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Corresponding Author: Khalid Hussain (Assistant Professor & Head, Department of Urology, GMC/Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan. Email: khaliduro@yahoo.com)

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Efficacy of Ultrasound-Guided Double Lumen Central Venous Catheter Insertion in Minimizing Mechanical Complications and Bloodstream Infections: An Empirical Evidence of Pakistan

Khalid Hussain [a] | Attiq Ur Rehman Khan [b] | Salman Athar Qureshi [c]

Ali Umair Tariq [d] | Maria Tariq [e] | Bilal Ahmed [f]

Abstract: *The aim of the study was to compare the outcomes of ultrasound-guided double-lumen central venous catheter (DLC) insertion and without ultrasound guidance in reducing mechanical complications and bloodstream infections. This quasi-experimental study was conducted at Urology Department in collaboration with the Anesthesia department at GMC Teaching Hospital Gujranwala. The study had 60 insertions in each group. The insertion duration ranged from 8-50 days in Group A and 9-60 days in the B group. Placements were done at the right internal jugular and right subclavian veins. Four patients in Group A and five patients in Group B experienced catheter-related bloodstream infections (CRBSI), but the difference was not significant. The Charlson Comorbidity Index (CCI) was 0-10 in Group A and 0-8 in Group B. Group A had no mechanical complications, while three patients in Group B experienced manageable complications. In conclusion, ultrasound-guided DLC placement improves safety but does not reduce CRBSI.*

Key Words: Dialysis, DLC, Ultrasound

Introduction

For patients who require vascular access for hemodialysis and severe critical care, double-lumen central venous catheters (DLC) are an effective therapy option. A DLC enables vascular access for hemodialysis and parenteral nutrition supplementation. The use of DLC is associated with many adverse events, such as deep venous thrombosis, intravenous catheter-associated

[a] Assistant Professor & Head, Department of Urology, GMC /Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan.
[b] Assistant Professor, Department of Urology, GMC/ Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan.
[c] Associate Professor, Department of Anesthesia, GMC/ Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan.
[d] Student MBBS, Gujranwala Medical College, Gujranwala, Punjab, Pakistan.
[e] PGR, Department of Urology, GMC/ Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan.
[f] PGR, Department of Urology, GMC/ Gujranwala Teaching Hospital, Gujranwala, Punjab, Pakistan.

infections and mechanical complications, even though they allow for the delivery of nutritional support and for the vascular access needed for hemodialysis that is difficult and unsafe to place via a peripheral vein (Machat et al., 2019). To overcome these complications Healthcare Infection Control Practices Advisory Committee has established guidelines for prevention of the intravascular catheter-related infection: aseptic technique, hand hygiene, catheter site dressing regimens, skin decontamination, and maximal barrier precautions. However, there is limited data about whether USG-guided DLC placement reduces the chances of CRBSI and infections. (Imataki et al., 2019).

Methods

This quasi-experimental study, which included 120 patients, (60 in each group) underwent DLC needed for hemodialysis and parental nutrition at the Department of Urology in collaboration with the Department of Anesthesia between January 2022 and December 2022. Group A patients underwent USG-guided DLC placement while in Group B DLC placement was done without USG guidance. Patients with haematological or immunological illnesses who needed parental nutrition and patient with CKD-V or AKI who needed DLC placement for dialysis were included in our study.

Treatment regimens

In this study, the Arrow double lumen (7Fr; Arrow) catheter was used. The hospital training programme that taught the standard insertion method was attended by all of the practitioners who took part in this study. Each practitioner decided about the indication of placement of DLC was necessary, as well as the best DLC catheter and the site for DLC insertion for every patient. Maximal sterile measures were adopted. The skin was prepped with a 10% tincture of povidone-iodine, and the catheter site was regularly dressed with Tegaderm Transparent Film Dressing.

Definition

Positive blood culture was used to define bloodstream infections (BSI) (Ombelet et al., 2019). The blood culture data were extensively examined by more than two investigators to differentiate between a real BSI and contamination. Additionally, a CRBSI was defined as the presence of bacteremia originating from an intravenous catheter with positive blood culture for the same organism on both peripheral smear and catheter tip. The possibility of other infection sources was clinically assessed. For the CRBSI diagnosis, HICPAC recommendation criteria are used (Buetti et al., 2022). Hematoma, arterial puncture and pneumothorax are mechanical complications.

Grade I bleeding involves minor symptoms, grade II bleeding necessitates medical intervention, grade III bleeding necessitates radiologic, endoscopic, transfusion, or surgery, while life-threatening hemodynamic or respiratory compromise comes from grade IV haemorrhage. Grade I pneumothoraxes are asymptomatic, Grade II pneumothoraxes are symptomatic, Grade III pneumothoraxes are indicative of sclerosis and/or surgical intervention, and Grade IV are potentially fatal. Garde I hematomas have modest symptoms, grade II hematomas are advised for minimally invasive evacuation or aspiration, and grade III hematomas are indicated for elective surgical intervention, radiologic, or endoscopic. While hematomas of grade IV are fatal. A widespread and effective measure for assessing general problems, organ dysfunction, and comorbidities is the Charlson comorbidity index. (Charlson et al., 2022). The study's major aim was to determine how the frequency of CRBSI was impacted by ultrasound guidance during CVC insertion.

Statistical Analysis

Data was entered in SPSS version 22.0 before statistical analysis. The quantitative variables were presented as mean (standard deviation). An Independent sample t-test was used for the comparison of quantitative variables when appropriate. For all tests, a p-value less than 0.05 was regarded as significant. The multivariate

analytic method was employed to investigate the risk factors for catheter-related infections. In the multivariate analysis, we used the regression model to assess the patient's biodata like gender, age and other clinical parameters and other conditions related to the catheter like duration, site and CRBSI onset as a dependent variable. The background risk factors mentioned above and a stepwise selection technique were used to build the multivariable logistic regression model.

Results

A total of 120 (60 in each group) insertion cases were done during our study at the Department of Urology in collaboration with Department of Anesthesia, GMC Teaching Hospital, Gujranwala. Patients with haematological or immunological illnesses who needed parental nutrition and patient with CKD-V or AKI who needed DLC placement for dialysis were included in our study. The age of patients in Group A ranged from 18-50 years while in Group B ranged from 19-60. 32 patients in Group A were males and 40 patients were males in Group B. The duration of insertion ranged from 8-50 days in Group A and 9-60 days in Group B. In group A 57 DLC placements were done in the right internal jugular vein while 03 insertions were performed at the right subclavian veins. In group B 50 DLC placements were done in the right internal jugular vein while 10 insertions were performed at the right subclavian vein. A total of 04 patients in Group A and 05 patients in Group B had CRBSI. Results were not significant regarding CRBSI. Gram-negative bacilli, gram-positive bacilli, and gram-positive cocci were the main bacteria causing CRBSI, but the results were not different regarding CRBSI between both groups. The Charlson Comorbidity Index (CCI) in our study was 0-10 in Group A and 0-8 in Group B. In group A no patients had any mechanical complications while in group B 03 patients had mechanical complications but all patients management conservatively. 02 cases of grade II pneumothorax were observed and grade I bleeding with grade II hematoma was observed in only one patient.

Table 1

Variables	Group A (USG Guided)		Group B (Non-USG)	
Number	60		60	
Gender	Male	Female	Male	Female
	32	28	40	20
Age	18-50 years		19-60 years	
CCI	0-10 score		0-8 score	
Site	Right Internal Jugular vein	Right Subclavian vein	Right Internal Jugular vein	Right Subclavian vein
	57	03	50	10
Duration of catheter	8-50 days		9-60 days	
CRBSI	04		05	
Mechanical Complications	00		03	

Discussion

Our study demonstrates that employing DLC placement with the help of ultrasound guidance does not significantly lower the risk of catheter-related bloodstream infections. Our research findings are close to those of an earlier study, which showed CRBSI of 24.5% in cases of haematological malignancies that included stem cell transplant recipients (Lukenbill et al., 2013). The DLC insertion location and line usage length were time-related factors in this study. The following is a list of the further developments discovered concurrently with the use of the USG-guided technique in our quasi-experimental study:

(1) More DLC is being placed in the internal jugular vein. (2) Decrease in the number of DLC insertions into subclavian veins, which is a major drop from the subclavian vein approach. (3) Increasing in number of catheter placements on the right side. All of these purposeful actions at our department were done to lessen the DLC-related issues in our hospital and by adapting these approaches in CKD-V patients we can save the left non-dominant hand for future arteriovenous fistula in most of patients. Although catheter-related bloodstream infections did not become less common over the research period. In contrast, with the development of the ultrasound-guided DLC insertion technique, mechanical complications drastically decreased. The in-house preferred suggestions that resulted from the trend of DLC insertion techniques for increasing the safety of patients described in our research are (1) a right internal jugular vein approach employing a double lumen, (2) a shorter insertion duration and early catheter removal. These suggestions, in our opinion, are necessary to avoid a variety of negative hazards, including BSI. Compared to the landmark approach, CVC placement using ultrasound guidance is a safer operation. (Saugel et al., 2017). Previous research has revealed that cannulation using ultrasound has other positive effects, such as a higher success rate for catheterization. (Maecken et al., 2015) In one trial, the authors claimed that ultrasound guiding had a success rate of 100 per cent (Karimi-Sari et al., 2014). Additional documented advantages include decreased complications such as hematomas, carotid punctures, hemothoraxes, and pneumothoraxes as well as shorter mean access times and mean attempt numbers (Xia et al., 2018). Additionally, the mechanical complications—pneumothorax, hematoma, and thoracic bleeding—showed a remarkable decrease in our research sample. Any location can be used for ultrasound-guided cannulation, including the internal jugular vein, subclavian vein, brachiocephalic vein, and others. Patients of any age can have this procedure (Van Gent et al., 2017). Our survey showed an intervention that led to a general change in the management of DLC insertion to reduce the risks causing mechanical complications, which are major DLC-related adverse events, whether they are intentional or unintentional (pneumothorax and hematoma or other organ injuries). Any provider's ability to employ ultrasound technology must be improved via training. However, we found no evidence of a delay in the impact of ultrasonography guiding. The safety of DLC implantation quickly and significantly increased thanks to the ultrasonic approach. However, despite the advent of ultrasound-guided DLC insertion, the risk of catheter-related bloodstream infections remained the same. Our quasi-experimental study's non-randomized constituted a significant flaw. The significant variations in the patients' background characteristics were another important limitation drawback of our study. Finally, only professionals who have received thorough training in this approach should use ultrasound guidance.

Conclusion

Our study shows that despite the use of ultrasound for DLC insertion there is no reduction in catheter-related bloodstream infections but the use of USG-guided DLC placement overall improves the safety of the patient for placing catheter with or without the intent of the physician.

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