



COMPARISON OF ANTERIOR AND POSTERIOR APPROACHES FOR INTERNAL JUGULAR VEIN CANNULATION

Anaesthesiology

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ABSTRACT

Background: Central venous cannulation is a vital intervention in the critically ill and in patients undergoing elective and emergency surgeries. Success depends on proper choice of insertion site. Internal jugular vein has a valveless course to superior Vene cava, possibility of repeated cannulation and low incidence of complications. Knowledge of various approaches for Internal jugular vein cannulation is imperative. **Aim:** The aim of the study is Comparison of the Anterior and Posterior approaches for internal jugular vein cannulation. **Materials and Methodology:** The study was conducted as a prospective randomized study. From the results obtained in the Pilot study, a target population of 30 subjects in each group was decided. An individual informed consent is taken from each patient who are selected for study. Patients of ASA-Physical Status 1-4 undergoing elective and emergency surgeries and critically ill patients of both the sex is selected. Patients with localized skin infection in the neck, history of neck surgery post burns or traumatic scar contracture in the neck (altered anatomy, localized swelling in the neck (e.g.: huge thyroid), coagulation abnormality are excluded. **Discussion:** Internal jugular vein cannulation can be performed by one of the various approaches, but the success depends on anatomical variations and operator experience. All the patients were comparable in terms of age, gender and body mass index. The number of attempts, time for identifying the vein and duration of cannulation was lesser in the posterior approach. The rate of carotid puncture, haematoma, pneumothorax, catheter kinking, displacement, thrombophlebitis and limitation of neck movements was less with the posterior approach. **Conclusion:** In conclusion, the posterior approach is better than the anterior approach for Internal jugular vein cannulation as it improves the success rate, permits easy threading of catheter, reduces the access time and duration of cannulation. It reduces the complications like carotid puncture, haematoma, pneumothorax, catheter kinking, catheter displacement, thrombophlebitis and limitation of neck movements.

KEYWORDS

Internal jugular vein cannulation, anterior approach, posterior approach.

INTRODUCTION

Central venous catheterization is a vital intervention in critically ill patients and in major elective and emergency surgeries. It has become indispensable for volume resuscitation, central venous pressure monitoring, hemodialysis, transvenous cardiac pacing, long term hyperalimentation, infusion of vasoactive or inotropic drugs and mixed venous oxygen saturation measurement.

The proper choice of insertion site is essential for success. Advantages of internal jugular vein cannulation relate to its consistent, predictable, anatomic location, its valveless course to the superior Vena cava and right atrium, the possibility of repeated cannulation and low incidence of complication in experienced hands.

Cannulation of the brachial and external jugular vein may fail because of technical difficulties and thrombosis, while the subclavian route raises the valid objection of dangerous pleural complications. Femoral vein cannulation is indicated in conditions like Superior venacaval obstruction. There is high rate of catheter sepsis and thrombophlebitis with femoral vein. The anterior approach is being practiced 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 puncture and haematoma. Many literatures has quoted a lesser incidence of these complications with the posterior approach. It is also easier to perform in critically ill patients as the trendelenberg position which may cause hemodynamic instability is not mandatory for this approach. This study compares the two commonly practiced anterior and posterior approaches for catheterization of the Internal jugular vein.

MATERIALS AND METHODS

The study was undertaken entirely in the Department of Anaesthesiology, ALLURI SITARAMAJU INSTITUTE OF MEDICAL SCIENCES, ELURU during the period from February 2023 to February 2024 with due permission from the Institutional Ethical committee. A Pilot study was first conducted to define the population and decide on the criteria for patient selection. The study was conducted as a prospective randomized study. From the results obtained in the Pilot study, a target population of 30 subjects in each group was decided.

Criteria For Patient Selection

Inclusion Criteria

1. Adult patients >18 years of age
2. Patients with weight between 40-80kg
3. Both sexes
4. Patients of ASA-Physical Status 1-4 undergoing elective and emergency
5. Surgeries and critically ill patients

Exclusion Criteria

1. Patients with localized skin infection in the neck
2. Patients with history of neck surgery
3. Patients with post burns or traumatic scar contracture in the neck (altered anatomy)
4. Patients with any localized swelling in the neck (eg: huge thyroid)
5. Patients with coagulation abnormalities

After proper screening of the above mentioned criteria, the patients were informed about the purpose of the study and the study methods the day before surgery. A written informed consent was obtained from the patients on the morning of surgery.

The patients were randomly classified into two groups as, Group A-Patients undergoing IJV cannulation by anterior approach Group P-Patients undergoing IJV cannulation by posterior approach.

Techniques Of Cannulation

The patient was in a supine 20degree head down position. The head was turned to the opposite side and a support was placed under the shoulders to accentuate the landmarks. Under sterile aseptic precautions, the following landmarks were identified at the onset of the procedure:

1. Medial and lateral heads of sternocleidomastoid muscle
2. Clavicle
3. Carotid artery pulsations
4. Ipsilateral nipple
5. External jugular vein
6. Suprasternal notch

Anterior Approach

The triangle formed by the two heads of sternocleidomastoid muscle and clavicle was identified. The carotid artery at the medial end of this triangle was palpated. Near the apex of this triangle, a skin wheal was

raised with 1ml of 2% Lignocaine. Skin puncture was made at 30degree to the skin with the needle. The direction of the needle was towards the ipsilateral nipple. With constant aspiration, the needle was slowly advanced until two tissue pops were felt at the prevertebral fascia and the vein.

Posterior Approach

The point where the external jugular vein crosses the posterolateral border of sternocleidomastoid muscle is the entry point. A skin wheal was raised at this point with 1ml of 2% lignocaine. The body of the muscle was lifted and the needle was then advanced at an angle of 30degree to the skin, directed towards the suprasternal notch. With constant aspiration, the needle was slowly advanced till two tissue pops were felt at the prevertebral fascia and the vein wall. The position in the vein was confirmed by aspiration of dark blood. The internal jugular vein was cannulated by modified Seldinger's technique. The hub of the cannula was anchored with sutures.

The Following Parameters were Compared During IJV Cannulation:

1. Number Of Attempts To Identify The Vein.

In all the patients the right IJV was cannulated first. The maximum no. of attempts for an approach was four. If the vein was not identified by four attempts, the alternate approach was tried on the same side. This was considered as failure of the respective approach. The left IJV was cannulated in case of unsuccessful cannulation with both the approaches on the same side and these patients were excluded from the study.

2. Time Taken For Identification Of The Vein.

This was 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.

3. Time Duration For Cannulation.

This was recorded as the time from skin puncture by the needle to complete threading of the catheter.

4. Ease Of Threading.

Threading of the catheter was considered to be easier or difficult based on the absence or presence of resistance, respectively.

5. Carotid Puncture.

It was identified by the presence of a gush of bright red blood. If carotid puncture occurs, the needle was withdrawn and compression was applied for five minutes. After five minutes another attempt was made with the same approach, upto to a maximum of four attempts as mentioned earlier. If landmarks are obliterated by haematoma before four attempts, it was considered as failure of the respective approach and the alternate approach was tried on the same side.

6. Pneumothorax.

It was treated by placing an intercostal drain.

7. Catheter Kinking.

Intraoperatively, inability to aspirate dark blood from the catheter and absent or distorted CVP waveforms was considered to be as kinking. Postoperatively kinking was identified by chest X-ray. In case of kinking, the catheter was removed and another central venous catheter was placed in situ.

8. Catheter Displacement.

Migration of the catheter to the ventricle or to extrathoracic site was considered as displacement of the catheter. Displacement in to the ventricle was identified from the CVP waveforms and migration to extrathoracic site was identified from the chest X-ray. The catheter was repositioned or replaced by another catheter.

OBSERVATION AND RESULTS

Table 1: Age

Anterior Approach		Posterior Approach		t-test	
Mean	Sd	Mean	Sd	Value	Significant level
43.80	15.33	38.80	16.22	1.24	0.22

The minimum age in both the groups was 18 years. The maximum age in Group A was 79yrs and in Group P was 78 yrs. Mean age was 43.8(+/- 15.38) in Group A and 38.8(+/- 16.22) in Group P. p-value is 0.22 which is not significant. So patients in both the groups were comparable by age.

Table 2: No. Of Attempts

No. of Attempts	Anterior Approach		Posterior Approach		Chi square-Test	
	N	%	N	%	Value	Significant level
1	06	20.00	20	66.70	15.07	p-value 0.002
2	16	53.30	09	30.00		
3	06	20.00	01	3.30		
4	02	06.70	00	-		
Total	30	100	30	100		

In group A only 6 patients were cannulated in the 1st attempt, whereas it was 20 in Group P. In the 2nd attempt 16 in group A and 9 in Group P were cannulated. 6 patients in Group A and just 1 patient in Group P were cannulated in 3rd attempt. In Group A, 2 patients could be successfully cannulated only at the 4th attempt but none of them in Group P required a 4th attempt. The p-value is 0.002. Statistically the no. of attempts for cannulation was lesser with the Posterior approach.

Table 3: Ease Of Threading:

Ease of Threading	Anterior Approach		Posterior Approach		Chisquare-Test	
	N	%	N	%	Value	Significant level
Yes	15	50.00	25	83.33	7.05	p-value 0.05
No	15	50.00	05	16.67		
Total	30	100	30	100		

The catheter could be threaded easily in only 15 patients in Group A, whereas it was 25 in Group P. p-value is 0.05. The results are statistically significant.

Table 4: Carotid Puncture

Carotid Puncture	Anterior Approach		Posterior Approach		Chisquare-Test	
	N	%	N	%	Value	Significant level
Yes	15	50.00	04	13.33	9.32	p-value 0.002
No	15	50.00	26	86.67		
Total	30	100	30	100		

Carotid puncture was encountered in 15 patients in Group A and only in 4 patients in Group P. p-value is 0.002. Statistically it is significant. Hence, the rate of carotid puncture is higher in the anterior approach than the posterior approach.

Table 5: Haematoma

Haematoma	Anterior Approach		Posterior Approach		Chi-square Test	
	N	%	N	%	Value	Significant level
Yes	12	40.00	03	10.00	7.20	p-value 0.01
No	18	60.00	27	90.00		
Total	30	100	30	100		

In Group A haematoma was observed in 12 patients and in only 3 patients in Group P. p-value 0.01. The results are statistically significant. Similar to carotid puncture, the rate of haematoma is also high in the anterior approach.

Table 6: Pneumothorax

Pneumothorax	Anterior Approach		Posterior Approach		Chi-square Test	
	N	%	N	%	Value	Significant level
Yes	3	10.00	1	3.30	1.07	p-value 0.30
No	27	90.00	29	96.70		
Total	30	100	30	100		

Pneumothorax was encountered in 3 patients in Group A and 1 patient in Group P. p-value is 0.30. Although few cases of pneumothorax is observed, the results are not statistically significant.

Table 7: Catheter Kinking

Catheter kinking	Anterior Approach		Posterior Approach		Chi-square Test	
	N	%	N	%	Value	Significant level
Yes	13	43.30	1	3.30	13.41	p-value 0.000
No	17	56.70	29	96.70		
Total	30	100	30	100		

There was kinking of the catheter in 13 patients in Group A and in just 1 patient in Group P. p-value is 0.000. It is both statistically significant. Hence, the rate of catheter kinking is high in the anterior approach than the posterior approach.

Table 8: Catheter Displacement

Catheter Displacement	Anterior Approach		Posterior Approach		Chi-square Test	
	N	%	N	%	Value	Significant level
Yes	3	10.00	1	3.30	1.07	p-value 0.30
No	27	90.00	29	96.70		
Total	30	100	30	100		

Catheter was found to be displaced in 3 patients in Group A and in 1 patient in Group P. p-value is 0.30. This is not statistically significant.

DISCUSSION

Internal jugular vein cannulation can be performed by one of the various approaches, but the success depends on anatomical variations and operator experience. In spite of the numerous approaches, the anterior approach was selected for the study as it is being

conventionally practiced in our institution. Since, Chudhari LS, Karmakar US, Dixit RT, Sonia K et al in Comparison of Anterior and Posterior approaches for Internal jugular vein cannulation(Journal of postgraduate medicine 1998 | Volume : 44 | Issue : 3 | Page : 57-62) has concluded that the posterior approach is easier and safe to cannulate in critically ill and hemodynamically compromised patients, this approach was chosen to compare with the anterior approach.

A sample size of 60 was arrived at based on the results of the Pilot study. A pilot study with a sample size of 5 cases in each group was done before the start of the study to decide on sample size. The mean time for identifying the vein and the standard deviation calculated from the study was used to calculate the sample size. It was calculated based on the formula given in monographers on statistics and applied probability.

Formula:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 2s^2}{d^2}$$

$Z_{1-\alpha/2} = 1.96$ (5% alpha level of significance) and $Z_{1-\beta} = 0.842$ (80% power)

$D =$ difference between two means and $S = S_1 + S_2 / 2$

On entering the values, the mean time for identifying the vein observed in the pilot study for anterior approach was 1.04 ± 1.2 mins. It was 0.47 ± 0.9 mins for the posterior approach.

$N = 2 \times (1.96 + 0.842)^2 (1.2 + 0.9/2)^2 / (1.04 - 0.47)^2$

$N = 15.7 \times 1.1 / 0.32$

$N = 53.96$

Sample size was taken as 60 to include for the drop outs. Randomisation was done by using sealed envelopes. Patients undergoing Internal jugular vein cannulation by Anterior approach were categorized as Group A and those by Posterior approach as Group P. Data were analyzed using SPSS 11.5 software. Parametric variables were described as Mean $\pm$ SD. Qualitative analysis was done using chi-square test and quantitative analysis by student's t-test.

The parameters for comparison were selected based on the inferences in various clinical trials and studies. Most of the studies correlate the anatomical variations of internal jugular vein and the relations to carotid artery with the success rate. Hence criteria like number of attempts, time taken for identification of the vein, duration of cannulation, carotid puncture and haematoma were considered for comparison. Apart from carotid puncture, haematoma and pneumothorax, complication like catheter kinking and displacement have also been reported. So, these were also considered for comparison in the study.

In the study conducted by Chudhari LS, Karmakar US, Dixit RT, Sonia K et al 58% of patients were cannulated by first attempt by anterior approach and 42% required more than one attempt. By the posterior approach, 80% of patients were cannulated by first attempt and 20% required more than one attempt. Mohan Chandrlekha V, Darlong V, Kashyap L et al observed in their study that successful cannulation with few attempts was more in posterior approach (93.8%) than in conventional anterior approach (87.5%). Similar results were obtained in our study. In Group A only 20% of them could be cannulated by first attempt, whereas in Group P it was 66.70%. In Group A 53.30% required a second attempt and in Group P it was only 30%. Clinically there was a vast difference in the number of patients who were cannulated by third and fourth attempt in both the groups. A third attempt was required for 20% of patients in Group A, but it was 3.30% in Group P. In Group A 6.70% of patients who could be cannulated only by the fourth attempt. In Group P none of the patients required a fourth attempt. The p value is 0.002. So, both clinically and statistically it is significant.

In our study the average time taken to identify the vein was 1 minute and 4 seconds in the anterior approach and 13 seconds in the posterior approach. The results were clinically and statistically significant ($p < 0.0001$). Our study results correlate with other studies in literature in which a lesser time was needed to identify the vein in the posterior approach.

The cannulation time is reported to be shorter in posterior approach than the anterior approach in both the obese and non-obese. In our study the mean duration of cannulation was 3 minutes and 50 seconds

in the anterior approach. By the posterior approach it was 2 minutes and 41 seconds. The results were statistically significant ($p < 0.000$). The reason for less time consumption in the posterior approach is that the cross-sectional area of the vein is greater in the posterior approach than the anterior approach in the trendelenberg position. A larger cross-sectional area in the posterior approach 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 our study threading of the catheter was more easier in the posterior approach (83.33%) than the anterior approach (50%). It was statistically significant ($p < 0.05$). The reason for easier threading of catheter in the posterior approach could be a larger cross-sectional area of the internal jugular vein in this approach.

Mohan Chandrlekha V, Darlong V, Kashyap L et al has noted that the incidence of arterial puncture was less in posterior approach (7/80) compared to central approach (18/80) in their study. In the study by Chudhari LS, Karmakar US, Dixit RT, Sonia K et al also the overall incidence of carotid puncture was high (5%) in anterior approach than the posterior approach (2%). In our study the rate of carotid puncture was overall higher in the anterior approach (50%) as compared to posterior approach (13.33%). On comparing with these studies, although our results were similar, the percentage of carotid puncture was higher in both the groups in our study. In our study also, carotid puncture was more in anterior approach (40%) than the posterior approach (16.70%). In all cases of carotid puncture cannula was withdrawn and firm compression was applied. By anterior approach, compression was difficult against the clavicle and the haematoma formed was larger. This is because by anterior approach, palpation of landmarks i.e., the heads of sternocleidomastoid is difficult. If carotid pulsations are not gently palpated, accidental carotid puncture may occur in the anterior approach and distort the anatomy. In contrast to this, the posterior approach needs identification of only the main bulk of the sternocleidomastoid muscle. The external jugular vein which is the other landmark could be identified easily by the trendelenburg position. Therefore the rate of carotid puncture is drastically reduced in the posterior approach.

Haematoma can develop rapidly following carotid puncture or slowly following multiple punctures on the vein due to difficult cannulation or threading. Most of the studies report a lesser incidence of haematoma with the posterior. In our study, by the anterior method there were 12 cases of haematoma all of which were due to carotid puncture, but only 3 cases of haematoma by posterior method. In the obese patients, by the anterior approach there were 4 cases of haematoma and 2 cases by the posterior approach. Haematoma in both the groups was due to carotid puncture. All haematomas resolved completely within 24 hours without causing any further complications. The lesser rate of haematoma in the posterior method could be due to smaller number of carotid puncture by this route.

Pneumothorax is a dreaded complication of Internal jugular vein cannulation. The incidence of pneumothorax could not be assessed in patients with ICD put in intraoperatively. Although it is a dreaded complication, the incidence reported is nil in many studies. On the contrary, in our study Pneumothorax occurred in 3 cases in anterior method. In the posterior method there was one case of pneumothorax. It is not statistically significant. As cannulation by the posterior approach is anatomically at a higher level than the anterior approach, the incidence of pneumothorax is less in the posterior approach.

Kinking of the catheter leads to inadequate Central venous pressure monitoring. Craig RG, Jones RA, Sproul GJ et al observed 4 cases of catheter kinking in the anterior approach and 5 cases in the posterior approach. On the contrary, in our study there was a higher rate of catheter kinking in the anterior method. In Group A catheter was kinked in 13 patients. In Group P, it was observed only in one patient. There was no catheter kinking in the posterior method. The results are both clinically and statistically significant. Mostly catheter kinking occurs due to imperfect suturing of the cannula hub to the skin. In some cases, sutures might become loose and cannula may slip out and kink at the junction between the hub and intravenous position. Proper precautions should be taken to fix the cannula.

Migration of the catheter also leads to false interpretation of central venous pressures. Infusion of fluids and vasoactive drugs may sometimes lead to hydrothorax and chylothorax. Pikwer, A. Baath, L. Davidson, B. Perstoft, I. Ayerson J et al has observed that the rate of

catheter malposition was 3.3% in the anterior approach compared with 1% in the posterior approach. Among obese patients it was 5% in the anterior method and 1.6% in the posterior method. In our study catheter was found to be displaced in 10% of cases in the anterior method and 3.3% of cases in the posterior method. Improper suturing leads to catheter slipping during neck movements. So, it can be avoided by proper suturing and fixation.

In the study by Chudhari LS, Karmarkar US, Dixit RT, Sonia K et al, mild thrombophlebitis was noted in 8 cases in the anterior approach and 7 cases in posterior approach. In our study, thrombophlebitis was observed in 14 cases in Group A. In Group P it was seen in 7 cases. The results were not statistically significant. Mild thrombophlebitis is usually associated with cases where cannulation was for 48 hours or more.

Craig RG, Jones RA, Sproul GJ et al have observed a comparatively higher rate of limitation in neck movements in the anterior approach in their study. In the anterior method it was 21% and in the posterior method it was 13.3%. Similar results were obtained by Sharrock NE, Fierro LE et al for obese patients in their study. In our study, movements of the neck were found to be limited in 46.7% of cases in Group A and only in 6.7% of cases in Group P. The results are both clinically and statistically significant.

CONCLUSION

In conclusion, the posterior approach is better than the anterior approach for Internal jugular vein cannulation as it improves the success rate, permits easy threading of catheter, reduces the access time and duration of cannulation. It reduces the complications like carotid puncture, haematoma, pneumothorax, catheter kinking, catheter displacement, thrombophlebitis and limitation of neck movements. It permits easier access, improves the success rate and reduces the complications.

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