



CENTRAL VENOUS CATHETERIZATION IN SURGICAL PATIENTS: A PROSPECTIVE EVALUATION OF INDICATIONS AND COMPLICATIONS

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ABSTRACT

Introduction: Central venous catheterization (CVC) is an essential procedure in surgical practice, providing reliable venous access for hemodynamic monitoring, fluid resuscitation, administration of vasoactive medications, total parenteral nutrition, and renal replacement therapy. Despite its clinical importance, CVC insertion is associated with mechanical, infectious, and thrombotic complications that may adversely affect patient outcomes.

Objectives: To evaluate the indications for central venous catheterization and determine the incidence and pattern of early and late catheter-related complications among surgical patients in a tertiary care teaching hospital.

Methodology: This descriptive cross-sectional observational study was conducted in the Department of General Surgery, Calcutta National Medical College & Hospital, Kolkata, over one year (June 2023–May 2024). A total of 172 consecutive surgical patients aged more than 12 years who required central venous catheterization were included. Demographic characteristics, indications for catheterization, insertion site, catheter duration, and procedure-related complications were recorded prospectively. Data were analyzed using SPSS version 27.0, and statistical significance was considered at $p < 0.05$.

Results: The mean age of the study population was 54.4 ± 15.67 years, with most patients belonging to the 51–60-year age group. Difficult peripheral venous access was the commonest indication for CVC placement (51.2%), followed by parenteral nutrition (23.3%). The subclavian vein was the preferred insertion site (45.9%). Arterial puncture was the most frequent early complication, whereas catheter occlusion was the most common late complication. Overall, the incidence of both early and late catheter-related complications was low. A significant association was observed between age and the indication for catheterization ($p = 0.025$), while no significant association was found with sex ($p = 0.184$).

Conclusion: Central venous catheterization is a safe and effective procedure in surgical patients when performed using meticulous aseptic technique and standardized protocols. Appropriate insertion-site selection, adherence to evidence-based catheter care practices, and early recognition of complications can further enhance procedural safety and improve patient outcomes.

Keywords: Central Venous Catheterization, Surgical Patients, Catheter-Related Complications, Vascular Access, Subclavian Vein.

INTRODUCTION

Central venous catheterization (CVC) is an indispensable procedure in modern surgical and critical care practice, providing reliable access to the central venous circulation for the

administration of medications, rapid fluid resuscitation, blood products, vasoactive drugs, total parenteral nutrition, hemodynamic monitoring, and renal replacement therapy. Owing to its versatility and clinical utility, CVC has become an integral component of perioperative management, particularly in patients undergoing major surgical procedures or requiring intensive postoperative care.^{1–3} Despite its widespread use, CVC insertion is an invasive procedure that carries the risk of several mechanical, infectious, and thrombotic complications, which may significantly increase patient morbidity, prolong hospital stay, and increase healthcare costs.^{4–6}

The indications for central venous catheterization have expanded considerably over the past few



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decades with advances in surgical and critical care. Besides providing secure venous access when peripheral venous cannulation is difficult or impossible, CVCs are routinely used for central venous pressure monitoring, administration of hyperosmolar solutions, long-term antibiotic therapy, chemotherapy, hemodialysis, plasmapheresis, and infusion of vasoactive medications.¹⁰ The selection of an appropriate insertion site—internal jugular, subclavian, or femoral vein—is determined by patient characteristics, the intended duration of catheterization, operator expertise, and the anticipated risk of complications.^{5,6}

Although central venous catheterization is generally considered a safe procedure when performed by experienced clinicians under strict aseptic precautions, complications remain relatively common. These complications may occur during insertion or develop during catheter maintenance. Immediate or mechanical complications include arterial puncture, hematoma, pneumothorax, hemothorax, air embolism, cardiac arrhythmias, nerve injury, and catheter malposition. Delayed complications include catheter-related bloodstream infections (CRBSIs), catheter occlusion, thrombosis, phlebitis, catheter fracture, and venous stenosis.^{2,4,5} The incidence of these complications varies widely depending on the insertion site, patient-related factors, catheter dwell time, operator experience, and adherence to standardized insertion protocols.^{5,6}

Mechanical complications remain an important concern during catheter placement. Mansfield et al. reported that subclavian vein catheterization, although associated with a lower risk of infection, carries a significant risk of pneumothorax and arterial injury, particularly when performed without imaging guidance.⁴ Similarly, McGee and Gould emphasized that many procedural complications are preventable through appropriate patient selection, meticulous sterile technique, ultrasound guidance, and adequate operator training.⁵ The adoption of ultrasound-guided catheter insertion has significantly improved first-pass success rates while reducing the incidence of arterial puncture and other mechanical complications.¹⁰

Catheter-related infections continue to be among the most serious complications associated with long-term central venous access. Sitzmann et al., in one of the earliest prospective studies evaluating septic and technical complications of CVCs, demonstrated that catheter-related sepsis contributes substantially to patient morbidity, particularly among critically ill patients requiring prolonged catheterization.² Likewise, Eyer et al. observed that catheter maintenance practices significantly influence the risk of catheter-related bloodstream infections,

highlighting the importance of strict aseptic handling and standardized catheter care protocols.⁸ Thrombotic complications represent another major source of morbidity associated with central venous catheterization. Joynt et al. demonstrated that femoral venous catheters are associated with a significant risk of deep venous thrombosis in critically ill adults, often occurring without overt clinical manifestations.³ Similarly, Parienti et al., in a large multicenter randomized trial comparing femoral, jugular, and subclavian catheterization sites, reported that femoral catheterization was associated with a significantly higher incidence of symptomatic thrombosis and catheter-related bloodstream infection, whereas subclavian catheterization showed the lowest overall rate of infectious and thrombotic complications despite a relatively higher incidence of pneumothorax.⁶ Comparable findings were previously reported by Merrer et al., who demonstrated significantly higher infectious and thrombotic complications following femoral catheterization compared with subclavian vein catheterization.⁹

Patient-related factors also influence procedural safety. Coagulopathy has traditionally been considered a relative contraindication for central venous catheterization because of concerns regarding bleeding complications. However, Fisher and Mutimer demonstrated that with careful patient selection and appropriate technique, central venous catheterization can be performed safely even in patients with liver disease and coagulation abnormalities, with a very low incidence of clinically significant hemorrhagic complications.⁷ These findings have broadened the applicability of central venous access in high-risk patient populations.

Despite substantial improvements in catheter materials, insertion techniques, and infection prevention strategies, complications associated with CVC continue to pose significant challenges in surgical practice. Furthermore, the pattern of catheter utilization and complication rates may vary across institutions depending on patient demographics, surgical case mix, operator expertise, and available resources. Data from Indian surgical settings remain relatively limited, particularly regarding the indications for catheter placement and the spectrum of complications encountered in routine clinical practice.¹

The present study was therefore undertaken to evaluate the indications for central venous catheterization and to determine the incidence and pattern of early and late complications among surgical patients undergoing CVC placement at a tertiary care teaching hospital. By identifying the common indications for catheterization and analyzing procedure-related complications according to the site of insertion, the study aims to

provide evidence that may contribute to safer catheterization practices, optimization of insertion-site selection, and improvement of patient outcomes in surgical care.

MATERIALS AND METHODS

This descriptive cross-sectional observational study was conducted in the Department of General Surgery, Calcutta National Medical College & Hospital, Kolkata, West Bengal, over a period of one year from 1st June 2023 to 30th May 2024, following approval from the Institutional Ethics Committee of Calcutta National Medical College & Hospital. The study was carried out in the male and female surgical inpatient wards of the hospital. The objective of the study was to determine the indications for central venous catheterization (CVC) in surgical patients and to evaluate the incidence and spectrum of catheter-related complications associated with the procedure.

The study population comprised patients aged more than 12 years who were admitted to the Surgical Inpatient Department and required central venous catheterization as part of their routine clinical management. Consecutive eligible patients presenting during the study period were recruited using the complete enumeration method until the completion of the study period. Although the proposed sample size was approximately 150 patients, a total of 172 eligible patients fulfilling the predefined selection criteria were included in the final analysis. Written informed consent was obtained from all participants or, where applicable, from their legally authorized representatives before enrolment in the study. Participation was entirely voluntary, and confidentiality of patient information was maintained throughout the study.

Patients were included if they underwent major surgical procedures requiring central venous catheterization for fluid resuscitation, administration of vasopressors, central venous pressure monitoring, total parenteral nutrition, long-term antibiotic therapy, chemotherapy, or hemodialysis access. Patients admitted from general surgery, oncology, and critical care units who underwent surgical interventions and fulfilled the eligibility criteria were considered for recruitment. Patients with severe coagulopathy (international normalized ratio >2.0 or platelet count $<50,000/\text{mm}^3$) unless corrected before catheterization, those with absolute contraindications to central venous catheterization, and patients who were unwilling to provide informed consent were excluded from the study.

Following enrolment, detailed demographic and clinical information was recorded using a predesigned structured case record form. Baseline variables included age, sex, body mass index, associated comorbidities, and underlying medical conditions. Clinical variables included the indication

for central venous catheterization, duration of catheterization, catheter insertion site, type of catheter used, and relevant procedural details. The indications for catheter placement were categorized into difficult peripheral venous access, central venous pressure monitoring, hemodynamic resuscitation, parenteral nutrition, hemodialysis, and other clinically indicated situations. The catheter insertion site was documented as subclavian vein, internal jugular vein, femoral vein, or peripherally inserted central catheter (PICC), depending on the operating surgeon's clinical judgment and the patient's clinical status.

Clinical examination, laboratory investigations, radiological investigations, operative records, and hospital medical records were utilized for comprehensive data collection. Procedural variables such as adherence to sterile precautions, catheter type and size, number of insertion attempts, use of ultrasound guidance whenever appropriate, and confirmation of catheter tip position by post-procedural chest radiography or other standard methods were also documented. Duration of catheterization and relevant healthcare-associated factors, including infection control practices and operator experience, were recorded wherever applicable to evaluate their possible influence on catheter-related complications.

All patients were prospectively monitored for the occurrence of catheter-related complications throughout the period of catheterization. Complications were categorized as early complications occurring within 24 hours of catheter insertion and late complications occurring after 24 hours. Early complications included arterial puncture, hematoma, pneumothorax, hemothorax, air embolism, and catheter malposition, whereas late complications included catheter occlusion, catheter fracture, phlebitis, catheter-related bloodstream infection, thrombosis, and other delayed catheter-related adverse events. Whenever a complication occurred, appropriate clinical evaluation and management were undertaken according to standard institutional protocols, and the event was documented in the study proforma. The duration of catheterization and final patient outcomes were also recorded for analysis.

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki for biomedical research involving human participants. Before initiation of the study, the protocol, patient information sheet, and informed consent documents in English, Bengali, and Hindi were reviewed and approved by the Institutional Ethics Committee. All eligible participants were informed in their vernacular language regarding the objectives of the study, study procedures, potential risks, expected benefits, and their right to withdraw from the study at any point without affecting their

treatment. Confidentiality of patient identity and clinical information was strictly maintained throughout the study by anonymizing all case records and securely storing study documents under the supervision of the principal investigator. Universal precautions and strict aseptic techniques were maintained during every catheterization procedure.

Data were compiled using Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp., Armonk, NY, USA). GraphPad Prism version 5 was used for graphical presentation of the findings. Continuous variables were summarized as mean $\pm$ standard deviation (SD), whereas categorical variables were expressed as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test or

Fisher's exact test wherever appropriate. Continuous variables were compared using the unpaired Student's *t*-test whenever applicable. All statistical tests were two-tailed, and a *p*-value of less than 0.05 was considered statistically significant. The findings were presented using appropriately designed tables, charts, and graphical illustrations to facilitate interpretation and comparison with previously published literature.

RESULTS

Results

A total of 172 surgical patients who underwent central venous catheterization (CVC) during the study period were included in the analysis. The demographic characteristics, indications for catheterization, catheter-related procedural details, and complications were evaluated.

Table 1. Baseline demographic and clinical characteristics of the study population (n=172)

Variable	Frequency (%)
Age group (years)	
12–20	3 (1.7)
21–30	11 (6.4)
31–40	21 (12.2)
41–50	28 (16.3)
51–60	48 (27.9)
61–70	37 (21.5)
71–80	13 (7.6)
81–90	11 (6.4)
Mean age (years)	54.4 $\pm$ 15.67
Male	87 (50.6)
Female	85 (49.4)
Catheter duration <2 weeks	127 (73.8)
Catheter duration $\geq$ 2 weeks	45 (26.2)

The majority of patients were aged 51–60 years (27.9%), followed by those aged 61–70 years (21.5%). The mean age of the study population was 54.4 $\pm$ 15.67 years. The sex distribution was nearly

equal, with males accounting for 50.6% of patients. Most catheters (73.8%) remained in situ for less than two weeks.

Table 2. Indications and routes of central venous catheterization

Variable	Frequency (%)
Indication for CVC	
Difficult peripheral venous access	88 (51.2)
Parenteral nutrition	40 (23.3)
CVP monitoring	20 (11.6)
Hemodynamic resuscitation	20 (11.6)
Hemodialysis	4 (2.3)
Route of catheterization	
Subclavian vein	79 (45.9)
Femoral vein	62 (36.0)
PICC	18 (10.5)
Internal jugular vein	13 (7.6)

Difficult peripheral venous access was the commonest indication for CVC placement (51.2%),

followed by parenteral nutritional support (23.3%). The subclavian vein was the preferred site for

catheterization (45.9%), while the internal jugular vein was the least frequently utilized (7.6%).

Table 3. Early (<24 hours) catheter-related complications according to insertion site

Early complication	Femoral (n=62)	IJV (n=13)	PICC (n=18)	Subclavian (n=79)
Air embolism	0 (0.0)	2 (15.4)	0 (0.0)	0 (0.0)
Hemothorax	1 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)
Pneumothorax	4 (6.5)	0 (0.0)	0 (0.0)	0 (0.0)
Arterial puncture	8 (12.9)	2 (15.4)	1 (5.6)	1 (1.3)
Hematoma	2 (3.2)	4 (30.8)	0 (0.0)	3 (3.8)
Malposition	3 (4.8)	4 (30.8)	0 (0.0)	0 (0.0)
No complication	44 (71.0)	1 (7.7)	17 (94.4)	75 (94.9)

Overall, early complications were infrequent. Arterial puncture was the most common immediate complication, followed by hematoma and catheter malposition. Pneumothorax and hemothorax

occurred only in isolated cases. More than three-fourths of patients did not experience any immediate catheter-related complication.

Table 4. Late (>24 hours) catheter-related complications according to insertion site

Late complication	Femoral (n=62)	IJV (n=13)	PICC (n=18)	Subclavian (n=79)
Catheter fracture	0 (0.0)	1 (7.7)	0 (0.0)	1 (1.3)
Catheter occlusion	3 (4.8)	2 (15.4)	1 (5.6)	1 (1.3)
Phlebitis	2 (3.2)	2 (15.4)	0 (0.0)	0 (0.0)
No complication	57 (91.9)	8 (61.5)	17 (94.4)	77 (97.5)

Late complications were uncommon, with catheter occlusion representing the most frequent delayed complication, followed by phlebitis. Catheter

fracture was rare, and the majority of patients (92.4%) remained free from delayed catheter-related complications.

Table 5. Association of age and sex with indications for central venous catheterization

Variable	p-value
Age versus indication for catheterization	0.025
Sex versus indication for catheterization	0.184

A statistically significant association was observed between patient age and the indication for CVC placement ($p=0.025$), indicating that indications

varied across different age groups. In contrast, no significant association was found between sex and indication for catheterization ($p=0.184$).

Figure 1. Stacked bar diagram showing early complications (<24 hours) according to the site of central venous catheter insertion.

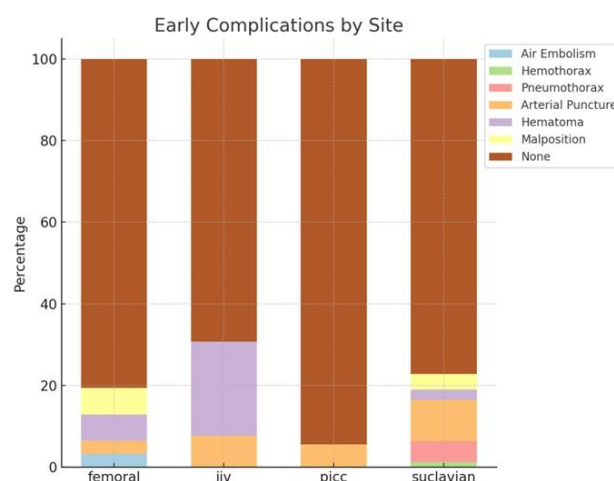


Figure 1 illustrates the distribution of early catheter-related complications according to the site of CVC insertion. Most patients did not experience any immediate complications irrespective of the insertion site. Arterial puncture was the most frequent early complication, followed by hematoma

and catheter malposition. Pneumothorax and hemothorax occurred infrequently and were observed only in isolated cases. Overall, early complications were uncommon across all catheter insertion sites.

Figure 2. Stacked bar diagram showing late complications (>24 hours) according to the site of central venous catheter insertion.

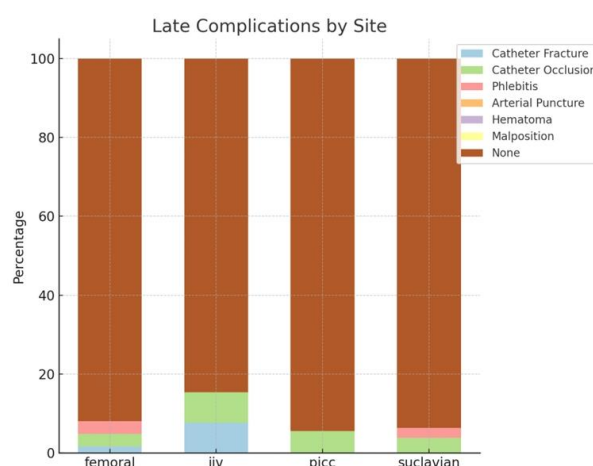


Figure 2 demonstrates the distribution of late catheter-related complications according to the site of CVC insertion. The majority of patients remained free of delayed complications. Catheter occlusion was the most common late complication, followed by phlebitis, while catheter fracture was encountered only rarely. Overall, the incidence of late complications was low irrespective of the catheter insertion site.

DISCUSSION

Central venous catheterization (CVC) has become an indispensable component of perioperative and critical surgical care, providing dependable vascular access for fluid resuscitation, administration of vasoactive drugs, total parenteral nutrition, hemodynamic monitoring, blood product transfusion, and renal replacement therapy. Despite its widespread use, CVC insertion is associated with several mechanical, infectious, and thrombotic complications that may adversely influence patient morbidity, duration of hospitalization, and healthcare expenditure. The present descriptive cross-sectional study evaluated the indications, preferred insertion sites, and complications of central venous catheterization in 172 surgical patients admitted to a tertiary care teaching hospital. The findings contribute important evidence regarding contemporary CVC practices in Indian surgical settings.

In the present study, the mean age of the study population was 54.4 ± 15.67 years, with the highest proportion of patients belonging to the 51–60-year

age group. Male and female patients were almost equally represented, accounting for 50.6% and 49.4% of the study population, respectively. Furthermore, no statistically significant association was observed between sex and the indication for catheterization, whereas age demonstrated a significant association with catheter indication ($p=0.025$). These findings suggest that the requirement for central venous access is determined primarily by the patient's clinical condition rather than gender. Similar observations have been reported in previous studies where demographic characteristics were not found to influence the incidence of catheter-related complications independently.^{1,5}

The most frequent indication for central venous catheterization in the present study was difficult peripheral venous access (51.2%), followed by parenteral nutrition (23.3%), central venous pressure monitoring (11.6%), hemodynamic resuscitation (11.6%), and hemodialysis (2.3%). This distribution differs from the findings of Yadav et al., who reported hemodynamic monitoring as the predominant indication for CVC placement among intensive care unit patients.¹ The difference is likely attributable to differences in study populations, as the present study exclusively included surgical patients, whereas Yadav et al. evaluated critically ill ICU patients. Kolikof et al. also emphasized that central venous catheterization is indicated whenever reliable peripheral venous access cannot be achieved or when administration of vasoactive agents, hyperosmolar solutions, total parenteral nutrition,

extracorporeal therapies, or advanced hemodynamic monitoring is required.¹⁰ The predominance of difficult venous access in the present study reflects the practical necessity of CVC in patients undergoing major surgical procedures requiring prolonged intravenous therapy.

With regard to the catheter insertion site, the subclavian vein was the most commonly utilized route (45.9%), followed by the femoral vein (36.0%), peripherally inserted central catheter (10.5%), and internal jugular vein (7.6%). Selection of the catheterization site is influenced by patient characteristics, operator expertise, anticipated catheter duration, and the balance between infectious and mechanical risks. McGee and Gould recommended individualized selection of insertion sites after careful consideration of these factors, emphasizing that adherence to evidence-based insertion techniques substantially reduces procedural complications.⁵ Similarly, Parienti et al. demonstrated that subclavian catheterization is associated with the lowest incidence of catheter-related bloodstream infection and symptomatic thrombosis compared with femoral and internal jugular catheterization, although it carries a relatively greater risk of pneumothorax.⁶ Mansfield et al. also reported that although subclavian catheterization offers excellent long-term venous access, the risk of pneumothorax and arterial injury should always be considered during insertion, particularly when anatomical landmarks rather than ultrasound guidance are used.⁴ The preference for subclavian access observed in the present study is therefore consistent with current evidence favoring reduced infectious complications in surgical patients.

The incidence of early mechanical complications in the present study was relatively low. Arterial puncture was the most common immediate complication, followed by hematoma, catheter malposition, pneumothorax, hemothorax, and air embolism. Importantly, the majority of patients experienced no immediate procedural complication. These findings are comparable with those reported by Mansfield et al., who identified arterial puncture, pneumothorax, bleeding, and catheter malposition as the most frequent mechanical complications following central venous catheterization.⁴ Eisen et al. similarly concluded that most mechanical complications are related to insertion technique, operator experience, and anatomical variation, and that appropriate training significantly reduces complication rates.¹⁴ The relatively low frequency of mechanical complications observed in the present study probably reflects increasing procedural experience and adherence to standardized catheter insertion protocols at the study centre.

Delayed catheter-related complications were also infrequent in the present study. Catheter occlusion

represented the most common late complication, followed by phlebitis and catheter fracture, while the majority of patients remained free of delayed complications throughout catheterization. Sitzmann et al. reported that prolonged catheterization is associated with an increasing incidence of septic and technical complications, highlighting the importance of routine catheter surveillance.² Similarly, Eyer et al. demonstrated that meticulous catheter maintenance and aseptic handling significantly reduce catheter-related sepsis irrespective of catheter replacement strategy.⁸ Altaee et al., in a prospective evaluation of temporary hemodialysis catheters, observed that catheter dysfunction and infection were the principal determinants of catheter survival, emphasizing the importance of regular monitoring and timely intervention to preserve catheter function.¹²

Although catheter-related bloodstream infection was observed only in a limited number of patients in the present study, its potential clinical impact remains considerable. Siempos et al., in a meta-analysis involving critically ill patients, demonstrated that catheter-related bloodstream infections significantly increase mortality, prolong intensive care unit stay, and increase healthcare costs.¹¹ Similarly, Maki et al. established the semiquantitative catheter-tip culture technique as an effective microbiological method for diagnosing catheter-related infection and differentiating true infection from contamination.¹³ Eisenberg further emphasized the importance of standardized microbiological evaluation of intravascular devices to facilitate early diagnosis and appropriate management of catheter-related infections.¹⁶ Collectively, these studies reinforce the importance of strict infection prevention bundles, maximal sterile barrier precautions, and prompt catheter removal when clinically indicated.

The relatively low incidence of thrombotic complications observed in the present study may be attributed to shorter catheter dwell time and careful patient selection. Nevertheless, thrombosis remains an important complication of central venous catheterization. Joynt et al. demonstrated that femoral venous catheters are associated with a significant risk of deep venous thrombosis, many of which remain clinically silent.³ Similarly, Merrer et al. reported that femoral catheterization was independently associated with a substantially higher incidence of thrombotic and infectious complications compared with subclavian catheterization.⁹ These findings support current recommendations favoring subclavian access whenever feasible and clinically appropriate.

An important strength of the present study is that it evaluated central venous catheterization practices in a real-world surgical population, thereby providing practical information regarding catheter utilization and complications encountered during routine

clinical care. However, certain limitations should be acknowledged. The study was conducted at a single tertiary care institution, which may limit the generalizability of the findings to other healthcare settings. Variables such as operator experience, number of insertion attempts, routine use of ultrasound guidance, catheter caliber, and long-term post-discharge complications were not specifically evaluated. Future multicentric prospective studies incorporating these variables would provide more comprehensive evidence regarding factors influencing catheter-related outcomes.

Overall, the findings of the present study indicate that central venous catheterization is a safe and effective procedure when performed for appropriate indications by adequately trained clinicians following strict aseptic precautions. Difficult peripheral venous access remained the principal indication for catheter placement, while the subclavian vein emerged as the preferred insertion site. The overall incidence of both early and late catheter-related complications was low, highlighting the effectiveness of careful patient selection, appropriate insertion-site choice, standardized procedural techniques, and vigilant catheter maintenance. Continued emphasis on operator training, ultrasound-guided catheter insertion whenever feasible, adherence to maximal sterile barrier precautions, and implementation of evidence-based catheter care bundles will further improve patient safety and optimize surgical outcomes.

CONCLUSION

Central venous catheterization remains an indispensable procedure in the management of surgical patients, providing reliable venous access for fluid resuscitation, administration of vasoactive medications, parenteral nutrition, central venous pressure monitoring, and other specialized therapeutic interventions. The present study demonstrated that difficult peripheral venous access was the most common indication for CVC placement, with the subclavian vein being the preferred insertion site. Overall, the incidence of both early and late catheter-related complications was low, indicating that CVC is a relatively safe procedure when performed by trained personnel using meticulous aseptic techniques and standardized institutional protocols. Arterial puncture was the most frequently encountered early complication, while catheter occlusion represented the commonest delayed complication. Most patients remained free from significant procedure-related adverse events throughout the period of catheterization. The findings of this study emphasize that appropriate patient selection, careful choice of catheter insertion site, strict adherence to infection prevention measures, and timely recognition and

management of complications are essential for improving patient safety and optimizing clinical outcomes. These observations support the continued use of central venous catheterization as an effective and dependable procedure in contemporary surgical practice.

Recommendations

Routine adherence to evidence-based catheter insertion bundles, strict aseptic precautions, and standardized catheter maintenance protocols should be emphasized to minimize catheter-related complications. Ultrasound-guided catheter insertion should be encouraged whenever feasible to improve first-pass success and reduce mechanical complications. Regular training and competency assessment of healthcare professionals involved in CVC insertion and maintenance should be undertaken to ensure procedural safety. Early removal of unnecessary catheters and vigilant monitoring for mechanical, infectious, and thrombotic complications should form an integral part of postoperative patient care. Furthermore, larger multicentric prospective studies with longer follow-up are recommended to validate the present findings and to develop institution-specific guidelines for optimizing central venous catheterization practices in surgical patients.

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