FREQUENCY OF MECHANICAL COMPLICATIONS ASSOCIATED WITH INSERTION OF CENTRAL VENOUS CATHETERS IN ADULT PATIENTS AT A TERTIARY CARE FACILITY

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ABSTRACT

Objective: To determine the frequency of overall mechanical complications associated with insertion of central venous catheters in adult patients reporting to hospital.

Study Design: Observational study.

Place and Duration of Study: Department of Medicine Combined Military Hospital, Lahore & Army Cardiac Center, Lahore (Pakistan) from June 2011 to December 2011.

Patients and Methods: Eighty seven adults fulfilling the inclusion criteria were included in the study through non-probability consecutive sampling. Central venous catheters (CVCs) were inserted using standardised kits and adopting Sledinger technique. The patients were observed for any immediate mechanical complications. Standard treatment was offered to those developing complications except for catheter malposition which was not corrected. All entries were made on the patients' proformas.

Results: A total of 61(70%) catheters had complications with highest frequency associated with malpositioned 40(46%) catheters.

Conclusion: Catheter malposition was the most frequent complication encountered.

Keywords: CVCs (Central Venous Catheters), Complications, Mechanical.

INTRODUCTION

Central venous catheters are used in critically ill patients throughout the world to allow hemodynamic monitoring and easy access for administration of fluids and medication[1]. There use is associated with various complications. Published rates of complications vary based upon anatomic site and operator experience. An observational cohort study of 385 consecutive CVC (Central Venous Catheter) attempts over a six month period found that mechanical complications occurred in 33 percent of attempts[2]. Other studies show variable rates from 30% to 56%[3,4]. The present study was designed to quantify the iatrogenic risk associated with insertion of Central venous Catheters at our center.

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PATIENTS AND METHODS

This Observational study recorded mechanical complications associated with insertion of 87 consecutive Central venous Catheter catheters at Combined Military Hospital (CMH) Lahore and Army Cardiac Center (ACC) Lahore over a period of 6 months and 15 days from 1st June 2011 to 15th December 2011 using non-probability consecutive sampling. The sample size was calculated using sample size calculator keeping confidence level of 95%, anticipated population proportion 0.33 and absolute precision of 0.10. All adults aging more than 18 years requiring a CVC on any grounds (emergent, non-urgent, for hemodialysis or for fluid status monitoring) were included. The standard Seldinger technique was employed.

This method gains access to the central vein via an introducer needle through which a matching guidewire is threaded to maintain venous access after needle withdrawal. The catheter is advanced into position over the intravascular guidewire which is subsequently removed from the catheter. The operators were from different departments and at different strata of their clinical experience Catheters inserted by any technique other than the standard Sledinger technique were excluded. CVCs selected were one of these manufacturers- Arrow, Health Line International Corporation and B Braun. Before attempting operators wore sterilised gloves and ensured sterile equipment. Verbal consent was sought from the patients prior to the procedure in all non-urgent cases. Choice regarding site of insertion was left at the discretion of the operator whose minimal qualification was MBBS. CVCs were inserted by the operators independently without ultrasound guidance and if they remained unable to do so expert help was sought or the procedure was abandoned. Failure of insertion at one site was recorded and when another site was chosen for insertion it was considered a fresh attempt and was accordingly entered into the data despite that it was the same patient but was regarded a new one with reference to the attempt made. Complications if any were identified and recorded. Patients with Jugular and subclavian vein catheters had their chest radiographs taken for identification of Pneumothorax and positioning of the catheters. Supine patients had their CXR (AP) views. These radiographs were personally seen by the author himself and if required, expert help was sought from the specialists in Radiology at the Department of Radiology, CMH Lahore. Catheters with ambiguous positioning had to be excluded from the study wherever it was practical and possible. Entries were made on special patients' proformas. Statistical analysis of all the data was entered in the Statistical Package for Social Sciences version 19.0 for analysis. Chi square calculator was used to calculate p values in cases where comparison was done. Mean and standard deviation were calculated for age. Frequency was calculated for qualitative variables including: If the operator remained unable to pass the catheter at the initially selected site. The decision to change the site of insertion after attempted insertion failure was also considered a failure of placement at that particular site; Assessed by return of blood and free flow of fluid in all ports or any catheter needing repositioning after review of the radiograph or if the distal catheter tip was not in the second right intercostal space[5] on a postro-anterior chest radiograph; Pulsatile flow into the syringe and the bright-red colour of the blood; Air in pleural space detectable clinically or on chest radiograph. Other variables included No Complication, Gender and Arrest.

RESULTS

A total of 87 patients were included in the study out of which 59 (67.8%) were males and 28 (32.2%) were females. The age of patients varied from 20 to 85 years with mean and SD 58.44 ± 13.80. 12 (13.8%) cases had history of prior catheterisation almost all being Double Lumen catheters. Distribution in three selected sites is shown table-1. The frequency of two main types of CVCs used was CVPs 53 (61%), Double Lumens 34 (39%). The Frequency of outcome variables is mentioned table-2. Some catheters were associated with more than one complication. Hemothorax and Arrest were not encountered whereas one patient (0.011%) developed SVT- a complication which had not been selected as an outcome variable but merited mention because frequency of arrhythmias in this setting is very low in the published literature and we encountered this rare complication. Overall frequency of complications was 60 (69%) table-3. Group comparison revealed: 23 (82%) females and 37 (62%) males had complications (p=0.06) table-4. 22 (64.7%) Double Lumens and 38 (71.6%) CVP Lines were associated with complications (p=0.49). Based upon site of insertion frequency of complications was: Jugular 45 (75%), Subcalvian 13 (21.6%), Femoral 2 (3.3%). 6 (50%) CVCs inserted in pateients having history of prior

catheterisation were complicated in contrast to 54 (72%) CVCs associated with complications in patients without prior history of catheterisation (p=0.12).

DISCUSSION

In the present study a total of 87 catheters were attempted over a period of about 6.5 months. Published rates of complications vary from as low as 15% to as high as 56%[6,7]. An observational cohort study of 385 consecutive CVC attempts over a six month period found that mechanical complications occurred in 33 percent of attempts. Complications included failure to place the catheter (22 percent), arterial puncture (5 percent), catheter malposition (4 percent), pneumothorax (1 percent), subcutaneous hematoma (1 percent), hemothorax (less than 1 percent), and asystolic cardiac arrest (less than 1 percent)[2]. Follows an account of salient features of mechanical complications.

Studies have shown that failure to place CVCs is proportional to the number of percutaneous punctures[2]. Based upon this it is recommended that the number of percutaneous attempts to be limited to three attempts at a time.

The tip of the catheter should ideally be outside the right atrium and inside the desired vein otherwise it can cause atrial perforation[8,9]. Several studies mention cavoatrial junction as the preferred site[10]. We defined right second intercostal space as the correct site for cathter tip position[5]. Recommended insertion distances are 16 cm for right-sided and 20 cm for left-sided internal jugular and subclavian vein catheters[11]. Newer techniques like use of Ultrasound and Right Atrial ECG prior to the placement of CVCs can also help[12,13] . The use of a chest radiograph for confirmation of CVC position is now mandatory[14], though its sensitivity and specificity are not that high[15].

Once an arterial stick is suspected either by bright red or pulsatile blood, the needle is immediately withdrawn and direct but nonocclusive pressure applied to the site

Table-1: Site distribution of the central venous catheterization.

Jugular	Subclavian	Femoral	Total
58 (66.7%)	21 (24.1%)	8 (9.2%)	87

Table-2: Frequency of outcome variables associated with the insertion of central venous catheterization.

Variable	Frequency
Malposition	38 (43.6%)
Failure to place	11 (12.6%)
Arterial puncture	4 (4.6%)
Pneumothorax	1 (0.011%)
Malposition +Pneumothorax	1(0.011%)
Malposition + Arterial puncture	1(0.011%)
Failure to place + Arterial puncture	4 (4.6%)
Hemothorax	0
No complication	27 (31%)
Total	87

Table-3: Overall frequency of complications.

Complication	No complication	Total
60 (68.9%)	27 (31%)	87

Table-4: Gender differences in frequency of complications.

Gender	Complications		Total
	Yes	No	
Female	23 (82%)	5	28
Male	37 (62%)	22	59
Total	60	27	87

continuously for 15 minutes to prevent hematoma formation. Unrecognized arterial cannulation with subsequent dilation and catheter placement is associated with life-threatening hemorrhage and neurologic complications[16].

Overall subclavian catheters are associated with higher rates of pneumothorax. Adherence to the recommended insertion techniques helps in reducing this complication.

Analysis of our data revealed that predominantly the patients were males. The patients were a mix of those on hemodialysis, some required urgent CVC insertion based on clinical grounds while others had undergone CABG. The mean age was 58 years. Jugular vein remained the favourite site of insertion (66.7%), it is not known whether operators found it more convenient or they relied on some studies which show less complication rate with jugular as compared to the subclavian approach[17]. Regarding the frequency of types of CVCs, more CVP lines were attempted than DLs. The overall frequency of complications was 68.9% with malposition being the chief complication (46%). In some studies which have kept middle to lower parts of Superior Vena Cava as positions of choice for catheter tip along with cavoatrial junction, complication rates as high as 56% have been reported[6,7]. In another study18 which compared the results of catheter position inserted with and without the use of atrial ECG (in our study we used a blind technique similar to the group without atrial ECG) 48% of catheters were malpositioned when carina and 4cm above it were kept as reference area. Another fact to note is that bedside chest x ray does not reliably predict catheter tip position as the sensitivity and specificity of chest x ray for proper catheter tip position were 74.3% and 58.3% respectively[15]. Nonetheless the complication rate can be reduced by familiarization with guidelines that specify the desired length of the catheter to be inserted[20]. Jugular cannulation had the highest frequency of complications (77.5%). Published literature shows variable rates with both approaches[2]. Consistent with international studies20, jugular cannulation in our study was associated with higher rates of arterial puncture as compared to subclavian cannulation (12% vs 4.8%), the latter was associated with higher rates of Pneumothorax instead as compared to the internal jugular cannulation (9.5% vs 0%). More females (82%) than males developed complications at our center. International data show varied results. Another interesting result was higher frequency of complications (72%) in patients who had not been previously catheterised. Though it has been seen that veins which have been previously cannulated have difficult re-cannulation because of thrombosis and possible alteration of anatomy but the paradox in our study may possibly be explained by recognition of this fact by the operators and therefore leading to a selection bias for the site. The patients who had experienced Pneumothorax were chest intubated. Another patient who developed SVT during catheter insertion was administered injection Adenosine 12 mg I/V stat followed by catheter repositioning. Sinus rhythm was restored after some time. To decrease complications further operators should be continuously kept informed of the latest guidelines on the subject. Obtaining radiographs was probably the most difficult part of the study. It is suggested that medical complexes should be built such that the clinical and the diagnostic services are under one roof.

CONCLUSION

The frequency of complications associated with CVC insertion at our center demands that we should set a standard for correct placement of catheter tips and then disseminate it to all of our hospitals. In our study, typically a female without history of previous catheterisation and undergoing jugular venous cannulation with a CVP line best depicts a patient whose is most likely to have a complication in our center with the chief complication being catheter malposition.

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