RESEARCH ARTICLE

NEUTRAL VERSUS 45 DEGREE ROTATED POSITION OF HEAD FOR INTERNAL JUGULAR VEIN CANNULATION: A COMPARATIVE STUDY BASED ON ULTRASONOGRAPHY

Siddharth Parmar[1], Harshil Mehta[2]

[1] Department of Anaesthesiology, BJ Medical College, Ahmedabad, Gujarat, India

[2] Department of Emergency Medicine, BJ Medical College, Ahmedabad, Gujarat, India

Correspondence to: Siddharth Parmar (drsid25@gmail.com)

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ABSTRACT

Background: Most of the methods do not specify its optimal degree of head rotation during central venous catheterization.

Aims & Objective: To compare neutral versus 45 degree rotated position of head for internal jugular vein (IJV) cannulation based on ultrasonography.

Material and Methods: This prospective, randomized study was conducted in a teaching and tertiary care hospital. Randomly selected 100 healthy volunteers were placed supine with 15º trendelenberg position. Head of the volunteer was kept neutral in group N (100 volunteers) and 45º rotated in group R (100 volunteers). 7.5 M Hz linear array probe of a portable ultrasound was placed perpendicular to the apex of triangle formed by two heads of sternocleidomastoid muscle and clavicle. We simulated a line as a needle insertion on ultrasound screen passing the mid-point of the IJV. A "hit" was defined as the intersection of the inner lumen of carotid artery (CA) by simulated line. The observations were recorded for both sides of neck for each group. Student's t test was applied for quantitative data and Fisher exact test for qualitative data. P value < 0.05 was taken as significant.

Results: The frequency of 'Hit' was less in group N than R (right side: 5% versus 15%, p=0.0317; left side: 15% versus 28% p=0.0381). Total frequency of 'Hit' was less in right side than left side for both groups (p<0.05). The diameter of IJV and CA were comparable in both groups for right and left side of neck (p>0.05). The distance of IJV from skin was more in group N than R (right side: 10.29±1.88 versus 9.75±1.88, p=0.0436; left side: 10.75±1.87 versus 10.21±1.86, p=0.0416).

Conclusion: A neutral position was safer than 45 º neck rotation during IJV cannulation with regard to CA puncture.

KEY-WORDS:, , Carotid Puncture; Central Venous Catheterization; Jugular Vein; Ultrasonography

Introduction

Most of the methods do not specify optimal degree of head rotation during Central venous catheterization (CVC). Unintended puncture of the carotid artery (CA) is the most common acute complication with incidence ranging from 1.9 to 15%.[1] Puncture of the CA is mostly benign but may lead to serious catastrophe.[2]

The IJV lies anterior and lateral to the CA in neutral head position. But, 45º head rotation may cause the CA to lie directly underneath the IJV which in turn, causes needle to puncture the posterior wall of the IJV and the CA. So, we designed a study to determine whether head rotation affect the position of IJV in relation to CA during CVC using ultrasonography. We simulated needle insertion on ultrasound screen passing the mid-point of the IJV to compare neutral head position versus 45º head rotation for CVC in the IJV to determine the intersection of the CA by simulated line.

Materials and Methods

This prospective study was conducted in a teaching and tertiary care hospital from October 2012 to December 2012. Total 100 healthy volunteers of either sex, aged 20 years to 40 years, were randomly selected after getting their informed written consent. The volunteers with abnormal neck anatomy, previous surgery, trauma or prior catheterization in the neck were excluded.

Each volunteer was placed supine with 15º trendlenberg position. Head of the volunteer was

kept neutral in group N (100 volunteers) and 45º rotated in group R (100 volunteers).

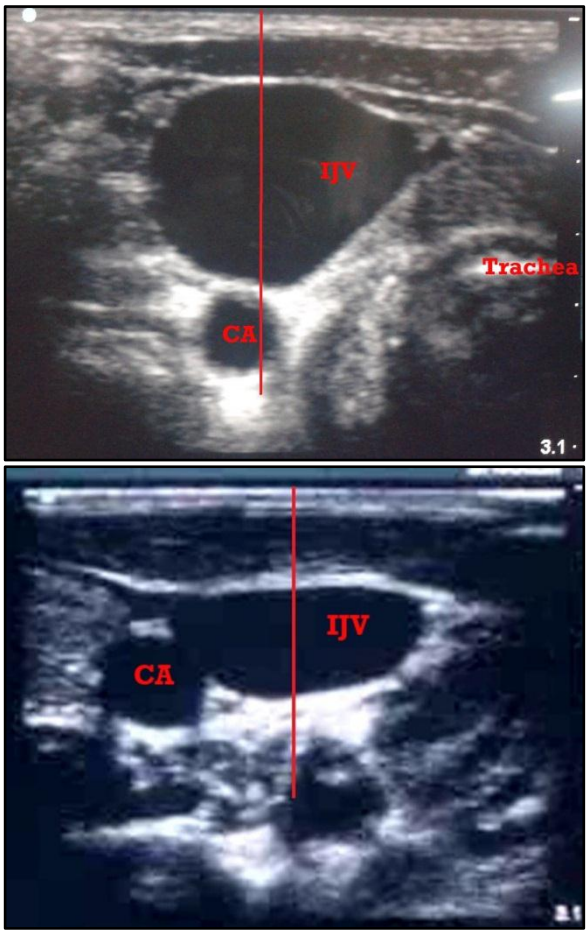

Figure-1: Simulating Needle Insertion on Ultrasound Scan Showing (a) Hit; (b) Miss

Figure-2: Showing Apex of the Triangle to be Scanned and Ultrasound Probe

A single investigator identified and marked a triangle formed by medial and lateral heads of the sternocleidomastoid muscle and base by the clavicle. 7.5 M Hz linear array probe of a portable ultrasound "Sonosite Micromaxx" machine was placed perpendicular to the apex of triangle. This was the point where a needle would be inserted to cannulate the IJV. The IJV and the CA were visualized in transverse section in 2-D ultrasound. We simulated a line as a needle insertion on ultrasound screen passing the mid-point of the IJV.

The primary outcome (dependent) variables were "hit" by a simulated line to CA. The diameter of IJV and CA, distance from skin to IJV were secondary outcome of the study.

A "hit" was defined as the intersection of the inner lumen of CA by simulated line. A "miss" was defined as no intersection of the inner lumen of CA by simulated line. The observations were recorded for both sides of neck for each group.

Date was analyzed using graphpad software. We summarized descriptive data as mean ± S.D. or percentage. Student's t test was applied for quantitative data and Fisher exact test for qualitative data. P value < 0.05 was taken as significant.

Results

Demographic data were shown in table 1. There were an equal number of men and women in the study. The IJV and CA were present and patent in all volunteers. The frequency of 'Hit' was 5% in group N and 15% in group R (p=0.0317). The frequency of 'Hit' was 15% in group N and 28% in group R (p=0.0381). The diameter of IJV and CA were comparable in both groups for right and left side of neck (p>0.05). The distance of IJV from skin was 10.29 ± 1.88 for group N and 9.75 ± 1.88 for group R for right side of the neck (p=0.0436). The distance of IJV from skin was 10.75 ± 1.87 for group N and 10.21 ± 1.86 for group R for left side of the neck (p=0.0416).

Total frequency of 'Hit' was less in right side than left side for group N (p=0.0317) and group R (p=0.0381).

Table-1: Demographics of the Study

Demographic Data	Mean ± SD	Minimum	Maximum
Age (years)	27.12 ± 4.41	18	39
Weight (kg)	61.98 ± 9.55	42	87
Height (cm)	164.31 ± 7.82	148	182
Gender (ratio)	1 : 1	-	-

Table-2: Measurements of the IJV and CA

Side of Neck	Parameter	Group N	Group R	P value
Right	Hit	5 %	15 %	0.0317
	Miss	95 %	85 %	
	Diameter of IJV	12.41 ± 2.36	12.86 ± 2.21	0.1655
	Diameter of CA	6.15 ± 0.48	6.14 ± 0.56	0.8923
	Distance of IJV from skin	10.29 ± 1.88	9.75 ± 1.88	0.0436
Left	Hit	15%	28%	0.0381
	Miss	85%	72%	
	Diameter of IJV	9.94 ± 2.24	10.25 ± 2.29	0.3344
	Diameter of CA	6.11 ± 0.75	6.2 ± 0.45	0.3047
	Distance of IJV from skin	10.75 ± 1.87	10.21 ± 1.86	0.0416

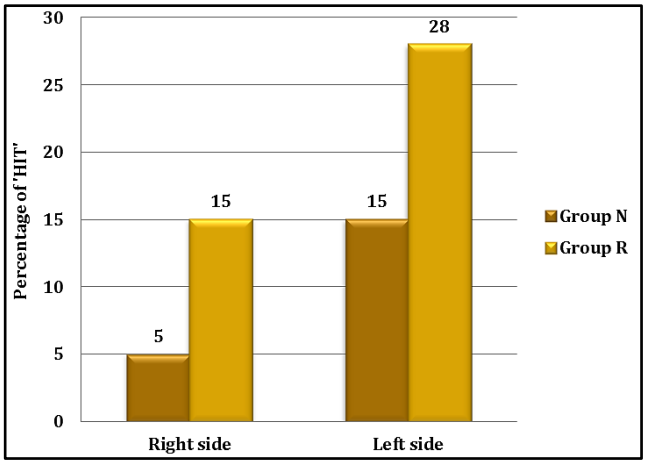

Figure-3: Percentage of 'HIT' on Both Sides of Neck in the Study

Discussion

Our study is based on simulation to address the consequence of two different head positions upon the CVC in terms of CA puncture in Indian population. In our study, the IJV becomes more superficial when head was rotated 45º contra-laterally in comparison with neutral head position which makes cannulation easy but if our sole objective was to cannulate the IJV while reducing the likelihood of the CA puncture then neutral was the best head position. The risk of the CA puncture was less on right side than left side of the IJV cannulation for both head position.

Sulek et al[3] studied to determine the effect of 0, 40 and 80 head rotated position on the relative positions of the IJV and CA in 12 volunteers with 2-D ultrasound. They concluded that the increased overlap of the CA and IJV with head rotation >40° increases the risk of puncture of CA. head should be kept in as near a neutral position as possible during CVC. Bazaral M et al[4] studied the ultrasonographic scans of the right side of the neck in 16 subjects and found that 14° head tilt downward and valsalva manoeuvre causes significant distension of the IJV. Both palpation of the CA and extreme rotation of the head produce anatomical changes that seem to make cannulation of the IJV difficult and increase the risk for the CA puncture. Both studies differ to our study by two ways: (1) sample size was small (2) conclusion was based on overlap of the CA and IJV.

Troianos et al[5] found that the degree of overlap of the CA and IJV is significantly greater in subjects older than 60 years. Gwak MJ et al[6] studied the effects of head rotation (0°, 40° and 80°) on the diameter of the IJV and overlap between the IJV and the CA in 88 infants and young children. As the head rotated from midline, the percentage of diameter of the IJV and overlap between the IJV and the CA increased significantly. They suggested 40 head rotation as an optimal for right IJV cannulation in paediatric patients. Alderson PJ et al[7] concluded in an ultrasound study of paediatric cardiac patients that the CA coursed posterior to the IJV in 10% of patients, which would predispose them to accidental CA puncture. However, our study included volunteers of 20 to 40 years old. So, results may vary in geriatric and paediatric population.

Lieberman et al[8] using similar methodology, reported that increased head rotation from 0°, 15°, 30°, 45°, and 60° to the left of midline was associated with higher probability of a simulated needle contacting the IJV and the CA. For both central and anterior approaches, the risk of CA contact was <10% for head rotations of ≤45°. To optimize the IJV contact while reducing the likelihood of inadvertent contact with the CA, the head should be rotated no more than 30° in patients with high BMI (Body mass index) or BSA (Body surface area), but it may be turned to 60° if BMI or BSA is low. Their study has adequate sample size and similar methodology. Their study differs to our study by two ways (1) their study limited to only the right side of the neck (2) their study included both anterior and central approach for CVC.

Thanaporn L et al[9] studied in 100 adult patients presenting for elective cardiac surgery and found that using the standard external landmark technique, the simulated needle would have hit the IJV in 82% of the attempts. The average distance between the skin and the middle of the IJV did not significantly change between sides or with head rotation. On both sides, as the head was rotated further from the midline, the amount of overlap between the IJV and CA increased from 20%–30% to as much as 50%. Their study included patients predominantly male (84%) and older aged (average 55.7 yrs) and Chinese (74%).

Although our method attempts to be more realistic but it actually overestimates the true risk of CA puncture as when the CA was hit, simulation line passed through the IJV first. So, if needle insertion ended at the IJV before reaching the CA then the CA puncture would be avoided. However, the IJV frequently collapses with needle insertion and the chances of the CA puncture after penetrating posterior wall of the IJV was up to 50%.[10]

Literature analysis[11-20] reveals that ultrasound guided catheterization increases success rates, minimizes attempts for cannulation and decreases the CA puncture in comparison with anatomical landmarks guided catheterization. But, the availability, cost and lack of training may limit the use of ultrasonography for CVC in developing country like India. So, one has to rely on anatomical landmarks for CVC.

An approach to cannulate the IJV in neutral head position is described for situations where head rotation and extension are contraindicated. Neutral head position during CVC is practically associated with acute angle of needle insertion and interference of mandible. So, familiarity with methods is a contributing factor and must be taken into account.

Lew YS et al[21] studied cannulation of the IJV in neutral position in 40 patients and found 97.5% success rate, 1.3 per patient attempt rate with 5% complication rate. They concluded that neutral head position during CVC was a reliable and safe position especially when lateral head rotation was contraindicated or restricted.

Massimo Lamperti et al[22] studied a randomized controlled clinical trial (RCT) in 1332 patients and found that complications and the perception of difficulty performing the procedure with the head position was not statistically different between neutral head and 45 º rotated head group. They concluded that a head neutral position was as safe as a 45º neck rotation during ultrasound guided IJV cannulation with regard to both major and minor complication and venous access time was similar.

Burhan Apilioqullari et al[23] studied a RCT comparing a neutral head position with >45˚ head rotation during landmark guided IJV cannulation and found that the success rates of finder needle passes into the IJV on the first attempt were 87.5% and 37.5% ($p < 0.05$), and the cumulative success rates on the first 3 attempts were 97.5% and 57.5% ($p < 0.05$) in the rotated and neutral groups, respectively. The CA puncture only occurred in 2 patients in the rotated group. Because of the lower success rate, the neutral head position is not an attractive alternative for IJV catheterization when compared with the rotated head position in a central landmark IJV approach.

Our study was based on simulation as a clinical trial involving actual needle insertion at two different head positions would be impractical and unethical in same patients. There was a single probe operator to determine the anatomical landmarks in our study as we wanted to avoid the confounding effect of operator experience. The probe operator was not blinded in our study because we wanted to exclude the effects of changes in vessel variables during breathing and probe compression, patient movement, operator movement.

Limitation: Simulation based study and non-blinding probe operator was our study's limitation.

Conclusion

We conclude that the IJV becomes more superficial when head was rotated 45º contra-laterally in comparison with neutral head position which makes cannulation easy but if our sole

objective was to cannulate the IJV while reducing the likelihood of the CA puncture then neutral was the best head position which reduces overlapping between the IJV and CA. The risk of the CA puncture was less on right side than left side of the IJV cannulation for both head position.

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