

Original Research Article

A randomized and comparative study on anterior approach versus posterior approach for internal jugular vein cannulation

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Abstract: Background: Central venous cannulation a vital intervention can be done using numerous approaches for cannulating the internal jugular vein such as anterior, posterior and approach. Of these, the anterior approach is being practised widely, since the identification of landmarks and palpation of carotid artery permits a beginner to learn the procedure easily. The major complications of this approach are carotid artery puncture and hematoma formation. Posterior approach needs identification of only the main bulk of the sternocleidomastoid muscle and external jugular vein, which could be identified even in obese patients easily by the trendelenberg position.

Aim: To evaluate and compare the success rates of anterior and posterior approach for internal jugular vein cannulation.

Material and methods: Hundred patients of American society of Anaesthesiologist (ASA) grade I and II, aged 20-60 years of age were divided into two groups. Group A patients were cannulated by anterior approach while Group-B patients cannulated by posterior approach. Number of attempts, time to identify vein, duration of cannulation, ease of threading and complications like carotid artery puncture, hematoma formation, pneumothorax, hemothorax, thrombophlebitis and catheter displacement were taken into consideration.

Result: The total number of attempts was statistically lower in group B as compared to group A (p value= 0.042). The mean time to identify vein and duration of cannulation was also found to be significantly lower in group B as compared to group A (p value= 0.0043, p value=0.001 respectively). The incidence of carotid artery puncture and hematoma formation was less in group-B as compared to group-A (p value=0.001).

Conclusion: Since Posterior approach for IJV cannulation required lesser number of attempts, less time to identify vein and also less duration of cannulation, It can be considered as a preferred choice for cannulation of internal jugular vein as compared to anterior approach.

Keywords: Cannulation; Carotid artery; Hematoma; Internal jugular vein.

1. Introduction

Central venous cannulation is a vital intervention in major elective and emergency surgeries as well as in critical care management. It has become indispensable for volume resuscitation, central venous monitoring, inability to obtain peripheral venous access, transvenous cardiac pacing, long term hyperalimentation, infusion of vasoactive inotropic drugs and mixed venous oxygen saturation measurement, hemodialysis or plasmapheresis, Insertion of pulmonary artery catheters [1–4].

The proper choice of insertion site is essential for success and depends on many factors including the indication, contraindication, previous insertion site with associated stenosis or thrombosis, intended duration

of use and anticipated future site of insertion. There are numerous approaches for cannulating the internal jugular vein such as anterior, posterior and central approach. Of these, the anterior approach is being practised widely, since the identification of landmarks and palpation of carotid artery permits a beginner to learn the procedure easily. The major complications of this approach are carotid artery puncture and hematoma formation [5]. Posterior approach needs identification of only the main bulk of the sternocleidomastoid muscle and external jugular vein, which could be identified even in obese patients easily by the trendelenberg position [6].

So hypothesizing the same, present study has been conducted to evaluate and compare the success rate of commonly used approach for IJV cannulation i.e. anterior approach with posterior approach in terms of number of attempts, time to identify vein, duration of cannulation and associated complications.

2. material and Methods

This randomised clinical study was conducted in Department of Anaesthesiology, Mahatma Gandhi Memorial Medical college and M.Y. Hospital, Indore, Madhya Pradesh, after approval from Institutional Ethics Committee (IEC) (EC/MGM/AUG-21/17) after obtaining informed consent from the participants. The study was conducted from April 2021 to September 2022.

The sample size was calculated using Fisher's exact test. Input: two Proportion $p_1 = 0.52$, Proportion $p_2 = 0.80$, ? err prob = 0.05, Power, $(1 - \beta \text{ err prob}) = 0.8$. Allocation ratio $N_2/N_1 = 1$. Output: Sample size group 1 = 50, Sample size group 2 = 50, Total sample size = 100. Actual power = 0.8009546. Actual $\alpha = 0.0281628$, Closed envelop method was used for randomization.

ASA II-III patients aged from 20-60 years of either gender were included and divided into two groups of 50 each, scheduled for surgeries which required fluid resuscitation, strict fluid regulation and central venous pressure (CVP) monitoring. Patients with superior vena cava syndrome, infection at the site of cannulation, coagulopathy, carotid artery disease, contralateral diaphragmatic dysfunction, thyromegaly, prior neck surgery, recent cannulation of internal jugular vein were excluded from study.

A thorough preanaesthetic assessment was performed and patients were randomly allocated using closed envelop method into two groups of 50 patients each. Group A- anterior approach, Group B -posterior approach.

On arrival of the patient in the operation theatre, a peripheral intravenous access was established. Baseline haemodynamic parameters like heart rate (HR), non invasive blood pressure (NIBP) and oxygen saturation (SpO₂) were noted down. General anaesthesia was induced as per standard protocol of the institute. The patient was placed in supine position with 15-20 degree trendelenberg position and neck was fully turned to opposite side to distend the internal jugular vein. One of two approaches was followed as mentioned.

2.1. Anterior approach

A triangle formed by two heads of sternocleidomastoid (two side) and clavicle (base) was identified [7]. The carotid artery in the middle of this triangle was palpated for skin prick test - A 25 -gauge locator needle was inserted along the medial border of the lateral head of sternocleidomastoid muscle, towards the ipsilateral nipple, at an angle of 30 degree to the skin. Aspiration of venous blood confirmed the vein location. A cannula attached to a 5ml syringe (7Fr- Double /triple lumen internal jugular venous cannulation set) was advanced along the same path as the locator needle, with a constant aspiration for the venous blood in the syringe. The vein was then cannulated by seldingers technique. The return flow of venous blood was confirmed, the catheter secured and a sterile dressing then applied.

2.2. Posterior approach

In trendelenberg position, head was turned to opposite side, so that the sternocleidomastoid muscle was clearly visible as a straight muscle and external jugular vein becomes prominent [7]. The point where the external jugular vein crosses the posterolateral border of sternocleidomastoid was punctured with cannula tip. Lifting up of the body of sternocleidomastoid, the cannula was then advanced in skin under the posterolateral border of sternocleidomastoid in a direction pointing towards the sternal notch, rest of procedure was similar to anterior approach (SELDINGER TECHNIQUE).

Numbers of attempts, time to identify vein, duration of cannulation, ease of threading and complications like carotid artery puncture, hematoma formation, pneumothorax, hemothorax, thrombophlebitis and catheter displacement were noted down.

- Number of attempts required to successfully cannulate the vein was noted. In all the patients the right IJV was cannulated first. The maximum no. of attempts for an approach was four. If cannulation was not succeeded in four attempts, the alternate approach was tried on the same side and this was considered as failure of the previous approach,
- Time required for identification of vein was defined as the time from skin puncture by the needle during the first attempt to identification of the vein (confirmed by aspiration of dark blood) irrespective of the number of attempts.
- Duration for cannulation was defined as the time from skin puncture by needle to complete threading of catheter.
- Carotid puncture was identified by the presence of a gush of bright red blood.
- Ease of threading

3. Statistical Analysis

The data was initially entered into the Microsoft excel from the customised proforma for analysis. Statistical Software Mini Tab Version 17.0 was used for calculating the p-values. Comparison of means between the two groups was done using unpaired 't' test, association between two non-parametric variables was done using Pearson's Chi-square test and comparison of proportions was done using Fisher's-Exact test. A p-value of <0.05 was taken as statistically significant. The final data was presented in form of table and graphs.

4. Results

Both the groups were comparable demographically i.e., Age, sex, body mass index (BMI) and ASA status, Table 1. The total number of attempts was lower in the group B than with group A and the difference was statistically significant (p value= 0.042). Thirty patients (60%) out of 50 were cannulated in first attempt in group B as compared to 16 patients (32%) in group A (p value= 0.0013) whereas 20 (40%) out of 50 patients in group A required two attempts as compared to 11 (22%) patients in group B (p value= 0.048), see Table 2. The mean time to identify vein was 68.4 ± 0.54 seconds in group A and 43.20 ± 0.28 seconds in group B. The difference was found to be statistically significant (p=0.0043) (Table 3). The duration of cannulation were 5.34 ± 0.15 minutes v/s 3.92 ± 0.10 minutes in group A and group B respectively and the difference was statistically significant (p value=0.001), (Table 3). Threading of catheter over the guidewire was found to be easier in 35 patients in group B as compared to 27 patients in group A, which is also statistically insignificant (p value=0.054) [Table 4]. The incidences of carotid artery puncture and hematoma formation were found to be lower in group B than in group A (p value=0.001) [Table 5]. However the difference in incidence of pneumothorax, hemothorax, thrombophlebitis, catheter displacement in two groups were not significant with (p value >0.05) [Table 5].

Table 1. Distribution of patients according to demographic data. Unpaired 't' test applied

Variable	Group A (n=50)	Group B(n=50)	P- Value
Age (Years)	40.10 \pm 13.52	41.20 \pm 12.23	0.37
Sex	(70%)M, (30%) F	(56%)M, (44%)F	0.14
BMI (Kg/m ²)	26.79 \pm 5.01	26.72 \pm 4.77	0.49
ASA grade II/III	33/17	30/20	0.32

Table 2. Comparison of number of attempts between the groups. Chi-square test applied. A p-value <0.05 was taken as statistically significant

NUMBER OF ATTEMPTS	GROUP A		GROUP B		p value (No. of attempts)
	Number of patients successfully cannulated	Total number of attempts	Number of patients successfully cannulated	Total number of attempts	
1	16 (32%)	16x 1= 16	30 (60%)	30x1=30	0.0013
2	20 (40%)	20x 2= 40	11(22%)	11x2=22	0.048
3	9 (18%)	9x 3=27	5 (10%)	5x3=15	0.15
4	2 (4%)	4x2=8	2 (4%)	2x4=8	0.68
Total for successful cannulations	47 (94%)	91	48 (96%)	75	0.042
Failure (>4)	3 (6%)	-	2 (4%)	-	
Total	50 (100%)	-	50 (100%)	-	

Table 3. Comparison of mean time to identify vein, duration of cannulation between the groups. Unpaired t test applied. A p-value <0.05 was taken as statistically significant

Variable	Group A	Group B	p value
Mean time to identify vein(seconds)	68.4 ± 0.54	43.20 ±0.28	0.0043
Mean duration of cannulation (minutes)	5.34 ± 0.15	3.92 ± 0.10	0.001

Table 4. Comparison of ease of cannulation between the groups. Chi-square test applied. A p-value <0.05 was taken as statistically significant

EASE OF THREADING	Group A, n (%)	Group B, n (%)	P value
Easy	27 (57)	35 (73)	0.054
Difficult	20 (43)	13 (27)	
TOTAL	47	48	

Table 5. Comparison of complications between the groups. Chi-square test applied. A p-value < 0.05 was taken as statistically significant

Complications	Group A	Group B	p value
Carotid artery puncture (Yes/No)	12/38	07/43	0.003
Hematoma formation (Yes/No)	6/44	04/46	0.002
Pneumothorax (Yes/No)	6/44	4/46	0.5
Hemothorax (Yes/No)	0/50	0/50	-
thrombophebitis(Yes/No)	16/31	12/36	0.18
Catheter displacement (Yes/No)	3/47	4/48	0.49

5. Discussion

The proper choice of insertion site is essential for successful central venous cannulation. Right IJV cannulation is usually preferred because it has a larger diameter and affords a straighter path to superior vena cava and right atrium. In spite of the numerous approaches for IJV cannulation, the anterior approach was selected for the study as it is being conventionally practiced in our institution, but major complications of this approach are carotid artery puncture and hematoma formation. Many studies have concluded that the posterior approach is easier and safer to cannulate in critically ill and hemodynamically compromised patients. With this hypothesis the present study has been conducted to compare two approaches in patients posted for elective and emergency surgeries under general anaesthesia and who required IJV cannulation. The number of attempts required for IJV cannulation, time to identify vein, duration of cannulation and complications like carotid artery puncture, hematoma formation were noted. The result of the present study shows that number of attempts, time to identify vein, duration of cannulation and complications like carotid artery puncture, hematoma formation were all less with posterior approach as compared to anterior approach.

In the present study, one of the primary objectives was to compare number of attempts. In first attempt 16 (32%) patients were cannulated in Group A and 30 (60%) patients were cannulated in Group B, (p value= 0.0013) (Table 2). These results were coherent with the findings in a study performed by Babu et al [8] on anterior approach versus posterior approach for IJV cannulation, in 50 patients. They found that eighty percent (80%) of the patients were cannulated successfully in the first attempt by posterior approach compared to

only 52% by anterior approach. The results of present study are again supported with that of a study done by Lamkinsi et al. [9] on 101 patients for IJV cannulation. Ninety six (96%) of the patients were cannulated successfully in the first attempt by posterior approach compared to only 68% by anterior approach, which was highly significant ($P < 0.001$). In the current study, in second attempt 20 (40%) patients were cannulated in Group A and 11(22%) patients were cannulated in Group B, (p value= 0.048). Nine (18%) patients in Group A and 5 (10%) in group B required third attempts (p value= 0.15). Two (4%) patients in both group A and group B each required fourth attempts (p value= 0.68). A total of 47 (94%) out of 50 patients in group A and 48 (96%) out of 50 patients in group B were successfully cannulated in present study (p value =0.66). The total number of attempts for cannulation was less in Group B (75) as compared to Group A (91), which is statistically significant ($p=0.042$).

In the present study, the mean time to identify vein was 68.4 ± 0.54 seconds in group A and 43.20 ± 0.28 seconds in group B. The difference was found to be statistically significant ($p=0.0043$), showing that the time required to identify the vein was less in group-B as compared to group-A (Table 3) and this observation was supported with similar results from the study conducted by Manjula et al. [10] in 100 patients (50 patients in each group). Time taken for identification of vein was lesser with posterior approach (0.2 ± 0.12 minutes) as compared to anterior approach (1.05 ± 0.37 minutes). Above finding are again supported by a study conducted by Babu et al. [8], who concluded that time to identify the vein was significantly less with posterior approach with a mean value of 0.18 min, compared to 1.06 min with anterior approach. In anterior approach, palpation of landmarks i.e. carotid pulsation and head of sternocleidomastoid are difficult in some patients. In contrast to this, posterior approach needs identification of only main bulk of sternocleidomastoid and external jugular vein, which is easily identified in trendelenburg position.

The mean duration of cannulation in group-A was greater (5.34 ± 0.15 minutes) than in group-B it was (3.92 ± 0.10 minutes) (Table 3). These results were coherent with the findings of a study done by Bhosale et al. [11] on 100 patients who concluded that the mean time taken in anterior approach in first attempt was 6.46 ± 0.73 as compared to 5.56 ± 0.51 minutes in posterior approach. The finding of present study again coincides with that of a study performed Babu et al. [8] where the duration of cannulation was significantly lower with posterior approach (2.43 min) compared to (3.64 min) with anterior approach. Posterior approach provides larger cross-sectional area in trendelenberg position which permits earlier identification of the vein and easy threading of the catheter. Hence the time required for cannulation is lesser in the posterior approach.

In current study, the ease of threading was found to be statistically insignificant ($p=0.054$) between the group-A and group-B, even though threading of catheter over the guidewire was found to be easier in 35 (73%) patients in group B as compared to 27 (57%) patients in group A (Table 4). These results were coherent with the findings of Bhosale et al. [11] where difficulty in threading the guide wire was observed only in 2 patients in the posterior approach and no difficulty in threading was observed in anterior approach. Ease of threading was observed in 18 (36%) patients in anterior approach and 20 (40%) patients by posterior approach, although statistically insignificant in a study done by Babu et al. [8].

In the current study, carotid artery puncture was encountered in 12 (24%) patients in Group A and only 7 (14%) patients in Group B. (p value=0.003) (Table 5). These results were coherent with the findings of Manjula et al. [10], who noted that the incidence of arterial puncture was less in posterior approach (2/50) compared to anterior approach (11/50).

In the current study, hematoma was observed in 06 (12%) patients in group-A and only 04 (8%) patients in Group B (p value=0.002) (Table 5). These results were coherent with the findings of Manjula et al. [10] where hematoma was observed in 10 patients in anterior approach and only 2 patients in posterior approach. Hematoma can develop rapidly following carotid puncture or slowly following multiple punctures on the vein due to difficult cannulation or threading. All hematomas resolved completely within 24 hours without causing further complications. The lesser rate of hematoma in the group B could be due to smaller number of carotid artery puncture.

In current study, pneumothorax was observed in 6 (12%) patients in group-A and only 4 (8%) patients in Group B. (p value=0.5) (Table 5). These results were coherent with the findings of Lamkinsi et al. [9], who concluded that no case of pneumothorax was observed by posterior approach and 2 cases were observed by anterior approach, which was statistically insignificant. As cannulation by the posterior approach is anatomically at higher level than the anterior approach, the incidence of pneumothorax is less in the posterior approach. Another rare complication reported with Internal jugular vein cannulation was hemothorax. In

current study, hemothorax was not observed in any patient in both the groups. (Table 5). These results were coherent with the findings of Babu et al. [8] where also no case of hemothorax was observed in both approaches. In current study, the thrombophlebitis was noted in 16 (34%) patients in group A as compared to 11 (25%) patients in group B (p value = 0.18). (Table 5). These results were coherent with finding by Babu et al. [8] concluded that 3 cases of thrombophlebitis were observed in anterior approach and 2 cases in posterior approach which was not statistically significant. In the present study, the incidence of catheter displacement/kinking was same i.e. 3 (6%) in both groups the groups (Table 5). These results were coherent with the findings of Pikwer et al. [13], who designed a prospective cohort study on incidence and risk of central venous catheter malpositioning in 1619 patients. The total incidence of radiographic catheter tip malposition was 1.4% by the right internal jugular vein.

6. Limitation

Although this study has tried to meet its aims and objective in all aspects, there are few limitations to it i.e. This study was a single- centric study using blind method for cannulation. A multicentric study with USG guided cannulation is needed in future.

7. Conclusion

From the above observation and results, it may be concluded that number of attempts required for cannulation, time to identify vein and duration of cannulation and complications like carotid artery puncture, hematoma formation were all found to be less with posterior approach as compared to anterior approach. Thus posterior approach can be considered as a preferred choice of IJV cannulation.

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