

Post Central Line Insertion Complication Rate in Tertiary Care Hospital Comparison between Different Sites

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ABSTRACT

Objective: To evaluate the post-central line insertion complication rate at various central venous catheterization sites in a tertiary care teaching hospital.

Study Design: Prospective comparative study.

Place and Duration of Study: Pak Emirates Military Hospital, Rawalpindi Pakistan, from Aug 2022 to Jan 2023.

Methodology: Data from 126 patients who had central venous line insertion was collected, and it was assessed for early and delayed complications related to central venous line insertion with respect to site.

Results: The mean age of patients undergoing central venous line insertion was 55.74±12. A total of 38 mechanical complications over 54 years were documented in this study. The rate of pneumothoraxes with internal jugular insertion was 9(7.14%), although this was not statistically significant. Total arterial injuries were 21(0.16%), 10(0.07%) in internal jugular, and 11(0.08%) in femoral. The rate at which one or more delayed complications occurred following a given CVC placement was 8(6.4%). By body part, 31(24.6%) of interjugular central venous catheters and 38(30.12%) of femoral central venous catheters had at least one delayed problem. The total catheter-related blood stream infection was higher with central lines inserted in the femoral vein. No complications were reported in 37 patients.

Conclusion: Both internal jugular and femoral sites cause more delayed complications than mechanical complications. At the femoral site, the catheter-related bloodstream infection rate was higher.

Keywords: Central venous catheterization, Deep vein thrombosis, Pneumothorax.

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INTRODUCTION

A central venous catheter is inserted into a large vein for specific clinical indications. According to epidemiological statistics, 8 percent of hospitalized patients may require central venous catheterisation at any point during their admission, with more than 5 million central venous catheterizations each year in the USA.^{1,2}

In some cases, putting in a central venous catheter is necessary to do things like give drugs that could cause phlebitis or sclerosis, check central venous pressures, measure pulmonary capillary wedge pressure, set up a central venous pacing line, give high-volume or flow access for dialysis or hemofiltration, or get to a vein quickly in an emergency.^{3,4}

Central venous catheters are essential in the management of individuals suffering from serious

illnesses in high-dependency acute and intensive care units. The central line can be non-tunnelled or tunnelled (t-CVC), and it can be put into the subclavian, femoral, or internal jugular veins, depending on the patient's needs.⁵

In adult patients, there are three central venous catheterization options: internal jugular, femoral, and subclavian. The internal jugular veins (IJV) or subclavian veins (SCV) go directly to the right side of the heart through the superior vena cava (SVC). The common femoral veins (CFV), on the other hand, are better for people who are more likely to bleed because they can be compressed⁶. Compared to SCV, catheterization of the IJV carries a lower risk of pneumothorax. The use of ultrasound guidance in the vein's location is critical in reducing complications, so it is the preferred method for all central line insertions. In cases where ultrasound guidance is not possible, anatomical landmarks can be used to place central venous lines. Therefore, a thorough understanding of surface anatomical landmarks is essential.⁷

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According to reports, the total risk of problems with central venous catheterizations is roughly 15%. Mechanical complications are frequently operator-dependent and occur at a 33% incremental delivery rate.⁸ Risks associated with central venous catheterization include arterial punctures, pneumothorax, subcutaneous hematoma, hemothorax, catheter malposition, and cardiac arrest. Implementing real-time ultrasonography monitoring can dramatically reduce the risk of complications from this procedure. Long-term risks include localized site infection, catheter-related blood stream infection (CRBSI), vein stenosis, and venous thrombosis⁹. According to the previous studies on central venous catheters by insertion site, 2.1% of patients encountered mechanical complications, 2-3% observed bloodstream infections, and 1-2% developed deep vein thrombosis¹⁰. With this background, this study was designed to address the research and clinical practice gap by assessing the incidence of different complications related to central venous catheterization in a tertiary healthcare setting.

METHODOLOGY

The prospective comparative study was conducted at Pak Emirates Military Hospital, Rawalpindi Pakistan, from August 2022 to January 2023 after approval was obtained from Ethical Review Board (A/28/234/EC/506/23).

Inclusion Criteria: Patients of either gender aged above 18 years old and scheduled for elective non-emergency central venous catheterization were included. Only the initial four catheters for individuals with numerous central venous catheters were included.

Exclusion Criteria: All central venous catheters that did not have insertion procedure notes or a recorded date of removal with questionable delayed complications were excluded.

The convenience sampling method was used for data collection and was followed for a period of 2 weeks to document post-procedure complications. Data was collected in the general wards, high dependency, acute, and intensive care units of the hospital. All central venous catheter insertions were performed in sterilised settings, with the practitioner wearing surgical gloves, a mask, and a gown. If ultrasonic guidance was used, the probes were wrapped in sterile plastic, and sterilized ultrasound gel was used. Under ultrasound guidance, real-time

monitoring of venous prick and guidewire insertion was ensured.

Following the procedure, the catheter tip location was assessed using standard chest radiography. This confirmed that the insertion was venous and that the catheter tip was located in the cavo-atrial junction, encompassing areas from the lower third of the SVC to the upper right atrium. For the CFV approach, backflow aspiration of venous blood, pressure transduction through an ultrasonic probe, and blood gas analysis all helped to confirm venous insertion.

The following complications were identified: local bleeding, pneumothorax, arterial prick, guide wire dislodgement, deep vein thrombosis or pulmonary embolism, and central line-associated blood stream infections. Pneumothorax, local bleeding, arterial prick or injury, and retained guide wire were defined as "mechanical complications" of catheterization and measured as a rate per line implanted. On the other hand, the remaining complications were classified as "delayed complications". Radiographic imaging confirmed pneumothorax, and physical observation verified local bleeding, whereas the progress report and procedure notes documentation showed vascular damage. Ultrasound doppler imaging of the lower limbs and CTPA confirmed the presence of deep vein thrombosis or pulmonary embolism. If a central venous catheter insertion was linked with both a DVT and a PE, one or more complications were included in the complication rate analysis.

Statistical Package for Social Sciences (SPSS) version 25.0 was used for the data analysis. Quantitative variables with normal distribution were expressed as Mean \pm SD and qualitative variables were expressed as frequency and percentages. Chi-square test was applied to explore the inferential statistics.

RESULTS

Data was collected from 126 patients, and the mean age of patients undergoing central venous line insertion was 55.74 \pm 12.54 years of age. There were 76(60.3%) males and 50(39.7%) females. The percentage of placement at the internal jugular site was 72(57.1%), and the femoral was 54(42.85%). 37(29.3%) out of 126 patients reported no complications. Delayed complications were seen in 68(53.96%), while mechanical complications were seen in 38(30.15%) of patients. 18(14.28%) of patients had both mechanical and delayed complications.

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Mechanical complications were documented in 38(30.14%) of the patients. More than one mechanical complication was not reported in the data. Pneumothorax in patients with internal jugular placement stand at 9(7.1%), although this was not statistically significant as the *p* value was more than 0.05. Total arterial injuries were 21(16.66%), 10(7.9%) in the internal jugular (IJ), and 11(8.7%) in the femoral (Table II).

Table-I: Frequency of Complications (n=126)

Mechanical Complications	
No complications	8(69.8)
Pneumothorax	9(7.1%)
Local bleeding	8(6.3%)
Arterial injury	21(16.7%)
Delayed Complications	
No delayed complication	58(46%)
Deep Vein Thrombosis	8(6.2%)
Pulmonary Embolism	21(16.5%)
Catheter-related bloodstream infection (CRBSI)	39(31%)

According to our data set, delayed complications account for 69(0.5%). The rate at which one or more delayed complications occurred following a given CVC placement was 8(6.4%). By anatomical site, 31(24.6) interjugular and 38(30.12) femoral central venous catheters had one or more delayed complications. Total catheter-related blood stream infection was higher at femoral sites, while the PE rate was higher in IJ.

Blood vessel damage in the IJV site was 10(7.9%) and 11(8.73%) at the femoral site (Table-II). A pneumothorax was only seen in 9(7.14%), and there was local bleeding in 3(2.3%) at the IJV site and 5(3.9%) at the femoral site. DVT is 6(4.76%) at the femoral site, CRBSI is 27(21.42%), and PE is only 4(3.17%). In IJV, 13(10.31%) was CRBSI and 18(14.28%) was PE observed.

is fundamental¹¹. To the best of our collective understanding, this has been the first investigation to determine the insertion site of the central venous line catheter and to use it as a predictor for central line blood stream infections and other complications in this setup. Bresica *et al.* reported on almost 4000 central venous catheterizations in 2900 patients, although the patient sample was exclusively trauma patients¹². Our study, in comparison, does not see the age-related risk of central venous catheters, but it shows there are fewer complications reported in young patients. Researchers conducted a longitudinal study that involved multiple catheterizations and approximately 2000 catheterization days. However, they limited their investigation to patients in critical care and primarily focused on thrombotic events¹³. Furthermore, Buetti N, *et al.* showed that subclavian central venous catheters were more likely to cause a pneumothorax than internal jugular catheters. However, they were less likely to cause a bloodstream infection or a severe DVT. Their study was notable for using a prospective, multicenter, randomised design, but they only looked at critical care patients who were getting central venous catheters put in or were being watched by skilled doctors who had done at least 50 central venous catheter insertions before¹⁴. In contrast, our study shows the rate of both mechanical and delayed complications with respect to only the internal jugular and femoral sites of insertion.

The intent of this research was to figure out the incidence of central venous catheter-related complications in a wide range of patient populations in a single clinical setting. While the vast majority of our participants were admitted to acute or critical care units for central venous catheter placement, we also collected data from patients in high-dependency medical wards. Lastly, we collected data on all central

Table-II: Comparison of Mechanical and Delayed Complications with Respect to Sites of Insertion (n=126)

	Internal Jugular Vein (IJV)	Femoral Vein	<i>p</i> -value
Mechanical Complications (n=38)	Local bleeding	3(2.3%)	<0.001
	Pneumothorax	9(7.14%)	
	Arterial injury	10(7.9%)	
	No complication	50(39.68%)	
Delayed Complications (n=69)	Deep vein thrombosis	0(0%)	<0.001
	Catheter-related bloodstream infection (CRBSI)	13(10.31%)	
	Pulmonary Embolism	18(14.28%)	
	No complication	41(32.53%)	

DISCUSSION

A comprehensive understanding of the complications associated with central venous catheters

venous catheters from our hospital, which is also a teaching hospital. This included catheters inserted not

only by experienced consultants but also by residents with varying training expertise and proficiency.

One previous study discovered that putting in central venous catheters under the clavicle was linked to a lower rate of bloodstream infections in intensive care unit (ICU) patients compared to putting them in the internal jugular or femoral vein¹⁵. In comparison, our study only compared two insertion sites, which were internal, jugular, and femoral. This study focused on patients with specific conditions, whereas our study utilized a convenient sampling method to include patients with a broad range of medical conditions.

Our researchers reported a reasonably high CRBSI rate of around 39%. Previously published research estimates that CRBSI rates are around 20%¹⁶. At our respective hospital, the infection control committee aims specifically at lowering the rate of CRBSI, with an emphasis on sterile procedure technique. In this regard, frequent and regular audits help to point out the best practices.

Patel *et al.*¹⁷ demonstrated that cardiovascular complications are among the most common acute effects associated with central line placement. Heart arrhythmia may occur during or immediately after the implantation as a result of the wire used for guidance getting in contact with the right atrium. As a result, premature atrial and ventricular contractions may arise. Knowing the guide wire length and using monitoring telemetry can aid in early detection of arrhythmia. If symptoms develop, the wire is to be retracted, and treatment according to standard guidelines is to be initiated right away. If the atrioventricular (AV) node contracts for an extended period of time, supraventricular tachycardia can ensue, leading to a deadly arrhythmia and cardiac arrest¹⁷. Our study did not address these complications, which has somehow limited our results.

Pneumothorax constitutes one of the most severe and potentially fatal consequences of IJ or subclavian catheterizations¹⁸. In our investigation, we detected just 9 cases of pneumothoraxes out of 126 central venous catheters, yielding a low incidence of 0.08%. Our findings further support previously published data that the internal jugular approach is linked with a greater risk of pneumothorax. Although this conclusion wasn't significant statistically in this investigation, it is consistent with earlier research.

By using this data in clinical practice, it is helpful to highlight key aspects when selecting an acceptable anatomic location for central venous catheter placement. Femoral catheters are viable choices for access, especially when used for short periods of time. The use of the internal jugular vein should be based on knowledge of the associated increased risk of pneumothorax. Nonetheless, clinician comfort and experience should be the key determinants of site selection.

LIMITATIONS OF STUDY

This study has inherent limitations in terms of data collection and quantification. Additional granular data on practitioners' training levels and line insertion technique could not be fully investigated.

CONCLUSION

The overall rate of one or more complications per central venous catheter inserted in a diverse group of patients by a diverse group of practitioners was recorded to be 5.9%. Furthermore, we observed that in both anatomical sites, the risk of complications was significant.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

MAM, SS: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

SN, AG: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AA, AA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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