Original Article

DOI: 10.17354/ijss/2016/160

Incidence of Infectious Complications in Central Venous Catheterization: Internal Jugular versus Subclavian Route

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Abstract

Introduction: Central venous catheters (CVC) are increasingly becoming an essential component of modern critical care. Despite their utility, placement of CVCs is often associated with mechanical, infectious, and thromboembolic complications.

Purpose: The present study was designed to compare the incidence of infectious complications in CVC by landmark technique between two routes (internal jugular and subclavian).

Materials and Methods: After approval from the Hospital Ethical Committee, the present study was conducted in 100 patients admitted to the medical intensive care unit (ICU)/surgical ICU of Shri Ram Murti Smarak Institute of Medical Sciences who underwent CVC for various reasons. Patients were divided into two groups: Group A - Internal jugular vein (IJV) and Group B - Subclavian vein with 50 patients in each group.

Results: The incidence of infectious complications in our study was 12% (exit site infections 7%, catheter tip infections 3%, and catheter-related bloodstream infection [CRBSI] 2%).The incidence of infectious complications in the internal jugular group (exit site and catheter tip) was more as compared to the subclavian group. The incidence of infection in IJV group can be attributed to its proximity to the oral cavity where the presence of oral secretions can result in infection at this site. The incidence of CRBSI was similar in both groups (2%). The *P* value obtained after application of *Z*-test to these proportions gave a value which was more than 0.05 showing that this difference was statistically insignificant.

Conclusion: Internal jugular route was associated with higher incidence of infectious complications as compared to the subclavian route of CVC, but statistically the difference was found to be insignificant.

Key words: Catheter tip infections, Catheter-related bloodstream infections, Central venous catheterization, Exit site infections, Internal jugular vein, Subclavian vein

INTRODUCTION

Central venous catheters (CVCs) are increasingly becoming an essential component of modern critical care.[1] CVCs are commonly inserted for hemodynamic monitoring, volume monitoring, administration of medications, long-term total parenteral nutrition, access for renal replacement therapy, cardiopulmonary resuscitation, and difficult peripheral catheterization.[2]

Despite their utility, placement of CVCs is often associated with mechanical, infectious, and thromboembolic complications.[1]

Hospital-acquired infection is a serious problem in the intensive care unit (ICU), the susceptibility of patients in the ICU, combined with the risk factors associated with the invasive treatments and monitoring that they may be receiving, and the ICU environment itself, contribute to the increased risk of infection in this patient group.[3]

Access this article online

www.ijss-sn.com

Month of Submission : 02-2016
Month of Peer Review : 03-2016
Month of Acceptance : 03-2016
Month of Publishing : 03-2016

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There has been very little data reported from adult Indian ICU on the rates of infectious complications associated with CVC insertions.[4]

Hence, in the present study, the incidence of infectious complications during CVC by landmark technique was studied, and comparison of two routes - internal jugular and subclavian routes were done.

MATERIALS AND METHODS

After approval by Hospital Ethical Committee, the study on CVC insertions by landmark technique was conducted in the ICU on 100 patients in Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly.

Informed consent was obtained either from the patient or his or her relative. Baseline data on each patient such as name, age, sex, admission number (I.P No.), body mass index, primary diagnosis, need for CVC insertion, site of CVC insertion, were recorded.

Patients were divided into two groups alternately: Group A - Internal jugular vein (IJV) and Group B - Subclavian vein (SCV) with 50 patients in each group.

Inclusion Criteria

About 100 patients admitted to medical ICU (MICU)/ surgical ICU (SICU) of SRMS-IMS needing insertion of CVC for various reasons.

Exclusion Criteria

1. Patients with infections at puncture site
2. Deranged coagulation profile
3. Contralateral pneumothorax
4. Trauma to clavicle and upper ribs
5. Distorted anatomy of neck of clavicle
6. Cervical spine trauma
7. Post-surgical/radiotherapy.

Painting and Draping

Complete sterile-barrier precautions were followed for all CVC insertions. Strict hand washing was followed by person inserting central venous line and assisting nurse with 2% chlorhexidine for skin disinfection and wore masks, gloves, surgical gowns, and hair covers. After anatomical landmarks were visualized, the skin was prepared with chlorhexidine and draped. Lidocaine (1%) was used for local anesthesia, and the patient was sedated at the discretion of the operator.

Procedure

All cannulations were performed either by an ICU consultant or by 3rd year registrar (with a minimum prior experience of at least 25 CVC insertions), under the supervision of a consultant. Each CVC insertion attempt was considered a new attempt, and if a cannulation attempt failed and was subsequently performed by another operator, these were considered as separate insertion events. By protocol, all catheters were inserted via a modification of the original Seldinger technique.

Post Procedure

Once the CVC was inserted, it was sutured into place with 2-0 silk sutures and covered with a sterile dressing. Catheter position was preliminarily confirmed by return of blood and free flow of fluid through all ports.

Procedure characteristics were the date of insertion, site of insertion, time of procedure (day defined as 8 am to 8 pm, night as 8 pm to 8 am), number of percutaneous punctures, and whether the procedure was emergent or elective.

The procedure was defined as emergent if the operator judged that 1-h delay would be harmful. Later caring of CVP line was done by trained ICU nurse.

Follow-up

All patients were followed-up daily, and the central venous insertion site was examined for purulence or soiling. If an exit site infection was suspected, exit site swabs were sent for microbiological analysis.

If catheter tip colonization/infection or catheter-related bloodstream infection (CRBSI) were suspected, the CVC was removed and the tip of the catheter along with two sets of blood was sent for culture analysis. CVC was inspected for the presence of infection until day 7 of catheter insertion.

1. Exit site infection - Erythema, tenderness, induration, or purulence within 2 cm of skin at the insertion site of catheter along with microbiological growth on culture of the purulent exudates
2. Catheter tip colonization - Growth of more than 15 colony forming units on culture of the distal segment of the CVC with clinical signs of infection
3. CRBSI - Isolation of the same organism from the catheter tip culture and at least one of two blood cultures, along with signs and symptoms of infection.

Statistical Analysis

Data were entered using Microsoft Excel 2010 and statistical analysis was done using IBM SPSS v 20.0.0. Categorical variables were analyzed using proportions and percentages. The absence of selection bias was ascertained using Chi-square test in the demographic distribution table and the difference between proportions was analyzed using Z-test for proportions. $P < 0.05$ was considered statistically significant.

RESULTS

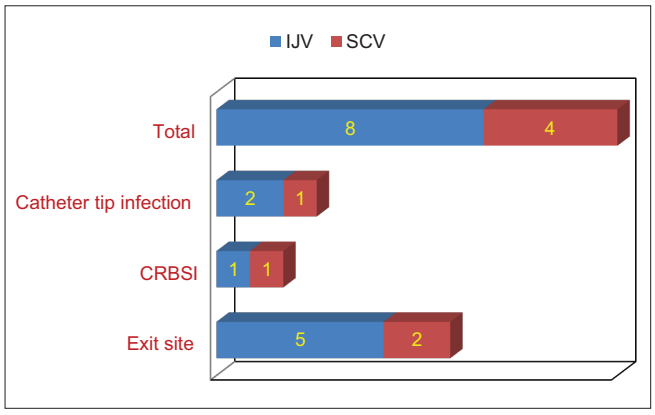
The proportion of infectious complications was higher when CVCs were inserted by internal jugular venous route (8%) as compared to the subclavian venous route (4%). The difference in proportions was tested using *Z*-test for proportions which gave a *P* value of more than 0.05 showing that the difference is statistically not significant (Graph 1).

The incidence of exit site infection was found to be more in IJV cannulations (10%) as compared to subclavian cannulations (4%). Z-test was applied to test the proportions which gave a *P* value of more than 0.05 showing that is the difference is statistically not significant (Table 1 and Graph 2).

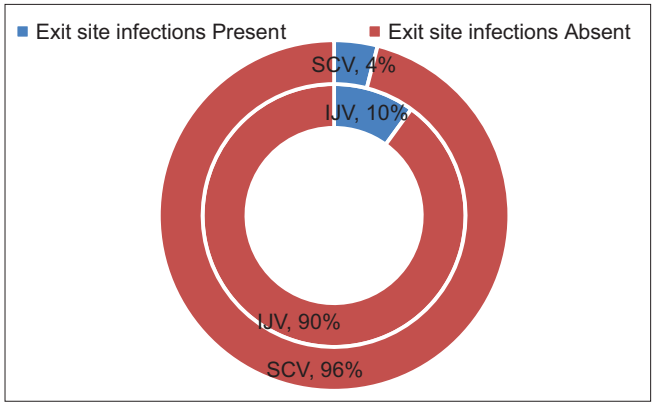
The incidence of taking two or more attempts at CVC insertion was found to be higher in internal jugular CVC (12%) and subclavian venous catheterization (10%). *Z*-test for proportions was applied to test the proportions which gave a *P* value of more than 0.05 showing that this difference is statistically not significant (Graph 3).

The incidence of catheter tip infection was found to be more in IJV cannulation (4%) in comparison to subclavian cannulation (2%). *Z*-test was applied to test the proportions which gave a *P* value of more than 0.05 showing that this difference is statistically not significant and could be by chance (Table 2 and Graph 4).

The proportion of CRBSI was found to be similar in both IJV and SCV groups (2%), and the *P* value obtained after application of *Z*-test to these proportions gave a value which was more than 0.05 showing that this difference is statistically not significant (Table 3 and Graph 5).



Graph 1: Incidence of infectious complications



Graph 2: Incidence of exit site infections in IJV and SCV

DISCUSSION

Complications associated with CVCs had a major impact on the hospital course of patients admitted to the ICU due to the morbidity, mortality, and increased healthcare costs associated with them.[4]

The present study was designed to compare the incidence of infectious complications in central venous cannulation by landmark technique between two routes (internal jugular and subclavian). After approval from the hospital ethical committee, the present study was conducted in 100 patients admitted in MICU/SICU who underwent central venous

Table 1: Incidence of exit site infections in IJV and SCV

Incidence of exit site infections in IJV and SCV	Site of insertion, *N* (%)		Total
	IJV	SCV	
Exit site infections			
Present	5 (10.0)	2 (4.0)	7
Absent	45 (90.0)	48 (96.0)	93
Total	50 (100.0)	50 (100.0)	100

IJV: Internal jugular vein, SCV: Subclavian vein

Table 2: Incidence of catheter tip infections in IJV and SCV

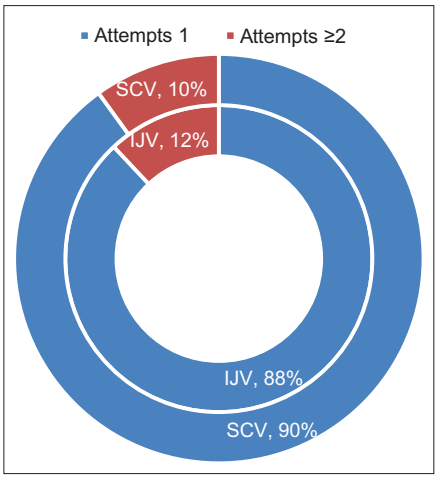
Incidence of catheter tip infections in IJV and SCV	Site of insertion, *N* (%)		Total
	IJV	SCV	
Catheter tip infections			
Present	2 (4.0)	1 (2.0)	3
Absent	48 (96.0)	49 (98.0)	97
Total	50 (100.0)	50 (100.0)	100

IJV: Internal jugular vein, SCV: Subclavian vein

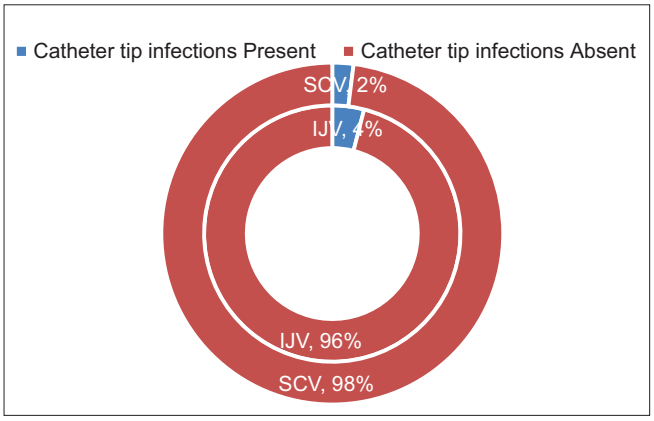
Table 3: Incidence of CRBSI in IJV and SCV

Incidence of CRBSI in IJV and SCV	Site of insertion, *N* (%)		Total
	IJV	SCV	
CRBSI			
Present	1 (2.0)	1 (2.0)	2
Absent	49 (98.0)	49 (98.0)	98
Total	50 (100.0)	50 (100.0)	100

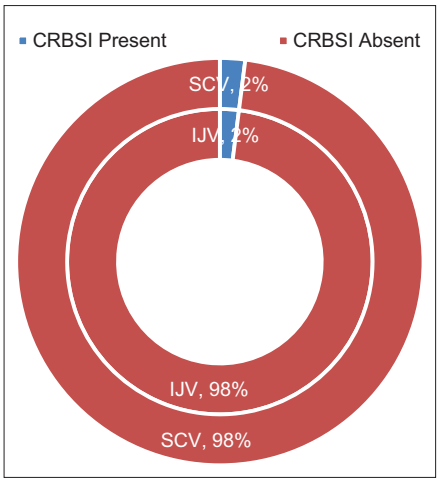
CRBSI: Catheter-related bloodstream infection, IJV: Internal jugular vein, SCV: Subclavian vein



Graph 3: Number of attempts during cannulation



Graph 4: Incidence of catheter tip infections in IJV and SCV



Graph 5: Incidence of CRBSI in IJV and SCV

cannulation for various reasons. Patients were divided into two groups: Group A - IJV and Group B - Subclavian with 50 patients in each group.

The incidence of infectious complications in our study was 12% (exit site infections 7%, catheter tip infections 3%, and CRBSI 2%) (Graph 1). The incidence of infectious complications in the internal jugular group (exit site and catheter tip) was more as compared to the subclavian group. The incidence of infection in IJV group can be attributed to its proximity to the oral cavity where the presence of oral secretions can result in infection at this site. The incidence of CRBSI was similar in both groups (2%) (Table 3 and Graph 5). The *P* value obtained after application of *Z*-test to these proportions gave a value which was more than 0.05 showing that this difference is statistically insignificant.

Seven patients were found to have exit site infection in our study out of which 5 were in group-IJV and 2 in Group-SCV (Table 1). The CVCs were removed in all these patients and were sent for culture analysis. Out of these patients, only 3 CVCs had the presence of organisms on catheter tip. The other catheter tip cultures remaning sterile. The organisms that were isolated from the catheter tip were *Acinetobacter* and *Pseudomonas*. *Staphylococcus aureus* was found most commonly at the exit site which can be attributed due to its presence as a skin commensal and in the external environment.

The presence of CRBSI was confirmed only in two patients. *Acinetobacter* was isolated in these two patients. In the present study, the presence of infection was inspected till day 7 from the day of catheter insertion. The incidence of infection was found to be statistically insignificant which can explain by the conclusion drawn from various studies conducted that found that infection rates were low in CVC *in situ* for <7 days.

Richet *et al.*[5] Conducted a multicenter trial to determine the incidence rate of complications associated with vascular catheters in ICU patients and to analyze risk factors for a positive vascular culture.

Siqueria *et al.*[6] in their prospective, descriptive, and comparative study of 114 CVCs placed in 96 patients admitted to the surgical wards of a tertiary care hospital compared the catheter-associated bloodstream infections between subclavian and jugular access. They found that the CABSI rate was higher in the SCV than in the internal jugular vein access (odds ratio 11.2, 95% confidence interval 1.4-90.8; $P = 0.023$). They found that the internal jugular vein access has a lesser incidence of CABSI than SCV access in patients admitted to surgical wards. They explained this by the fact that ward patients do not present the difficult clinical problems seen in ICU patients.

They also concluded that infection in the jugular access compared to the subclavian access remains under investigation. It is probably due to two factors: (1) Proximity to the oral cavity; (2) higher density of the local bacterial

flora due to the high local temperature and difficulty of keeping occlusive bandages. The limitation of all studies is that they were carried out in the ICU setting, with sicker patients with fever, some of them on ventilatory support with an endotracheal tube or tracheostomy and difficulty to clear oral secretions. Thus, from this study, they concluded that their results showed the superiority of the jugular access over the subclavian access regarding the incidence of CABSI in settings other than the ICU.

Kaur *et al.*[4] in their study on 480 CVCs found that the risks of infectious complications increased significantly if the CVC was *in situ* for longer than 7 days ($P = 0.009$), especially with IJV cannulae. They explained these findings due to the proximity of the IJV insertion site to the mouth and the oropharyngeal secretion, the higher density of local skin flora due to the higher local skin temperature and the difficulties in maintaining occlusive dressings. The risk of infectious complications with CVCs has also been reported to be more with increased duration of use.

Marik *et al.*[7] in their study on the risk of CRBSI with femoral venous catheters as compared to subclavian and internal jugular venous catheters: A systematic review of the literature and meta-analysis in which they included two randomized controlled trials (1006 catheters) and 8 cohorts (16,370 catheters) studies.

There was no significant difference in the risk of CRBSIs between the femoral and subclavian/internal jugular sites in the two randomized controlled trials. There was no significant difference in the risk of CRBSI between the subclavian and internal jugular sites. These results were consistent with the present study.

In 2005, Lorente *et al.*[8] evaluated 2595 catheters and found a statistically significant difference of infection rate between three sites: Femoral access was associated with higher incidence of infection compared to the other accesses, and the jugular access was associated with a significantly higher incidence of infection, compared to the subclavian access (risk ratio: 3.1; $P = 0.005$).

Sadoyama and Gontijo Filho[9] conducted a prospective observational study of non-tunneled CVC (116 patients) in 2003. Most patients were catheterized in the SCV (69%). The significant risk factors for contamination at the jugular vein were: >7 days catheterization and >3 invasive devices. This indicates that the patients with catheters at this site were more seriously affected, and therefore required more care by the health workers.

A significant association of the type of isolate at the insertion site and in the catheter tip also confirmed the importance of the skin as a CRBSI reservoir. Although patients with catheters in the jugular vein were more severely ill and therefore had a greater bacterial contamination/infection risk when compared to those with CVC in the SCV, there were no quantitative differences in the skin contamination of the insertion site nor was there a greater contamination of the catheter tips in this vein.

Since the presence of infection was observed for a period of 7-day of CVC insertion, the low incidence of infection in the present study can be attributed to the incidence of infection being greater when CVC is *in situ* for more than 7 days.

Parameswaran *et al.*[10] in their case-control study which was conducted over 19 months involving 232 patients at a tertiary care hospital with the objectives to determine the clinical and microbiological profiles of patients developing intravascular catheter-related local (localized catheter colonization and exit site) and systemic infections and their predisposing factors and to study the antibiotic sensitivity patterns of the organisms isolated found that the incidence of CRBSIs in their institute was 8.75 per 1000 catheter days. The most common organisms causing local infections were coagulase-negative *Staphylococci*, and those causing CRBSI were *S. aureus*.

Multidrug-resistant organisms accounted for 30.2% of the infections. Risk factors for the development of catheter-related infections included an immune compromised state, duration of the catheter *in situ*, femoral venous cannulation, and triple lumen catheters.

Choice of venous cannulation to minimize the risk of catheter-related infection in ascending order for risk of infection is the SCV, jugular vein, basilic vein and then the femoral vein. There was no role for empirical antibiotic therapy to prevent intravascular catheter-related local or systemic infections.

Similar results were found in the present study with *S. aureus* being the most common organism being isolated from the local site and incidence of infection being less with the subclavian route.

CONCLUSION

All the observations were statistically analyzed, and the following results were drawn:

The total incidence of infectious complications was 12% and the risk of infectious complications during 7 days of insertion was less. The internal jugular route was associated with higher incidence of infectious complications as compared to the subclavian route of CVC.

The study was conducted for a period of 7-day from the day of insertion, and the incidence of infection was found to be statistically insignificant and can be explained from various studies conducted which have found that infection rates were low if CVC's were placed for <7 days.

In conclusion, maximal sterility during insertion with suitable sterile-barrier precautions and scrupulous sterile aftercare of the wound and catheter hub can have a major impaction reducing the level of CVC-related infection.

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How to cite this article: Mowar A, Nanda HS, Goyal RK. Incidence of Infectious Complications in Central Venous Catheterization: Internal Jugular versus Subclavian Route. Int J Sci Stud 2016;3(12):255-260.

Source of Support: Nil, **Conflict of Interest:** None declared.