to subclavian.[3,14] Merrer et al had reported incidence of arterial puncture was more during the internal jugular cannulations (6.3-9.4%) than with subclavian (3.1-4.9%).[3]

Malposition of central line was noted in IJV (2.86%) however it was not seen with the subclavian site of insertion. These results were in contrast to other studies where Reusch et al have reported that the incidence of malposition to be 9.3% with subclavian approach compared to 5.3% with the IJV.[14]

There was no incidence of hemothorax, pneumothorax and arrhythmias in either approach.

Limitations

There were several limitations in our study that can explain why some of our results differed from those in previous studies. Site of insertion was not randomised which introduced a bias of selecting the high risk patients for the IJV approach. Small sample size and short study period. Use of ultrasound for inserting the lines in ICU, not when the line was inserted in the wards or emergency.

CONCLUSION

The observations of complications associated with central line insertion and comparing the results with the review of literature, we concluded that IJV route of cannulation was noted with more incidence of bleeding complications in this study this may be because IJV was more frequently cannulated than the SCV. The incidence of hematoma, bleeding and arterial puncture increased with the increase in the number of attempts. Ultrasound is an important equipment for CVC insertion to avoid immediate complications.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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