



One-Year Evaluation of Complications of Central Venous Catheterization in A General Intensive Care Unit

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Abstract

Introduction: Although central venous catheters are among the fastest and most convenient ways to achieve blood flow, they have some side effects. This study aimed to investigate the complications of central venous catheter implantation in the general intensive care unit of Imam Khomeini University Hospital in Urmia, West Azerbaijan, Iran.

Methods & Materials: In this retrospective study, all individuals for whom central venous catheters were implanted in the intensive care unit were included, and patients' information was collected at intervals during and after catheter implantation to control possible complications.

Results: Out of 474 patients, 280 (59.1%) were male, 194 (40.9%) were female, and the mean age of the patients was 55.7 years. Catheters were mostly inserted using anatomical landmarks (98.9%), for the first time (79.1%), on the right side (85%), in the internal jugular vein (67.5%), and by experienced physicians (72.2%). Frequency of early complications was 11.2% including arterial insertion (1.3%), hematoma (7.4%) and improper placement (2.5%) and delayed complications of 6.3% included local infection (5%) and deep vein thrombosis (1.3%). Only in 7% of cases the needle was passed more than twice to access the vein, and complications were more on the left side (53.5% vs. 11.2%).

Conclusion: Complications of catheter implantation in 17.5% of patients necessitate catheter insertion under ultrasound guidance, preferably from the right side of the body, and close monitoring of the work of inexperienced assistants.

Keywords: Central Venous Catheter; Complications; Intensive Care Unit

Introduction

Today, central venous catheter (CVC) implantation is necessary for daily clinical work. This is done mainly by assistants and often without coherent supervision or training [1]. Access to the central vein continues to be the cornerstone of resuscitation and critical care in both the emergency department (ED) and the intensive care unit (ICU) [2]. Advanced hemodynamic monitoring, rapid fluid injection, placement of intravascular pacemakers, and

prescription of selected drugs all require a safe intravenous route. Some indications for central venous catheter implantation include the impossibility of access to the peripheral vein, central venous pressure monitoring, fluid therapy or administration of high volume or blood flow products, complete intravenous nutrition, administration of potent, irritating, and caustic drugs, implantation of intravenous pacemakers, Hemodialysis or plasmapheresis, and implantation of pulmonary artery catheters for angiography of the

lungs [2-5]. Possible complications of central venous catheterization include 1- artery perforation and hematoma formation 2- pneumothorax (in subclavian and internal jugular approaches) 3- hemothorax (in subclavian and internal jugular approaches) 4- vascular injury 5 -Air embolism 6- Cardiac dysrhythmia 7- Nerve damage 8- Infection 9- Thrombosis and 10- Catheter misplacement [6-8]. In the internal jugular approach, the risk of complications is 5 to 10%, and dangerous complications are 1% [9]. If the implant is done by an inexperienced, it will not be able to find the vessel at 19.4% according to the anatomical signs for experienced people, the failure rate is 5 to 10 percent [10]. A skilled person can enter a vein in 75% of cases on their first attempt. Disadvantages of the internal jugular approach include the possibility of carotid artery perforation and difficulty finding anatomical symptoms in obese patients [11]. The anatomy of the internal jugular region is impaired in 9 to 19% of patients. Catheter insertion into the left internal jugular vein is slightly more complex, time-consuming, and complicated than the right side [12]. The possibility of implanting a catheter in an inappropriate location is higher in the subclavian approach, while the risk of infection in the internal jugular vein is slightly higher [13]. In an emergency, catheter insertion into the femoral vein may be faster and less risky because there is no risk of hemothorax or pneumothorax in the femoral approach. Still, the risk of infection and thrombosis is higher than in the subclavian and internal jugular regions. Also, in the subclavian and internal jugular areas, the catheter can be stored for four weeks or more, while the femoral catheter must be removed or replaced after 72 to 96 hours [14-16]. Since central venous catheters are implanted in patients admitted to the General Intensive Care Unit (G-ICU) using anatomical symptoms, the primary purpose of this study was to evaluate the types and frequency of complications of central venous catheters for one year.

Materials and Methods

In this study, patients who needed to have central venous catheter implantation or replacement were included. They were admitted to the general intensive care unit. Sometimes, the patients admitted to other wards were also transferred to the general intensive care unit to have a central venous catheter implanted. They were also included in the study. Monitoring was used to evaluate cardiac arrhythmia, and after catheter placement, a chest x-ray was taken. Patients were evaluated for up to one hour for early complications, including hemorrhage, hematoma, arterial cannulation, pneumothorax, and hemothorax. Patients were evaluated Local.

Hematoma and pneumothorax 24 hours later, in this study, catheter dysfunction due to the impossibility of fluid passage through the catheter, infection through clinical and laboratory signs, and catheter head culture and thrombosis were investigated by using clinical signs and Doppler ultrasound. After implanting a central venous catheter, the implanter completed the research checklist. Each of the checklists was carefully checked for completeness by a medical student (executive) as well as the

consultant professor, and in case of incompleteness, the patient's file and clinical documents were re-examined and the checklists were completed. In the next step, the data recorded in checklists were imported into the SPSS software version 16 with the utmost care and reliability. Finally, the collected data were analyzed by Chi-square test, and $p < 0.05$ was considered significant. It is necessary to explain that the ethical points in the research (with the ethics code IR.SUMS.MED.REC.1399.070) were considered in this study.

Results

The aim of this study was to evaluate the complications of central venous catheter implantation on 474 patients in the General Intensive Care Unit (G-ICU) of Imam Khomeini Educational and Medical Center in Urmia from January 1, 2017, to December 1, 2017. Among 474 studied patients in this study, 280 patients (59.1%) were male, and 194 patients (40.9%) were female. The mean age was 55.7 (minimum: 18, maximum: 96) years, the mean height 170.2 (minimum: 122, maximum: 190) cm, and the mean estimated weight of patients was 73.1 (minimum: 45, maximum: 110) kg. Of the patients studied, 118 (24.9%) underwent CVC implantation in current or previous hospitalizations, and for 356 patients (75.1%) central venous catheters were implanted for the first time. In the case of current CVC, a new catheter was inserted for 375 patients (79.1%); for 75 patients (15.8%) replacement of new CVC was performed in the same place and for 24 patients (5.1%) the location of the previous catheter was exchanged, and the new catheter was placed in another position. Most CVCs were located on the right side of the patients (85%, 403 cases), and the rest (15%, 71 cases) on the left side (Figure 1). Summarizes the anatomical positions of CVCs implantation. Central venous catheter implanters for 342 patients (72.2%) were attending physicians (ICU Man) or anesthesiologists, and occasionally other specialist physicians. In 132 cases (27.8%) CVC implantation was done by the first year, the second-year, third year, and fourth-year assistants in 86 cases (65.2%); 6 cases (4.5%); 36 cases (27.3%); 4 cases (3%), respectively. The frequency distribution of the anatomical position of the catheter by assistants and physicians is shown in (Table 1). As can be seen in Table 2, the assistants did not implant any catheter in the subclavian position, and their preference was to implant a catheter in the internal jugular vein. This difference was statistically significant using the Pearson Chi-Square test ($P < 0.001$). Also, the assistants had more catheters on the right side compared to the experienced physicians, which was also statistically significant ($P = 0.03$). Residents, unlike specialist physicians, preferred to replace the CVC as much as possible, but specialist physicians used the approach of removing the previous catheter and placing the catheter in a new location, which was also statistically significant using the chi-square test ($P < 0.001$). In this study, anatomical landmarks were used to implant a central venous catheter in 98.9% (469 cases), and only in 5 cases (1.1%), the catheter was administered under ultrasonography by transferring the patient to the radiology department. The mean storage time of CVCs in this study was 16.2 (SD: 7.6; Min: 4 and Max: 35) days, in which there was no statistically significant difference

between specialist physicians and assistants. The frequency distribution of early and delayed complications of central venous catheter implantation according to the anatomical position of catheter implantation in the studied patients is shown in (Table 3).

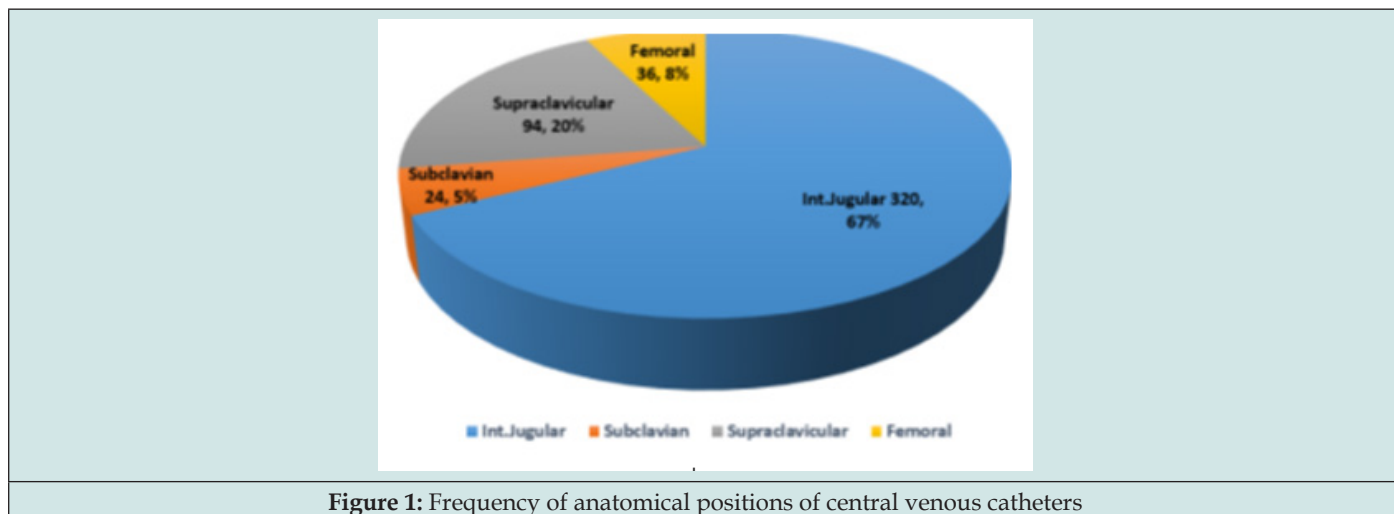


Figure 1: Frequency of anatomical positions of central venous catheters

Table 1: Distribution of the anatomic position and central vein catheter implantationside according to the physician.

Catheter installation type	Internal jugular vein		Subclavian vein		Supraclavicular vein		Femoral		Total		Total
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	
	Physicians	201	32	18	6	46	21	18	0	283	
Assistants (years 1 to 4)	78	9	0	0	24	3	18	0	120	12	132
Total	279	41	18	6	70	24	36	0	403	71	474
	58.80%	9.30%	5.30%	1.80%	13.40%	6.10%	5.30%	0%	82.70%	17.30%	72.15%
	59.10%	6.80%	0%	0%	18.20%	2.30%	13.60%	0%	90.90%	9.10%	27.85%
	58.90%	8.60%	3.80%	1.30%	14.80%	5.10%	7.60%	0%	85%	15%	100%

Table 2: Distribution of central venous catheter maintenance time according to catheter type, and anatomical position.

Grouping	Variable	Number	Average	Time (day)		
				Standard deviation	Minimum	Maximum
Anatomical position of the catheter	Internal jugular	320	15.5	7.7	4	35
	Subclavian	24	17.8	7	5	29
	Supraclavicular	94	18.6	6.7	6	32
	Femoral	36	15.5	7.8	5	35

Table 3: Distribution of early and delayed complications according to the anatomical position of central venous catheter implantation.

Complication	Internal jugular vein		Subclavian vein		Supraclavicular vein		Femoral			Total		Percent	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Total		
Percentage of complications													
12.2 %	48.8 %	0%	50%	17.10%	37.5 %	0%	-	11.20%	53.50%	17.50%			
Arterial Perforation													
	3	3	0	0	0	0	0	0	3	3	6	1.30%	
Early (11.2%)	13	8	0	3	3	3	0	0	21	14	35	7.40%	
Late	Mispositioning	6	3	0	0	0	3	0	0	6	6	12	2.50%
	Local infection	12	6	0	0	6	0	0	0	12	12	24	5%
	DVT	0	0	0	0	3	3	0	0	3	3	6	1.30%
Total (17.7%)	34	20	0	3	12	9	0	0	45	38	83	17.50%	

As can be seen in the Table 4 the incidence of early complications is 11.2%, including arterial perforation (1.3%), hematoma (7.4%), and improper placement (2.6%), and the incidence of delayed complications is 6.3%, including local infection (5.1%) in the catheter position, and deep vein thrombosis (DVT) in 1.3% of patients. Interestingly, no early or late complications were reported in the right femoral vein. In terms of gender-related complications, early complications occurred in 13.9% of women (27 out of 194 cases) and in 7.5% of men (21 out of 280 cases), which was statistically significant by applying the Pearson Chi-square test (P = 0.023). Conversely, late complications occurred in 8.6% (24 out of 280) men and 3.1% (6 out of 194) women, which was also a significant difference (P = 0.016). The incidence of complications in terms of body mass index (BMI) classification was not statistically significant. The frequency of early complications in catheter implantation by assistants was 11.4%, and by specialist physicians were 9.6%

(no statistically significant relationship), and the frequency of late complications in catheter implantation by assistants was zero percent while it was 8.8% by specialist physicians. The relationship between complications and previous experience of central venous catheter implanters was also investigated. The frequency of early complications in less experienced implanters (<10 previous attempts), average experience implanters (11-50 previous attempts), and experienced implanters (>50 previous attempts) was 14.5%, 9.8%, and 1%, respectively. However, in all 30 cases (8.8%) of the delayed complications were related to experienced installers. Antibiotics prescription to the patients was 86.4% by assistants, and 71.3% by specialist physicians, which was also statistically significant (P = 0.001). Blood products were injected for 36.9% of the patients, they included fresh frozen plasma (FFP) for 6 cases; Platelets (Plt) for 30 patients; and FFP + Plt for 139 patients.

Table 4: Distribution of previous experience of physicians in implanting central venous catheter in general intensive care unit.

Previous experience of catheter insertion	Less than 10 times	11 to 50 times	More than 50 times	Total
Physicians	1	2	339	342
	0.30%	0.60%	99.10%	100%
Assistant (years 1 to 4)	82	49	1	132
	62.10%	37.10%	0.80%	100%
Total	83	51	340	474
	17.50%	10.80%	71.70%	100%

Discussion

The study investigated the frequency of early and late complications of CVC implantation in 474 patients over a one-year period in the intensive care unit of a teaching hospital. CVC implantation is a common procedure performed frequently in hospitals around the world for access to a safe intravenous route. Due to the large number of implanted catheters, the possible side effects have decreased, however, 15-20% of patients experience some complications during the catheter implantation [17-19]. Our study showed that the rate of catheter infection in our center is like the rate reported in other centers [20-21]. Interestingly, in this study, no complication of infection or DVT was observed in the approach of catheter insertion through the femoral vein, despite holding the catheters longer than the recommended time of 3 to 4 days in the femoral position. The degree of mechanical complications associated with central venous perforation was also rare, while in various studies the incidence of local infectious complications and infection diffusion (bacteremia and septicemia) due to catheter placement in the femoral position were reported more than the internal jugular and subclavian areas [22- 23]. The most common site for central venous catheter placement in this study was the internal jugular vein (67.5%) followed by the supraclavicular position (19.8%), which was consistent with most previous studies [24-25]. The internal jugular vein as the access site was associated with more general complications (61% of the total complications). The incidence of complications in this study was 17.5%, consisting of early complications 11.2%, perforation of the artery (1.3%), hematoma (7.4%) and improper placement (2.5%). The incidence of late (delayed) complications was 6.3% including the incidence of local infection at the catheter site (5.0%), and deep vein thrombosis (1.3%). In fact, in our center, mechanical complications were more than in the other centers. Comparing the two groups of implanters, the specialist physicians, and our assistants, it is found that catheter implantation in the femoral region and the right side was preferred by the assistants, and no catheter was implanted in the subclavian position. In patients with a previous catheter, assistants were more likely to replace the catheter than to remove it completely and reinsert it in a new position. The mean number of vascular perforations, as well as the average time required for catheter implantation by assistants, were significantly higher than specialist physicians. Also, the frequency of early complications during catheter placement by assistants was slightly higher than specialist physicians (11.4% vs. 9.6%), although the difference was not significant. According to previous studies, one of the most common mechanical complications of catheter placement is pneumothorax especially in the subclavian [26-29] while it was surprising that in our study, there was no report on any serious complications such as pneumothorax, hemothorax, subcutaneous emphysema, thrombosis and obstruction of blood vessels, arterial and venous fistula. This lack of accurate documentation of patients' clinical records can be due to the ignorance of the assistants and medical students, which in turn can be considered among the limitations of this study.

Conclusion

In catheter placement using the anatomical landmarks, our results were parallel to the finding of other studies around the world. The incidence of mechanical complications with central venous catheterization in our center was estimated to be 17.5%, which was higher than the other centers, and it did not have any relationship with the implanter experience. Based on the results, it is highly recommended to document and record the files correctly. On the other hand, today, the installation of a central venous catheter under ultrasound guidance is accepted as a standard method that can effectively reduce complications, and all hospitals, especially in the intensive care unit, must prepare this facility. Further studies are needed to determine ways to reduce catheterization complications.

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