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Comparative evaluation of subclavian vein catheterization using supraclavicular versus infraclavicular approach

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Abstract

Aims and Objectives: Supraclavicular approach (SC) is less popular route of subclavian vein catheterization than infraclavicular approach (IC). The aim of the study was to compare the advantages and disadvantages of subclavian vein catheterization by either approach and also record the incidence of complications, if any.

Methods: In the study, 50 patients enrolled were randomly divided into two groups of 25 patients each. In Grp. SC, Subclavian vein catheterization was performed using SC approach and in Grp. IC catheterization was performed using IC approach. Access time, success rate of cannulation, number of attempts to cannulate vein, ease of guidewire and catheter insertion and length of catheter inserted and any associated complications were recorded.

Conclusion: SC approach offers distinct advantage that catheter is always guided downwards with greater ease in contrast to IC approach where catheter may be guided upwards. Secondly, it can be used intraoperatively and on mechanically ventilated patients duo to it's cephalad access. Sometimes when IC approach fails, anesthetists awareness of this alternate approach helps in successful placement of central venous catheter.

Keywords: Subclavian vein catheterization, Supraclavicular, Infraclavicular.

Introduction

In modern day anesthesia, central venous catheterization (CVC) is a mandatory for various purposes like volume resuscitation, CVP monitoring, trans venous cardiac pacing, Hemodialysis access, in cancer patients with difficult venous access and for Chemotherapy. There are mainly three large venous routes of Central lines insertion namely the internal jugular, subclavian, or femoral veins, each with its own advantages, disadvantages and potential complications.[(1)]

IJV cannulation is not performed for neuroanesthesia due to possibility of kinking while positioning the head for surgery and subsequent venous congestion and raised intracranial pressure. Similarly femoral vein cannulation has a high incidence of infection and is not convenient for the patient.

Subclavian vein (SCV) is feasible site for CVC because of a lower risk of infection as compared with internal jugular or femoral sites, easy placement in immobilized severely traumatic patients, less interference while endotracheal intubation and mechanical ventilation during cardiopulmonary cerebral resuscitation (CPCR) and less patient discomfort for long-term intravenous treatment especially like chemotherapy, total parenteral nutrition and in cases of long-term coma or severe burns management.

Anatomical advantages of the subclavian vein include its large diameter (7-12 mm) and flow rate (350-800 ml/min), absence of valves, and its absolute consistency and patency. Infraclavicular (IC) approach is the 'traditional' and routinely practiced technique but the literature describes that supraclavicular (SC) approach too has some distinct advantages.[(1)]

Therefore, an attempt was made to compare the advantage and difficulties of right SCV catheter insertion using supraclavicular (SC) versus Infraclavicular(IC) approach.

Material and Methods

A total number of 50 patients of age 18-75 of either sex or ASA grade I, II and III were included and randomly assigned into two groups. Patients had congenital or acquired deformity of neck, clavicle or thorax, recent trauma or infection at procedure site, spine deformity; abnormal coagulation profile and contralateral pneumothorax were excluded.

Group SC: 25 patients

Group IC: 25 patients

Informed and written consent from each patient was taken. Routine investigations such as CBC, BT, CT, coagulation profile, HIV, HBSAG were done in all patients. We preferred right subclavian vein because of low risk of pleural puncture due to lower pleural dome, straight pathway of superior vena cava and thoracic duct absence. Procedure was performed in either ICU or OT after securing peripheral venous access, with cardiac monitoring and after proper sterile painting and draping. After preparation of the part, local infiltration was done at the puncture site with 2% xylocaine 3-5 ml. Trendelenburg position and flushing of central catheters with saline was done prior to placement to avoid air embolism. Sandbag placed below the shoulder and ring kept under head to support it.

Clavicular head of SCM was identified by asking the patient to lift head; especially in obese patients with

short neck where identification was difficult. In mechanically ventilated patients, tidal volume was always reduced to 5-6 ml/kg instead of 10 ml/kg to avoid complication of pneumothorax. OT patients were ventilated with 100% O2 and traces of inhalation agent. Nitrous oxide was not administered during the procedure in view of possibility of arrhythmia during guidewire insertion. Cannulation was performed by modified seldinger technique. Catheter position and complication were confirmed by post procedure vital data and chest X-ray.

Data was analyzed using Pearson chi square test and unpaired T test (www.graphpad.com)

Approach

IC approach: In head low position, SCV was punctured at 1 cm below the junction of medial 2/3 and lateral 1/3 of clavicle. After successful aspiration of blood, bevel of puncture needle was turned inferiorly to prevent j-tipped guidewire going up towards IJV or opposite side.[1,2]

SC approach: In head low position, SCV was punctured 1 cm cephalad and 1 cm lateral to clavisternomastoid angle (junction of lateral border of clavicular head of sternocleidomastoid (SCM) muscle to upper border of clavicle). Bevel of puncture needle was kept upward initially while puncture to prevent inferior vessel entrapment. After successful aspiration of blood, it was turned downward to prevent guidewire and catheter from going into IJV.[1,2]

Observation

- Demographic profile like age, height and weight were noted.
- Access time (Time period from first puncture up to successful catheter placement).
- Rate of successful cannulation by both approaches.
- Number of attempts for successful aspiration of blood (the venipuncture was limited for two attempts then other route was used).
- Smooth or failed insertion of guide wire and catheter, length of catheter inserted in centimeter (cm).
- Observation of post procedure CXR for catheter tip position, kinking or any malposition and repositioning if necessary.
- Associated complications such as arrhythmias, pneumothorax, haemothorax, arterial puncture etc. by either approach were recorded.[1,2]

Table 1: Demographic profile

Demographic profile	(n=25)	
	Group SC	Group IC
Age (yrs)	4 5.32 ± 10.43	50.20 ± 10.2
Weight (kg)	60.30 ± 15.56	55.60 ± 13.72
Height (cm)	162.12 ± 6.81	160.30 ± 7.62
SC- Supraclavicular; IC – Infraclavicular		

Table 2: Comparison of procedure time between SC and IC approaches

Group	Access Time (Min)
Group SC	5.30 ± 1.02 min
Group IC	7.30 ± 2.14 min
P value <o.ooo1	
SC-Supraclavicular; IC- Infraclavicular	

Table 3: Comparison of successful SCV catheterization

Result	Group SC		Group IC	
	(n=25)	Percentage	(n=25)	Percentage
Successful	23	92%	20	80%
Failure	2	8%	5	20%
Chi-square(with yates correction)= 0.6645, degree of freedom= 1, P= 0.4150, SC-Supraclavicular; IC-Infraclavicular				

Table 4: Numbers of Attempts for catheterizations using SC and IC approach

Attempts	Group SC		Group IC	
	(n=25)	Percentage	(n=25)	Percentage
First	20	80%	17	68%
Second	3	12%	3	12%
Failure	2	8%	5	20%
SC- Supraclavicular; IC – Infraclavicular				

Table 5: Failures and complications

Failure/Complication	Group SC (%)	Group IC (%)
Failure	2 (8)	5 (20)
Due to subclavian artery puncture	-	-
Failure to locate vein	1 (4)	2 (8)
Catheter malposition	-	1 (4)
Problem with guidewire insertion-kinking	0	2
Complication		
Pneumothorax	-	2 (8)
Haemothorax	-	-
Hematoma at puncture site	1 (4)	-
Arrhythmias	-	-
SC- Supraclavicular; IC – Infraclavicular		

Discussion

In our study SC approach provided distinct advantage of well identified landmark of the clavisternomastoid angle, closer distance from skin to vein, straight pathway to SVC, with less chance of pleural or arterial puncture and its associated complication i.e. pneumothorax or haemothorax due to greater distance from puncture site to pleural cavity. Time duration of procedure was noted in both the approaches and found that time taken for SC approach (5.30 ± 1.02 min) was far less than IC approach (7.30 ± 2.149 min), when statistically calculated by using unpaired T-test (P = <0.ooo1) was found to be

extremely significant. The overall success rate was better for supraclavicular (SC) approach (23 out of 25) compared to infraclavicular(IC) approach (20 out of 25). SC approach also much better in term of number of attempts but on comparing overall success rate, the difference was not statistically significant in both groups(P = 0.4150).

M Iqbal at al (2011): Compared the two approaches in 144 patients (72 in each group) selected by non-random sampling in the study. The overall success rate was 95.83% for right SC and 87.50% for right IC approach (p>0.05). The number of successful attempts for SC and IC approach were 1.13 ± 0.42 and 1.35 ± 0.69 respectively (p=0.029). Complications are higher in SC group, but the difference was not statistically significant. This study conclude that supraclavicular approach was the more successful method of Central venous catheterization compared to the infraclavicular approach.[3]

In our study, we encountered difficulty during guidewire insertion in IC approach. It got kinked inside in one case and in other case the spiral wil got damaged and the guidewire had to turned from the other end (as spiral wil was damaged at j tip), No such technical difficulty occurred during SC approach. The catheter length was measured by overlaying the catheter from the site of puncture to second intercostal space, but average length of catheter for group SC was 10.50 cm and for group IC was 12 cm. ECG changes noted on cardiac monitor in many patients, but none of them had severe arrhythmias mandating treatment. Placement of catheter was confirmed "just above the carina" by post procedure chest X-ray.[1,2]

Malpositioning- catheter went upwards in IJV in 2 patients in IC group. Literature too mentions higher incidence of malpositioning in IC group in study conducted by Dronen et al in year 1982. however one study conducted by Parin Lalwani et al (2016) demonstrated malpositioning in SC group, in that case of malpositioning of catheter via right SC approach of CVC noted which revealed that catheter entered right EJV (external jugular vein) and right AJV (anterior jugular vein) junction and then from the horizontal component of AJV it entered the JVA (jugular venous arch) and finally reached into left AJV. Anterior jugular venous system thus may become a route for malpositioning. In this case use of recent advance like USG guided catheter insertion, more horizontal route of skin puncture, caudal direction of bevel and early suspicion of resistance while guide wire insertion could have prevented the malposition.[4]

Dronen et al (1982): Compared the two approach in 76 patients conclude that SC approach to subclavian vein catheterization was probably the technique of choice when central venous access is required during CPR because the incidence of malpositioning or kinking of the catheter was significantly higher with the IC approach furthermore, excessive interruption of CPR (five seconds or greater) occurred in 40% of IC attempts compared to only 20% of SC attempts.[5]

This study was conducted in cancer institute where patients are posted for major oncosurgeries like 3stage oesaphagectomy and hepatectomy. In such cases CVP measurement is crucial intraoperatively and therefore correct positioning of CVC has clinical implications. In such cases SC approach gives added advantage of correct positioning in adverently, as the catheter is always directed caudally; with very minimal chance of upward migration into IJV.

Complications were higher in term of failure to locate the vein and pnuemothorax in IC approach compared to SC approach. In our study pneumothorax was radiologically detected in 2 patients in IC approach but both are clinically stable and didn't mandate ICD insertion. In such cases ultrasound guidance does have a role in era of technology; but it requires special setup and training. It definitely has future scope as it would help in reducing the complication; especially in paediatric and difficult cases.

Conclusion

CVC placement can at times prove to be a tricky job for anesthetist and therefore thorough knowledge of multiple approaches is definitely useful. SC approach offers some distinct advantages like less chance of malpositioning and applicability in mechanically ventilated patients for immediate and quick venous access and should not be forgotten; and put to use more widely.

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