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Right internal jugular vein, right supraclavicular and right infraclavicular subclavian vein approach to central venous cannulation in pediatric patients: A randomized comparative study

Running title: Comparison of right internal jugular vein, right supraclavicular and right infraclavicular subclavian vein approach to central venous cannulation in pediatric patient

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Abstract

Background: Central venous catheterization (CVC) is an important procedure for infant patients for different purposes like nutritional support, surgical operation, hemodynamic monitoring and medications. Different approaches for CVC in children are internal jugular vein, supraclavicular subclavian and infraclavicular subclavian. The purpose of this study was to evaluate the relative effectiveness and complication risks of these three cannulation locations in infants.

Method: Assuming the effect size of 0.5 between groups, at 5% confidence level and 80% power, 10 patients were randomly assigned to each group - Group A: right internal jugular vein, Group B: right supraclavicular subclavian, Group C: right Infraclavicular subclavian. Parameters assessed were - number of attempts, successful placement of central line at superior vena casa-right atrium (SVC-RA) junction, time for insertion, complications like arterial puncture, incidence for post-op local infection, hemothorax, pneumothorax, hematoma formation. Data was compared using chi square test and ANOVA test.

Results: Time taken for catheterization in Group C was the least followed by Group A then Group B. Number of attempts taken for a successful placement of catheter in 1st attempt was maximum in Group C followed by Group A and B. It was noted that 2 of 10 patients had arterial puncture in Group A during catheterization. There was 100% successful placement in all 3 groups. No incidence of haematoma formation, haemothorax, pneumothorax, post-op local infection seen.

Conclusion: Infraclavicular approach takes the least amount of time and number of attempts for catheterization, with no incidence of any complications.

Keywords: central venous canulation, supraclavicular subclavian, infraclavicular subclavian, internal jugular vein, infants

Introduction

For patients with limited peripheral access, central venous catheterization (CVC) is frequently used for fluid infusion, hemodynamic monitoring, the infusion of irritable or hypertonic solutions, the infusion of vasoactive drugs, and hemodialysis. [1] The subclavian and internal jugular veins are the most commonly used routes for CVC. [1,2]

Numerous criteria need to be taken into consideration while choosing the location for central venous catheterization. The subclavian vein (SCV) is advocated by many physicians considering patient comfort and infection risk with prolonged usage. [3,4] Others, however, prefer the internal jugular vein (IJV) since it has a short, direct course to the superior vena cava and fatal consequences such pneumothorax or hemothorax are uncommon. [5-9]

Because of the thoracic duct's existence and the left's pleural dome's more cephalad location, the right side is favored.

For a variety of reasons, infant's central venous access site selection criteria differ from those for adults or children. First, the most crucial criterion is success rate since central venous cannulation in infants is technically more difficult. [2,10,11] Second, complications tend to occur more frequently and are typically more severe. [10-14] Third, infant's anatomical characteristics differ from adults.

Normally adult configuration predominates after one year of age. [15] Due to the anatomical feature of the SCV in infants, [16] many a times catheter inserted are placed in an aberrant position. [17,18]

The operator's expertise and underlying disease are the key determinants for selection of the anatomical location for CVC insertion. The incidence of mechanical and infectious problems for each technique is a significant consideration that might affect the choice of anatomical location for CVC insertion.

Materials and method

Aim:

To compare approach for central venous cannulation for right internal jugular vein, right supraclavicular and right infraclavicular subclavian vein in paediatric patients.

Objectives:

1. Number of attempts
2. Successful placement of central line at SVC-RA junction
3. Time for insertion
4. Complications

Inclusion criteria: Age 6 months-2 years, all patients undergoing cardiac surgery requiring central venous canulation with ASA grade 1-3.

Exclusion criteria: Unwilling patients, Patients posted for emergency procedures, Patients having local infections, Patients with known left superior vena cava, Patients with mediastinal mass causing SVC obstruction, Patients having any coagulation defects

Assuming the effect size of 0.5 between groups, at 5% confidence level and 80% power, 10 patients were randomly assigned to each group - Group A: right internal jugular vein, Group B: right supraclavicular subclavian, Group C: right Infraclavicular subclavian.

Each child completed a predetermined age-adjusted fasting period (4-6 hours) and was premedicated with oral pedichloryl syrup 0.5mg/kg or 50 mg/kg. Nasal ketamine 7mg/kg and nasal Midazolam 0.4 mg/kg was given and Intravenous access was established.

Patients were induced with inj. Ketamine 2mg/kg, Inj. Midazolam 0.05mg/kg, inj. fentanyl 2μg/kg and inj. Vecuronium 0.1mg/kg

Patients were intubated with endotracheal tubes of appropriate size and Isoflurane 0.2% to 1.5% was administered to assure depth of anesthesia.

CVC was then done.

A shoulder roll was placed to extend the neck, which was rotated to expose the puncture site.

In the **IJV group**, the right internal jugular vein was located at the apex of the triangle formed by the sternal and clavicular heads of the sternocleidomastoid muscle and the clavicle. The needle was advanced past the apex of the triangle, in the direction of the ipsilateral nipple. When return of venous blood into the syringe was observed, a guide-wire was placed through the needle into the vein and the needle was be removed.

Supraclavicular approach:

Patients were placed in a Trendelenburg's position with slight shoulders extension and the procedure was performed under local anaesthesia (20 cc of lidocaine 1%).

The key success factor was the correct identification of the clavi-sternomastoid angle landmark formed by the junction of the lateral head of the sternocleidomastoid muscle and the clavicle using active rising of the patient's head.

The site of needle insertion was 0.5 to 1cm lateral to the clavicular head of the sternocleidomastoid muscle and 1 cm posterior to the clavicle. The needle was oriented at a 45° angle to the sagittal and transverse planes and a 15° angle below the coronal plane with the contralateral nipple as a target for directing the introducer. Subsequently to the vein puncture, a guidewire was inserted through the needle which was withdrawn and catheter was placed after dilating the point of insertion.

Infraclavicular approach:

Following the same positioning and initial steps, the landmark of needle insertion for this approach was 1 cm lateral to the middle third of the clavicle with a 10 to 15° incline from the coronal plane to the direction of the sternal notch or the contralateral acromioclavicular articulation.

A double or triple lumen and 4 F, 4.4F, 5 F, or 5.5 F sized catheter was inserted to a depth of 5 cm to 8 cm based on the patient size and the type of surgery. The duration of CVC was recorded, starting from the skin puncture and ending with the aspiration of blood from the distal lumen of the catheter following catheter insertion.

The optimal length of insertion of central venous catheters for pediatric patients:-

For patients <100cm: (height [cm]/10)-1=distance(cm) to SVC-RA junction

For patients >100cm: (height [cm]/10-2=distance(cm) to SVC-RA junction

Statistical analysis:

All the cases were completed in stipulated time and tabulated. SPSS software was used for analysis of data. Komolgorov- Smirnov's 'one-sample test was used to assess the normality of distribution of the continuous data. Categorical variable is expressed in terms of frequency and percentage and continuous variables in terms of mean and standard deviation (SD). Chi square test and ANOVA test was used to test the significance of mean of 3 groups with $P<0.05$ as statistically significant at 95% confidence level.

Results:

Age:

The mean age (mean ± S.D.) in Group A was 14.50 ± 6.36 months, Group B 8.80 ± 6.60 months and Group C 13.50 ± 7.95 . The groups were comparable in terms of age ($P=0.171$)

Sex:

The percentage distribution of age in Group A, Group B and Group C were comparable in terms of sex ($P=0.99$)

Weight:

The mean weight (mean ± S.D.) in Group A was 7.33 ± 2.18 months, Group B 6.00 ± 3.02 months and Group C 7.00 ± 2.40 . The groups were comparable in terms of weight ($P=0.508$)

Surgries:

Since $P < 0.05$, there is significant difference in surgeries opted in each group as different surgeries were performed during the period of study though the selection criteria based on age sex and weight remains the same.

Time taken:

Since $P < 0.05$, there is significant difference in grades of time taken for catheterization between Group A (2.89±2.07), Group B (2.93±1.58) and Group C (1.91±0.71). The mean values suggests that the grades are significantly less at Group C than Group A and Group B.

Number of attempts:

Since $P > 0.05$, there is no significant difference in grades of number of attempts taken for a successful placement of catheter between Group A and Group B.

Since $P < 0.05$, there is significant difference in grades of number of attempts taken for a successful placement of catheter between Group A and Group C.
Since $P < 0.05$, there is significant difference in grades of number of attempts taken for a successful placement of catheter between Group B and Group C.
$P < 0.05$ signifies the comparison of grades of number of attempts taken for a successful placement of catheter in Group C with Group A and Group B. The mean values suggests that the number of attempts taken were significantly less with Group C than Group A and Group B.
Success rate:
There was 100% successful placement in all 3 groups.
Complications:
It was noted that 2 of 10 patients had arterial puncture in group A during catheterization. No incidence of haematoma formation, haemothorax, pneumothorax, post op local infection seen.

Discussion:

Intraoperatively, central venous catheterization is a vital procedure. Because of the small necks and larger than normal head to body ratios in infants, jugular vein catheterization is challenging. The risks associated with carotid artery puncture are greater than those associated with subclavian artery puncture and include cerebral thromboembolism and airway compromise. Articles evaluating and contrasting benefits and hazards of the various SVC locations in infants are few.
In this study we have compared 3 different approaches to Central venous catheterization as not seen in the previous studies.
As observed from the results, time taken for catheterization was significantly less in Group C than Group A and Group B.
Number of attempts taken for a successful placement of catheter were significantly less in Group C than Group A and Group B.
In the current study, there were 30 patients in total with 10 in each group. Age considered was between 0-2 years. It was noted that, all (100%) patients had successful placement of catheter. A study done by MS Huttel, P Christensen and AS Olesen in Denmark showed that, the success rate for catheterization was 96% which is found to be near similar. [19]
In the current study, it was noted that the time taken for catheterization among internal jugular vein group was 2.89±2.07 minutes and for infraclavicular subclavian vein was 1.91±0.71 minutes. A study done in Osaka of Japan showed that, internal jugular vein catheterization in infants showed 6.31±0.71 minutes. [20]
A study done in Osaka of Japan showed that, internal jugular vein catheterization in infants showed that, 79.5% was the success rate for placement of catheter in the 1st attempt; whereas in the current study, 80% was the success rate in the ISV group (group C) in the 1st attempt and 43.4% overall success rate in the 1st attempt. [21]
A study done by Byon et al., in Nepal showed that, no complications such as pneumothorax and arterial puncture was found in the comparative study of supraclavicular and infraclavicular

subclavian catheterization which was similar to the current study, wherein there were no such complications in both the groups of supraclavicular and infraclavicular subclavian vein catheterization. [22]

Conclusion:

Infraclavicular approach takes the least amount of time and number of attempts for catheterization, with no incidence of arterial puncture, haematoma formation, haemothorax, pneumothorax and post op local infection.

Limitations:

A larger sample would help in establishing complication rate in all approaches in central venous canulation.

References:

1) Chung DH, Ziegler MM: Central venousc atheter access. Nutrition 1998; 14: 119 – 123.

2) Stovroff M, Teague WG: Intravenous access in infants and children. Pediatr Clin North Am1998; 45: 1373 – 1393, viii.

3) Huttel MS, Christensen P, Olesen AS:Subclavian venous catheterization in children.Acta AnaesthesiolScand 1985; 29: 733 – 735.

4) Hoyt DB: Internal jugular vein cannulation versus subclavian vein cannulation. Asurgeon's view: the subclavian vein. J Clin Monit1985; 1: 61 – 63.

5) English IC, Frew RM, Pigott JF, Zaki M: Percutaneous catheterisation of the internal jugular vein. Anaesthesia 1969; 24: 521 – 531.

6) Cobb LM, Vinocur CD, Wagner CW, WintraubWH: The central venous anatomy in infants.SurgGynecolObstet 1987; 165: 230 – 234.

7) Daily PO, Griepp RB, Shumway NE: Percutaneous internal jugular vein cannulation.Arch Surg 1970; 101: 534 – 536.

8) Hayashi Y, Uchida O, Takaki O, Ohnishi Y,Nakajima T, Kataoka H, et al: Internal jugularvein catheterization in infants undergoing cardiovascular surgery: an analysis of thefactors influencing successful catheterization.AnesthAnalg 1992; 74: 688 – 693.

9) Eisenhauer ED, Derveloy RJ, Hastings PR:Prospective evaluation of central venous pressure (CVP) catheters in a large city-countyhospital. Ann Surg 1982; 196: 560 – 564.

10) Bonventre EV, Lally KP, Chwals WJ, Hardin WD,Jr, Atkinson JB: Percutaneous insertion of subclavian venous catheters in infants and children.SurgGynecolObstet 1989; 169: 203 – 205.

11) Cote CJ, Jobes DR, Schwartz AJ, Ellison N: Two approaches to cannulation of a child's internal jugular vein. Anesthesiology 1979; 50: 371 – 373.

12) Vane DW OB, Rescorla FJ, West KW, Grosfeld JL:Complications of central venous access inchildren. PediatrSurg Int 1990; 5: 174 – 178.

13) Groff DB, Ahmed N: Subclavian vein catheterization in the infant. J PediatrSurg1974; 9: 171 – 174.

14) Casado-Flores J, Valdivielso-Serna A, Perez-Jurado L, Pozo-Roman J, Monleon-Luque M,Garcia-Perez J, et al: Subclavian vein catheterization in critically ill children:analysis of 322 cannulations. Intensive CareMed 1991; 17: 350 – 354.
15) Cobb LM, Goss JC, Gilsdorf RB: Regional anatomy regarding the placement of central venous cannulas. Ariz Med 1981; 38: 33 – 36.
16) Jung CW, Bahk JH, Kim MW, Lee KH, Ko H:Head position for facilitating the superior venacaval placement of catheters during right subclavian approach in children. Crit Care Med2002; 30: 297 – 299.
17) Fischer J, Lundstrom J, Ottander HG. Central venous cannulation: a radiological determination of catheter positions and immediate intrathoracic complications. Acta AnaesthesiolScand 1977; 21: 45 – 49.
18) Conces DJ, Jr, Holden RW: Aberrant locations and complications in initial placement of subclavian vein catheters. Arch Surg 1984; 119:293 – 295.
19) Hüttel MS, Christensen P, Olesen AS. Subclavian venous catheterization in children. Acta anaesthesiologica scandinavica. 1985 Oct;29(7):733-5.
20) Hayashi Y, Uchida O, Takaki O, Ohnishi Y, Nakajima T, Kataoka H, Kuro M. Internal jugular vein catheterization in infants undergoing cardiovascular surgery: an analysis of the factors influencing successful catheterization. Anesthesia and analgesia. 1992 May 1;74(5):688-93.
21) Hayashi Y, Uchida O, Takaki O, Ohnishi Y, Nakajima T, Kataoka H, Kuro M. Internal jugular vein catheterization in infants undergoing cardiovascular surgery: an analysis of the factors influencing successful catheterization. Anesthesia and analgesia. 1992 May 1;74(5):688-93.
22) Byon HJ, Lee GW, Lee JH, Park YH, Kim HS, Kim CS, Kim JT. Comparison between ultrasound-guided supraclavicular and infraclavicular approaches for subclavian venous catheterization in children—a randomized trial. British Journal of Anaesthesia. 2013 Nov 1;111(5):788-92.

Tables and legends

Table 1: CVC for age and weight

WEIGHT (KG)	AGE	CENTRAL VENOUS LINE (FR)
<10	NEONATE-6 MONTH	4
10-15	1-2 YEAR	4.5
15-30	2-5 YEAR	5
30-50	8-12 YEAR	5.5
>50	>14 YEAR	7

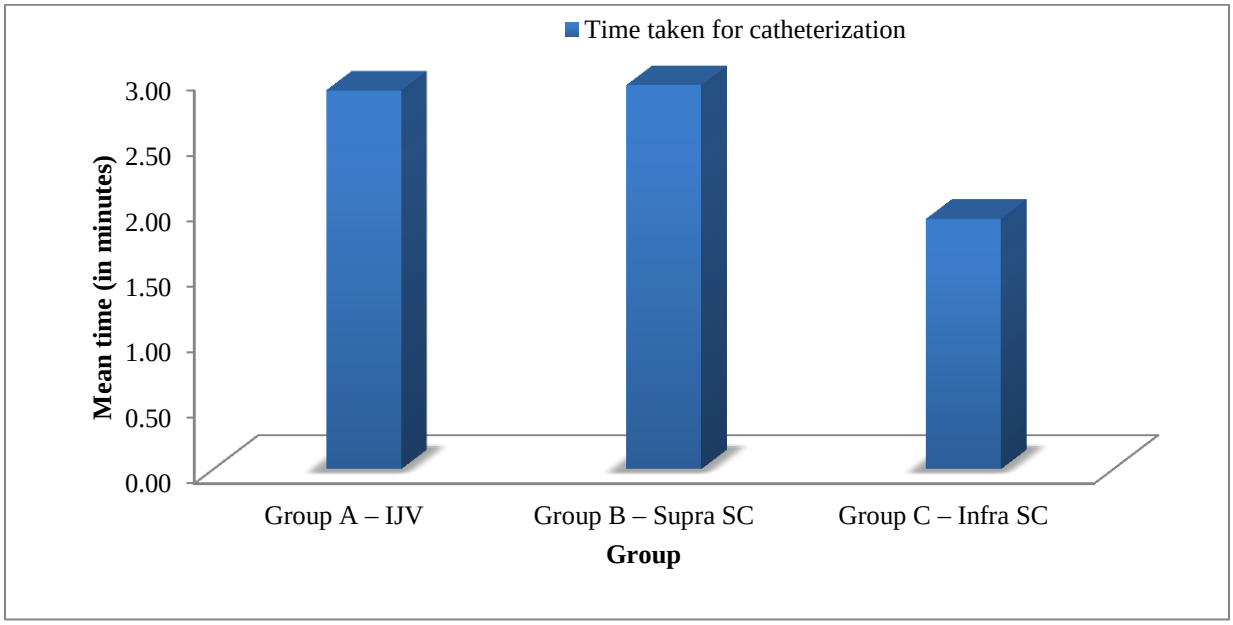
FR- French

Table2: Time taken for catheterization among patients in each group

Time taken (in minutes)	Group A – IJV	Group B – Supraclavicular SCV	Group C – Infraclavicular SCV
Time taken (Mean±SD)	2.89±2.07	2.93±1.58	1.91±0.71

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein, SD- standard deviation

Figure2: Time taken for catheterization among patients in each group



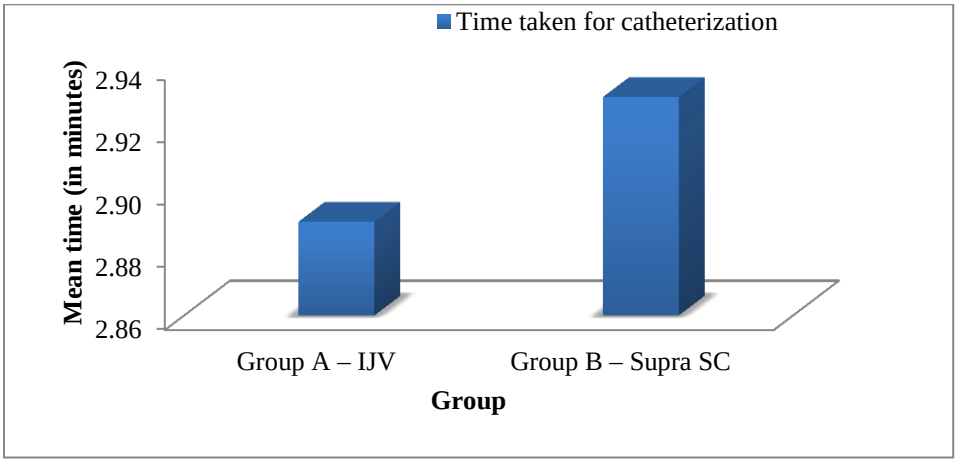
Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein

Table 3: Time taken for catheterization between Group A and B patients

Time taken (in minutes)	Group A – IJV	Group B – Supraclavicular SCV	*P VALUE*
Time taken (Mean±SD)	2.89±2.07	2.93±1.58	*0.433*

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, SD- standard deviation

Figure 3: Time taken for catheterization between Group A and B patients



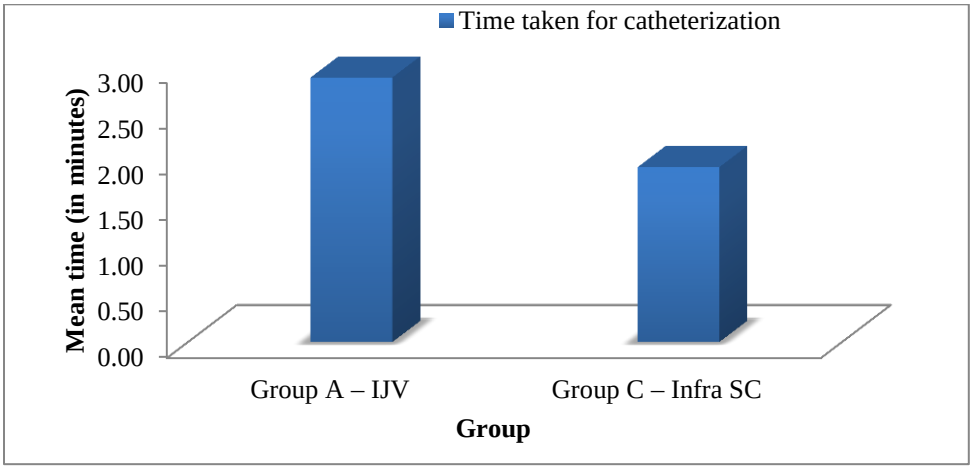
Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein

Table 4: Time taken for catheterization between Group A and C patients

Time taken (in minutes)	Group A – IJV	Group C – Infraclavicular SCV	*P VALUE*
Time taken (Mean±SD)	2.89±2.07	1.91±0.71	***0.003***

Group A- right internal jugularvein, Group C- right infraclavicular subclavian vein, SD- standard deviation

Figure 4: Time taken for catheterization between Group A and C patients



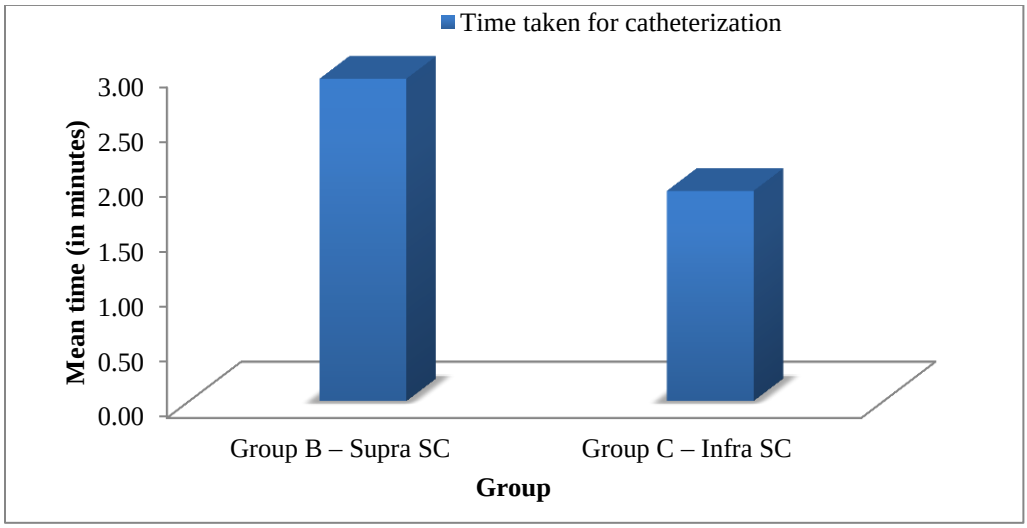
Group A- right internal jugular vein, Group C- right infraclavicular subclavian vein

Table 5: Time taken for catheterization between Group B and C patients

Time taken (in minutes)	Group B – Supraclavicular SCV	Group C – Infraclavicular SCV	*P VALUE*
Time taken (Mean±SD)	2.93±1.58	1.91±0.71	***0.025***

Group B- right supraclavicular subclavian vein , Group C- right infraclavicular subclavian vein, SD- standard deviation

Figure 5: Time taken for catheterization between Group B and C patients



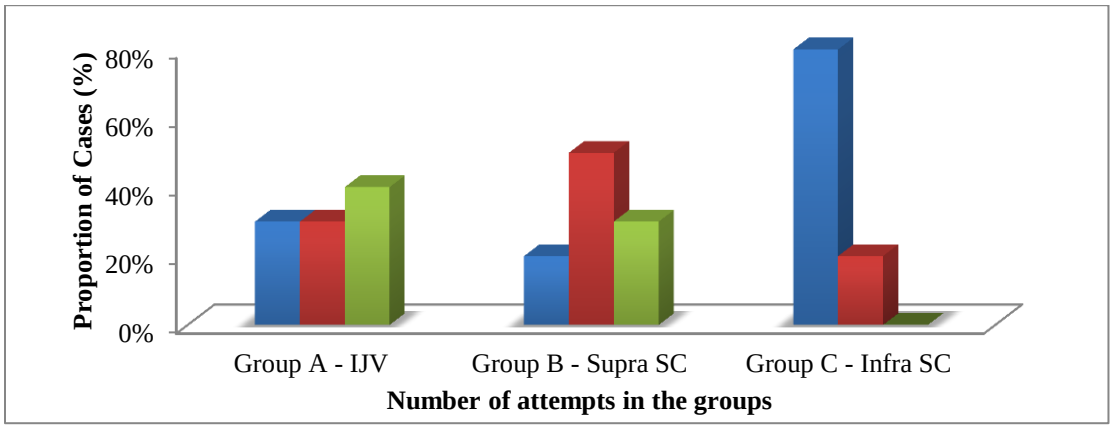
Group B- right supraclavicular subclavian vein, , Group C- right infraclavicular subclavian vein

Table 6: Number of attempts taken for a successful placement of catheter in each group

Number of Attempts taken for successful placement of catheter	Group A - IJV N (%) 10 (33.3%)	Group B - Supra SC N (%) 10 (33.3%)	Group C - Infra SC N (%) 10 (33.3%)	Total N (%) 30 (100.0)
1st	3 (30.0)	2 (20.0)	8 (80.0)	13 (43.4)
2nd	3 (30.0)	5 (50.0)	2 (20.0)	10 (33.3)
3rd	4 (40.0)	3 (30.0)	0 (00.0)	07 (23.3)
P = 0.04244				

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein, N- number

Figure 6: Number of attempts taken for successful placement of catheter in each group



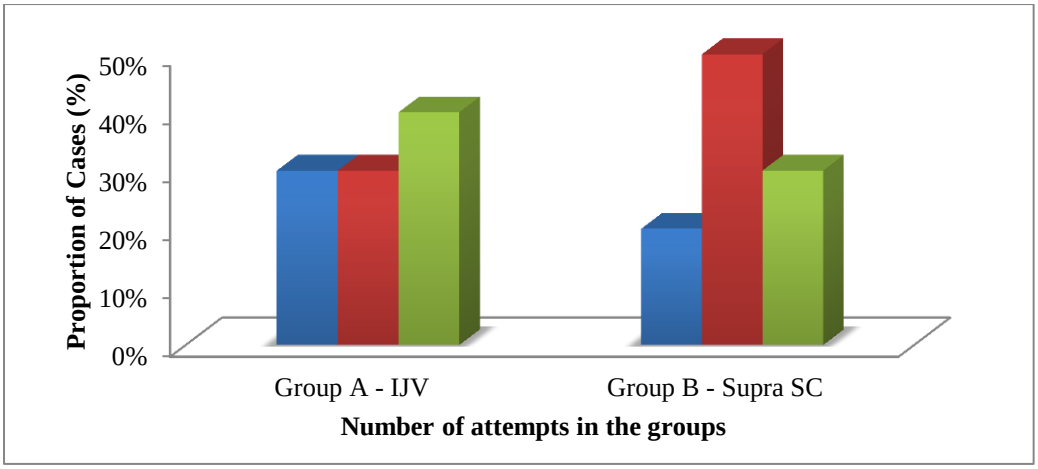
Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein

Table 7: Number of attempts taken for a successful placement of catheter between Group A and B patients

Number of Attempts taken for successful placement of catheter	Group A - IJV N (%) 10 (33.3%)	Group B - Supra SC N (%) 10 (33.3%)	Total N (%) 20 (100.0)
1st	3 (30.0)	2 (20.0)	05 (25.0)
2nd	3 (30.0)	5 (50.0)	08 (40.0)
3rd	4 (40.0)	3 (30.0)	07 (35.0)
P = 0.6561			

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, N- number

Figure 7: Number of attempts taken for a successful placement of catheter between Group A and B patients



Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein

Table 8: Number of attempts taken for a successful placement of catheter between Group A and C patients

Number of Attempts taken for successful placement of catheter	Group A - IJV N (%) 10 (33.3%)	Group C - Infra SC N (%) 10 (33.3%)	Total N (%) 20 (100.0)
1st	3 (30.0)	8 (80.0)	11 (55.0)
2nd	3 (30.0)	2 (20.0)	05 (25.0)
3rd	4 (40.0)	0 (00.0)	04 (20.0)
P = 0.03931			

Group A- right internal jugular vein, Group C- right infraclavicular subclavian vein, N- number

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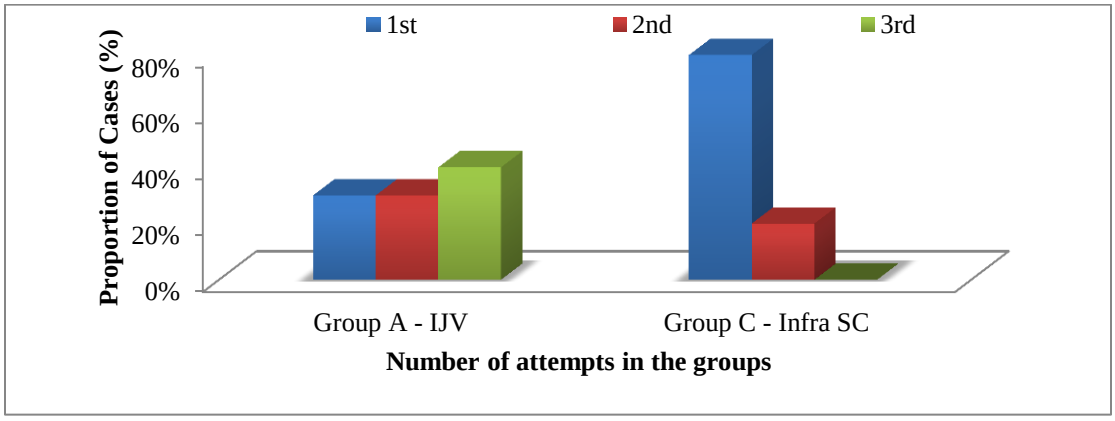
Figure 8: Number of attempts taken for a successful placement of catheter between Group A and C patients



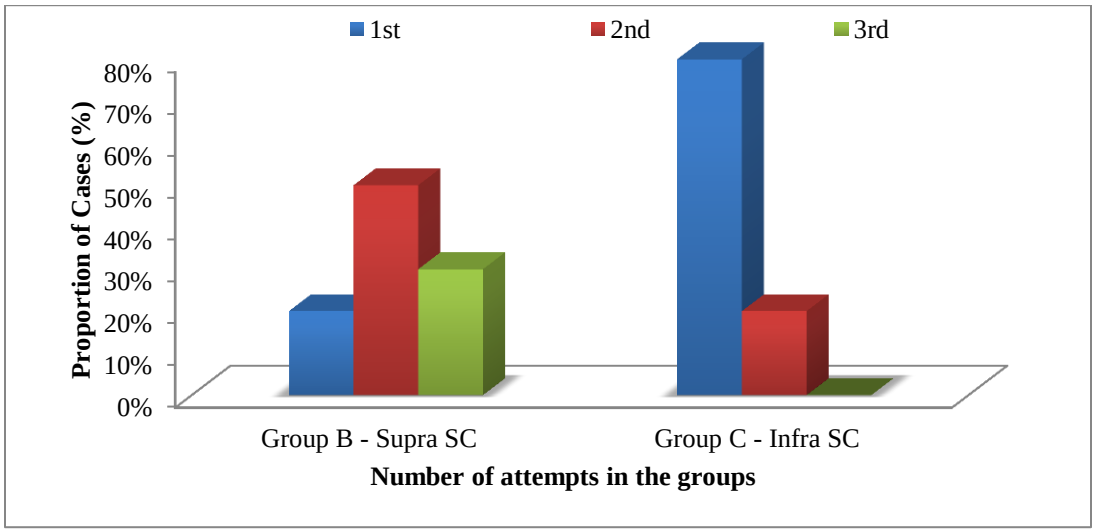
Group A- right internal jugular vein, Group C- right infraclavicular subclavian vein

Table 9: Number of attempts taken for a successful placement of catheter between Group B and C patients

Number of Attempts taken for successful placement of catheter	Group B - Supra SC N (%) 10 (33.3%)	Group C - Infra SC N (%) 10 (33.3%)	Total N (%) 20 (100.0)
1st	2 (20.0)	8 (80.0)	10 (50.0)
2nd	5 (50.0)	2 (20.0)	07 (35.0)
3rd	3 (30.0)	0 (00.0)	03 (15.0)
P = 0.01939			

Group B- right supraclavicular subclavian vein, , Group C- right infraclavicular subclavian vein, N- number

Figure 9: Number of attempts taken for a successful placement of catheter between Group B and C patients



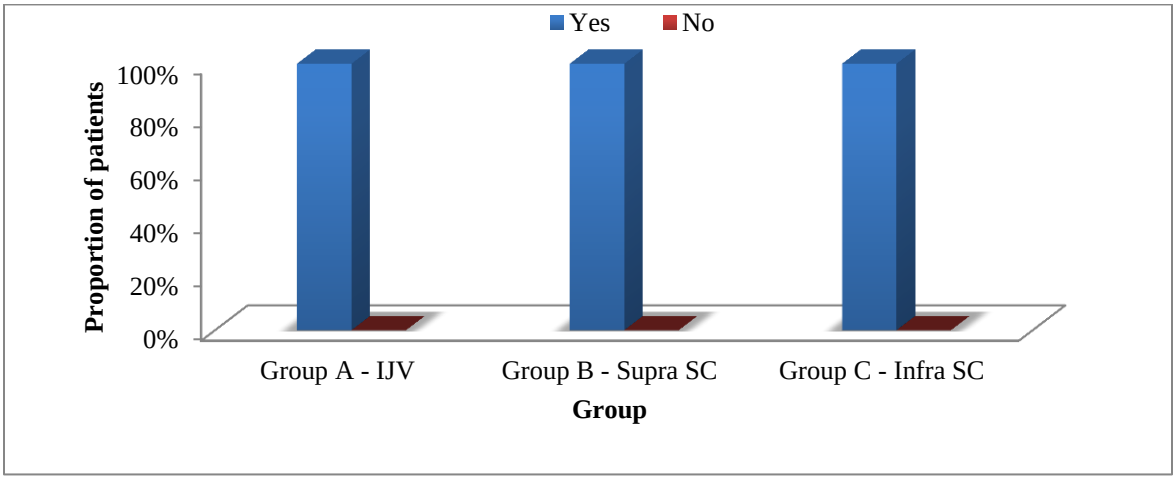
Group B- right supraclavicular subclavian vein, , Group C- right infraclavicular subclavian vein

Table 10: Comparison of successful placements of catheters in each group

Successful placements of catheter	Group A - IJV N (%) 10 (33.3%)	Group B - Supra SC N (%) 10 (33.3%)	Group C - Infra SC N (%) 10 (33.3%)	Total N (%) 30 (100.0)
Yes	10 (100.0)	10 (100.0)	10 (100.0)	30 (100.0)
No	00 (00.0)	00 (00.0)	00 (00.0)	00 (00.0)

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein, N- number

Figure 10: Comparison of successful placement of catheter in each group



Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein

Table 11: Comparison of complications in each group

Complications	Group A - IJV N (%) 10 (33.3%)	Group B - Supra SC N (%) 10 (33.3%)	Group C - Infra SC N (%) 10 (33.3%)	Total N (%) 30 (100.0)
Arterial puncture	02 (6.67)	00 (00.0)	00 (00.0)	02 (6.67)
Post-op local infection	00 (00.0)	00 (00.0)	00 (00.0)	00 (00.0)
Hematomma formation	00 (00.0)	00 (00.0)	00 (00.0)	00 (00.0)
Hemothorax	00 (00.0)	00 (00.0)	00 (00.0)	00 (00.0)
Pneumothorax	00 (00.0)	00 (00.0)	00 (00.0)	00 (00.0)

Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein, N- number

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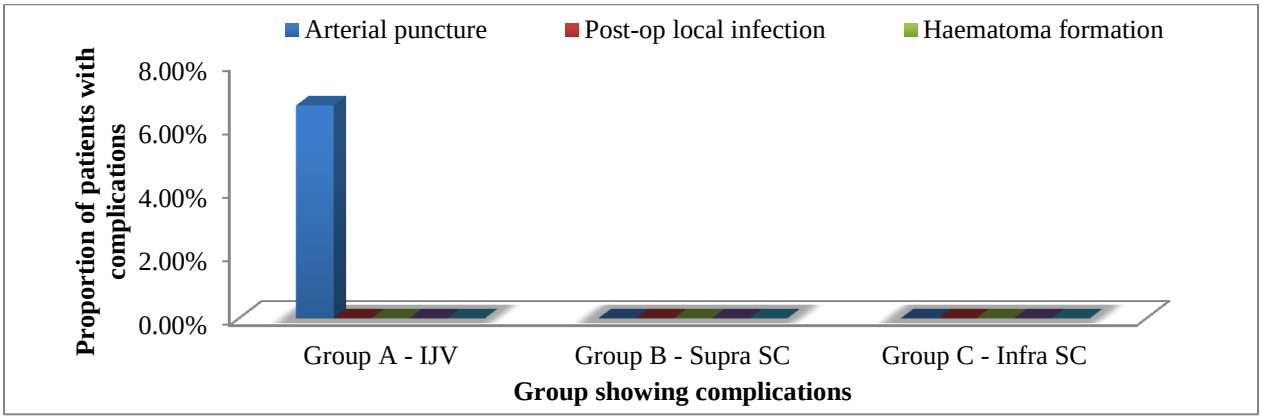
Figure 11: Proportion of patients with complications in each group



Group A- right internal jugular vein, Group B- right supraclavicular subclavian vein, Group C- right infraclavicular subclavian vein

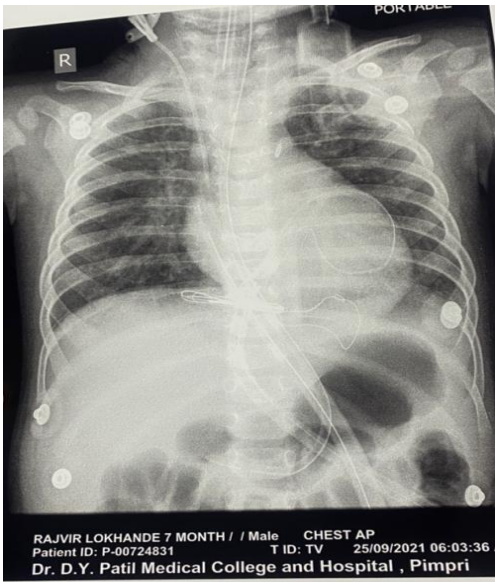


Figure 12: Internal jugular vein

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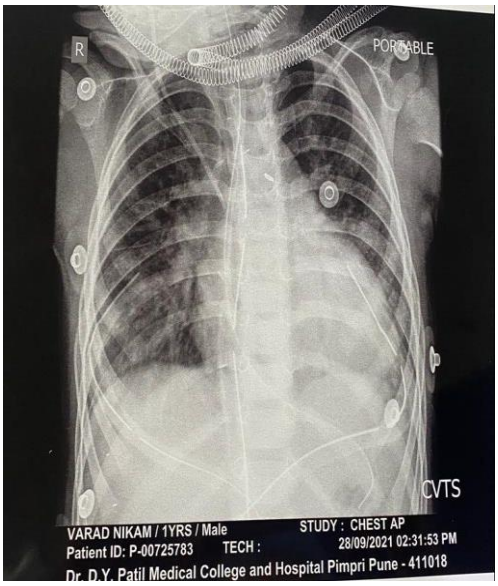

Figure 13: supra clavicular subclavian vein

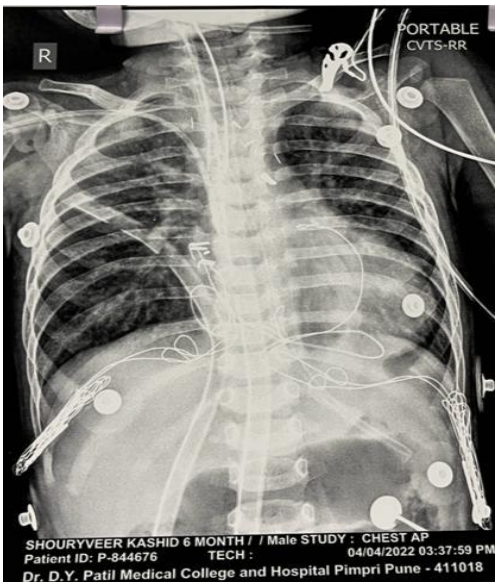

Figure 14: infra clavicular subclavian vein