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Incidence of Incorrect Central Venous Catheter Tip Placement - A Retrospective Study with Fixed Length Central Venous Catheter Insertion in a Tertiary Care Hospital

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Abstract

Objective: Aim of the present study was to find the incidence of inaccurately placed CVC tips, with fixed length insertion through right subclavian vein.

Methodology: It is a retrospective study conducted in tertiary care hospital. Chest X Rays of patients in whom CVC was inserted, were retrieved through PACS and distance of CVC tip was measured from carina.

Results: Total of 289 cases were included in the study, 193 (66.8%) were males and 96 (33.2%) were females. Overall rate of misplaced CVC tips was 26.6%, it was 26.9% in males and 26% in females.

Conclusion: Fixed length insertion technique has been described by many authors, but these results in high rate of inaccurate placement of CVC tip. Accuracy can be increased by using available technology or landmark techniques.

Keywords: Catheter, venous, central line, fixed length, tip placement.

Introduction

With the advent of simpler techniques and easy availability of customized kits, placement of central venous catheters (CVC) has become a routine procedure in intensive care units and cardiac operation theatres. Various indications of Central Venous Catheter placement include long term venous access, infusion of irritant drugs, total parenteral nutrition, inadequate peripheral access, monitoring of certain pressures. [1].

CVC can be inserted through various sites including subclavian vein (SCV), internal jugular vein or femoral vein. Choice of insertion site depends upon patient condition and expertise of the person carrying out the procedure. Position of CVC tip can be verified by various modalities at the time or after the insertion. While Ultrasounds, ECG, CT scan and X Ray chest have been commonly used to ascertain the position of CVC tip, post procedure X Ray chest remains the most common means. Carina has been described as simple and reliable landmark to evaluate the positioning of CVC tip. [2,3]

As per recommendations, tip of CVC should lie in the superior vena cava (SVC), above the point where SVC

enters right atrium. The tip should be parallel to the vessel wall. [4]

SVC can be divided into two zones in relation to carina. Upper SVC zone extends upwards for 3 cm from carina and Lower SVC zone extends for 3 cm below carina. [5] Figure 1.

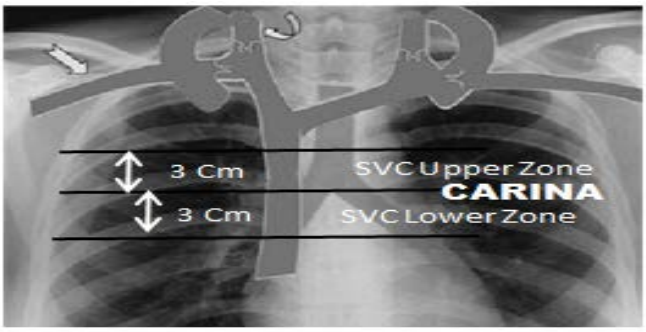

Figure 1

Misplaced CVC tip can lead to various complications. Placement too close to the vessel wall can lead to failed aspiration or infusion, thrombus formation or erosion of the vessel wall. If inserted beyond the required length, it can cause arrhythmias and damage heart valve. [6] It can also lead to cardiac tamponade which can be fatal. [7]

Various techniques have been described to help in right placement of CVC tip in the SVC including Peres' formula, landmark technique, ECG guided technique [8] and fixed length technique. [9]

A depth of insertion of 14 cm has been recommended for Asian population for insertion through right SVC. [10]

Aim

Aim of this retrospective study was to find the efficiency of fixed length insertion of CVC through Right SVC approach in correct placement of the CVC tip in SVC.

Material and Method

After obtaining clearance from Institutional Ethics Committee, this retrospective study was conducted at a tertiary care hospital and comprised patients who underwent CVC insertion during the period July 2019 to June 2020. Cases whose post CVC insertion X Rays were available, were included in the study. CVCs were inserted for various clinical indications including drug infusions, pressure measurements, parenteral nutrition, long term venous access etc.

Central lines were inserted by the same team of anaesthesiology team, following the same standard protocols. All lines were inserted with Seldinger technique in the right SVC and were inserted to a fixed depth of 13-14 cm for males and 12-13 cm for females. Post insertion chest X Ray was done to rule out any procedural complications.

X Ray images of all the patients with CVC were retrieved from picture archiving and communication system (PACS). Tip position was marked and distance from carina was noted. Tip position within 3 cm of carina, either above or below was taken to be accurate placement.[5]

Results

Total of 289 cases, whose chest X Rays were available in PACS, were included in the study. Out of these, 193 were males and 96 were females. Figure 2. Table 1.

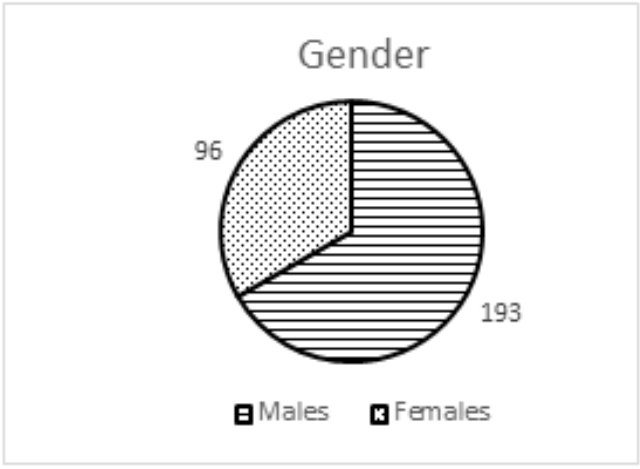

Figure 2: Gender Distribution

Gender	Number	%
Male	193	66.8
Female	96	33.2

Table 1: Gender Distribution

Average age of males was 53.8 years (range 15 years to 93 years) and that of females was 61.2 years (range 21 years to 91 years). Figure 3.

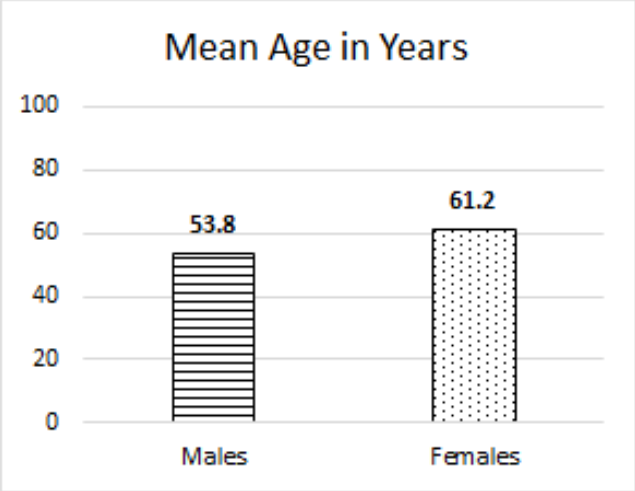

Figure 3: Mean Age in years

CVC tip was correctly placed in 212 (73.4%) cases and the position was inaccurate in 77 (26.6%) cases. Figure 4. Table 2.

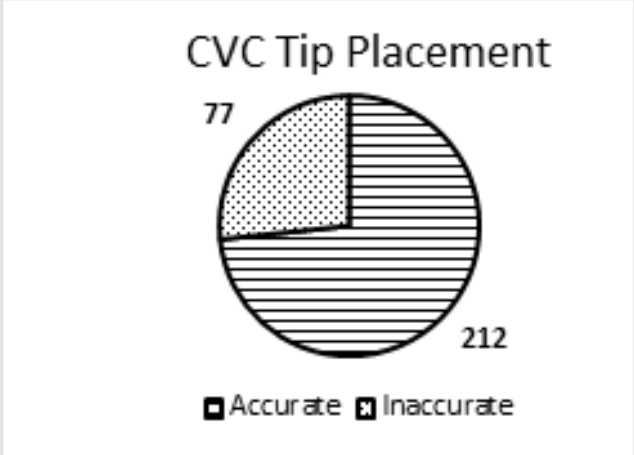

Figure 4: CVC Tip Placement

Tip Placement	Number	%
Accurate	212	73.4
Inaccurate	77	26.6

Table 2: Frequency of tip placement

Out of 212 correctly placed, 124 (58.5%) cases had tip in upper SVC zone and 88 (41.5%) had CVC tip in lower SVC zone. Figure 5. Table 3.

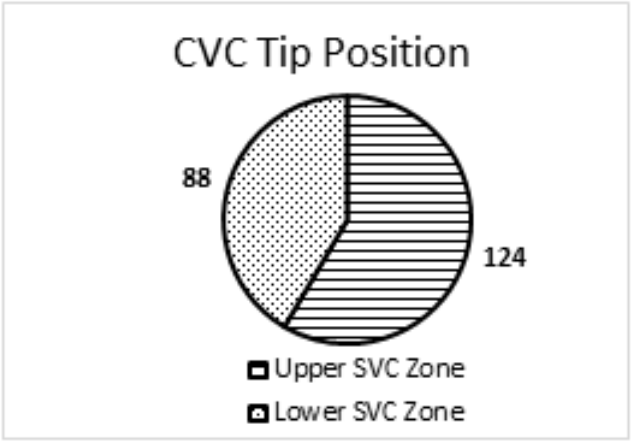

Figure 5: Zone wise position of CVC tip

Tip Position	Number	%
Upper SVC Zone	124	58.5
Lower SVC Zone	88	41.5

Table 3: Frequency of tip position

Out of 193 males, CVC tip was correctly placed in 141 (73.1%). 88 (62.4%) patients had the tip placed in upper SVC zone and 53 (37.6%) had it in the lower SVC zone.

In case of 96 female patients, 71 (74%) had correctly placed CVC tip. 36 (50.7%) female patients had the tip in upper SVC zone and 35 (49.3%).

Total of 77 (26.6%) cases had inaccurately placed tip of CVC. Out of these, 52 (67.5%) were male patients and 25 (32.5%) were female patients.

Out of 52 male patients with wrong placement of CVC tip, 32 (61.5%) had CVC tip short of upper SVC zone and the average distance from carina was 4.68 cm

(above) and 11 (21.2%) had the CVC tip below the lower SVC zone, average distance from carina being 4.52 cm (below). 6 (11.6%) patients had CVC tip in right Internal Jugular vein, in 2 (3.8%) cases CVC tip was in right subclavian vein and 1 (1.9%) case had CVC tip in left internal jugular vein. Figure 6. Table 4.

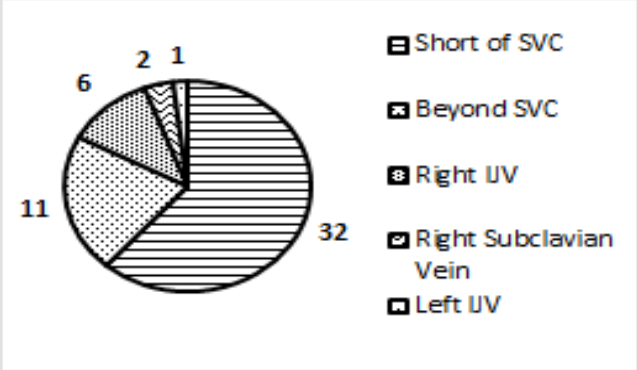

Figure 6: Incidence of Inaccurate CVC tip placement in males

Location	Number	%
Above Upper SVC Zone	32	61.5
Below Lower SVC Zone	11	21.2
Right IJV	6	11.6
Right Subclavian vein	2	3.8
Left IJV	1	1.9

Table 4: Incidence of Inaccurate CVC tip placement in males

Out of 25 female patients with wrong placement of CVC tip, , 7 (28%) had CVC tip short of upper SVC zone and the average distance from carina was 4.83 cm (above) and 8 (32%) had the CVC tip below the lower SVC zone, average distance from carina being 3.83 cm (below). 8 (32%) patients had CVC tip in right Internal Jugular vein, in 1 (4%) case CVC tip was in left subclavian vein and 1 (4%) case had CVC tip in left brachiocephalic vein. Figure 7. Table 5.

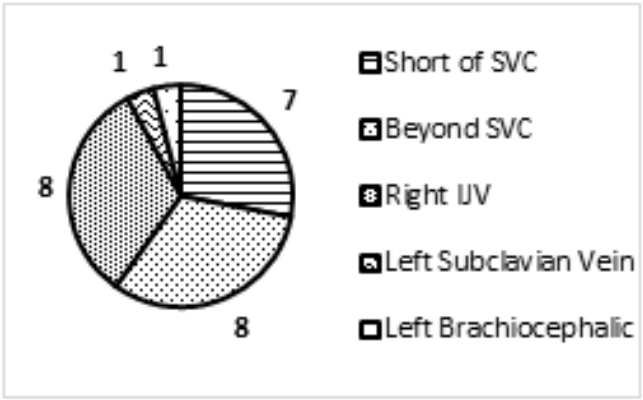

Figure 7: Incidence of Inaccurate CVC tip placement in females

Location	Number	%
Above Upper SVC Zone	7	28
Below Lower SVC Zone	8	32
Right IJV	8	32
Left Subclavian vein	1	4
Left Brachiocephalic	1	4

Table 5: Incidence of Inaccurate CVC tip placement in females

Discussion

CVCs are an important contraption in the management of patients in intensive care units and patients undergoing major surgeries, especially cardiac surgeries. Inaccurate placement of CVC tip can result in number of complications, including fatal ones. In the present study which used fixed length insertion technique, overall rate of inaccurately placed CVC tip was 26.6% (77 out of 289). This was almost evenly divided into male and female population. CVC tip was inaccurately placed in 26.9% males (52 out of 193) and 26% females (25 out of 96).

Khatodkar JK et al made topographical measurements to determine the insertion depth of CVC. [11] through right subclavian vein. As per their study, average insertion length for males was 13.2 cm and in females it was 11.9 cm. Success rate of correct CVC tip positioning was 89.6% in males and 95.1% in females.

Insertion lengths are almost similar in present study. Success rate was better in their study as measurements were made for individual patients whereas fixed insertion length was used for all patients in present study.

Kwon HJ et al in their study, used premeasured length for inserting CVC through right subclavian vein, using pre procedure chest x ray. [12].They were able to place all the CVC tip correctly in SVC upper or lower zone. Measurements involved required pre procedure chest and neck x ray and PACS. This facility might not be available for every patient. Other limitations include altered local anatomy and children age group.

Demble A and Dave S in their study for estimation of CVC insertion length with the help of surface landmarks for insertion through various routes. [13]. Mean depth of insertion through right subclavian vein was found to be 12.86 cm which is close to depth used in present study.

Lee JB et al in their study used fixed length technique of CVC insertion through right IJV.[5]. 37.8% cases had misplaced CVC tip. Length used in their study, 15 cm, was more than the insertion length used in present study. That can be the reason for high percentage of misplaced tips in the right atrium zone.

Kujur R et al recommended fixed insertion length for CVC through IJV for Indian population. [9] In their study, catheter repositioning was required in 21.1% males (15 of 71) and 38.9% females (14 of 36). This difference between males and females may be for the fact that same insertion length was used for both the genders.

Ryu HG et al in their study used premeasured length based on pre procedure chest x ray, to insert CVC via right IJV or right subclavian vein. [14]. 4.6% CVC tips (7 of 153) were placed inaccurately in the subclavian group.

Conclusion

Various techniques have been proposed and worked upon for correct placement of CVC tip in SVC. This is important to prevent complications, some of which can be fatal also. Some of the techniques are anatomical landmarks, measurements from preprocedural chest X Ray, ultrasound guidance, ECG based and certain other formulae. Present study, based on fixed insertion length, had incidence of 26.6% of inaccurately placed CVC tip. Pre procedural chest x ray, ultrasound or ECG help may not be available for every patient, in every situation. Still, it would be better to make use of any help in the form of technology or landmarks, to ensure correct positioning of CVC tip. Estimation of insertion length for every patient with available resources should decrease the incidence of inaccurate placed CVC tip.

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