An Observational Study Of Change In Diameter Of Right Internal Jugular Vein With Various Body Positions In Volunteers With The Aid Of 2-Dimensional Ultrasonography

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Citation

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Abstract

INTRODUCTION: The right internal jugular vein is commonly preferred for securing central venous access, and success of cannulation shows a positive correlation with veins diameter OBJECTIVE: The objective of our study is to establish the optimal position resulting in the largest RIJV diameter. METHODS: We conducted an observational study done on 100 volunteers and 2D USG was used to measure the lateral diameter of RIJV in different body positions, participants of either sex of age 18-60 years are included.RESULTS: All the 100 volunteers participated in this study. The RIJV was easy to visualize in all subjects. The mean diameter with table flat, head resting on table and in the midline was 12.7±2.02 mm which increased to 13.3±2.4 mm when a pillow was placed under the head. The diameter further increased to 15.8±2.6 mm in 15° Trendelenburg tilt and no change in diameter was seen when head was rotated to left (15.39±2.71 mm). There was significant reduction in diameter on placing shoulder pad and gentle palpation of carotid artery. CONCLUSION: From this study we concluded that the optimal position for IJV cannulation may be achieved by positioning the subject in supine, head on a pillow, with 15° Trendelenburg tilt of the table and head in midline or rotated not more than 45° to left without shoulder pad and avoiding carotid artery palpation.

INTRODUCTION

The jugular and subclavian venous routes have become increasingly popular for establishing central venous access. Very often anaesthesiologists are called for securing these lines. For the anaesthesiologist the internal jugular vein (IJV) is the route of choice and more often the right internal jugular vein is preferred.1

Cannulation of the IJV was first described in 1969. The traditional methods of using anatomic landmarks to guide cannulation of the right internal jugular vein (RIJV) have yielded various rates of successful access and complications.3

Logically speaking, the larger the target area of the IJV, the easier it is to locate and cannulate. Better conditions and the reduction of complications are continuing concerns. A variety of manoeuvres and different body positions have been used in the past to maximize the RIJV diameter for increasing the success rate of cannulation and to decrease complications.4,5

Ultrasound has been applied to describe the anatomy of the IJV and to evaluate various techniques for percutaneous cannulation. 6 Real time sonography improves access to the vein compared with the traditional method. Ultrasound guided cannulation limits complications and also it decreases the cannulation time. However this facility may not be available in many centers because of its high cost. It also needs an experienced operator which is an additional limiting factor for its use.

Real time ultrasonography (USG) can be used to view the in vivo vascular anatomy of the neck and in asserting the size of IJV and its anatomical relations. 7,8 These features make this instrument a useful tool to study various body positions and in finding out the position which maximize IJV diameter, thereby increasing the first pass success rate of RIJV cannulation.

.Our objective is to know the optimal body position that maximizes the right internal jugular vein diameter, thereby increasing the first pass success rate of IJV cannulation.

MATERIAL AND METHODS

Study was conducted on 100 participants who are volunteers belonging to ASA grade I or II of either sex between 18 to 60 years. After obtaining institutional ethical committee clearance and informed consent from the volunteers the study was conducted into USG room in department of radiology in our hospital. Volunteers with any of the following conditions i.e. previous neck surgeries, cervical spine deformities, post burn contracture of the neck, neck swellings and obese patients with short neck were excluded from the study.

Baseline values of heart rate and blood pressure were noted

Participants were taken to the USG room and asked to lie flat on the table in supine position. With the aid of the radiologist the right internal jugular vein was visualized in the transverse axis with the linear probe 2D ultrasonography machine 7.5 MHz (Seimans Sonoline Adara) 4cms lateral to the cricoid cartilage. The surface marking of the apex of the triangle formed by the two heads of the sternocleidomastioid was marked and the lateral diameter of the right internal jugular vein was measured at this point in the following 6 positions

The following six positions were used

P_1 Table flat, subject supine, with head midline on the table

P_2 Table flat, subject supine, with head on a small pillow

P_3 15° Trendelenburg tilt and head on a small pillow

P_4 15° Trendelenburg tilt and head on a small pillow and rotated 45° to left

P_5 15° Trendelenburg tilt and head on a small pillow and rotated 45° to left with shoulder pad below.

P_6 15° Trendelenburg tilt, head on a small pillow and rotated 45° to left, with shoulder pad below and carotid artery (CA) gently palpated.

Head in neutral (midline) position was defined as having the subject's sagittal plane perpendicular to the floor. The operator can reasonably approximate 45° angle without needing any tools. Table flat means patient positioned with no tilt.

CA was palpated gently by another operator with the left hand from the head end so as to simulate the real cannulation technique. The shoulder pad and pillow used were of 8 cms height. The lateral diameter of the IJV in millimetre (mm) was measured because we assume that the increase in lateral diameter decreases the chances of hitting the carotid artery. The ultrasound probe was held in a horizontal plane directed 30° caudal. The probe was held on to the skin with minimal pressure to limit neck vessel compression. A single operator performed all the measurements. The mean of the higher 2 of 3 measurements was taken with accuracy up to 0.1 mm.

Considering a difference in IJV diameter of 2.5 mm between two positions as clinically significant and for an alpha value of 0.05 and power of 90%, a sample size of > 40 was calculated15. We included 100 volunteers. All results were analyzed using unpaired Student's t test, a $p < 0.05$ was considered statistically significant. Karl Pearson's correlation test was applied for correlation.

RESULTS

The study was conducted on 100 volunteers. All the volunteers participated in the study,

(Males 59, Females 41)

Figure 1

Table No. 1: Demographic Data of the Participants

Independent Variables	Mean ± SD
Age (Yrs)	35.65 ± 9.69
Weight (Kgs)	59.11 ± 10.23
Height (Cms)	161.85 ± 11.58

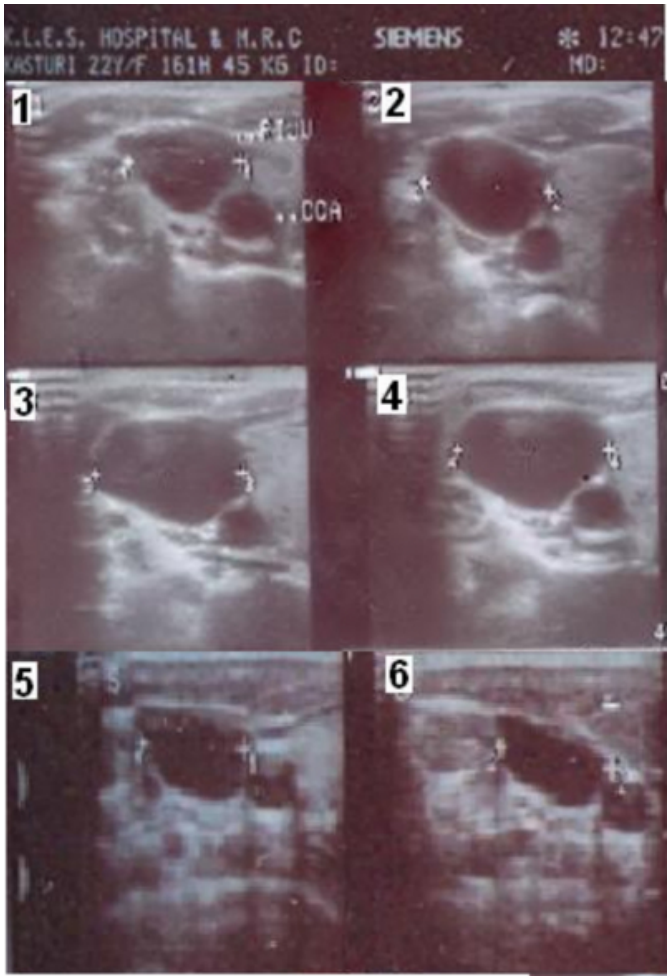
Figure 2

Table No. 2: Mean RIJV diameters in various positions

Sl. No.	Position of subject	Mean ±SD (diameter in mm)
P_1	Table flat, subject supine with head midline on table	12.7±2.02
P_2	Table flat, subject supine with head on small pillow	13.3±2.34
P_3	15° Trendelenburg tilt, head in midline on small pillow	15.8±2.6
P_4	15 Trendelenburg tilt, head on small pillow and rotated 45° to left	15.9±2.71
P_5	15° Trendelenburg tilt, head on small pillow and rotated 45° to left and a pad below the shoulder.	14.0±2.41
P_6	15° Trendelenburg tilt, head on small pillow and rotated 45° to left and shoulder pad below and carotid artery gently palpated	12.1±2.63

Figure 3

Figure: Real time ultrasonography images in different body positions in a subject (refer to text)



The RIJV diameter significantly improved in position P_2 when compared with position P_1 ($p<0.05$). So a small pillow under the head increases the RIJV diameter. The RIJV diameter significantly improved in position P_3 when compared with position P_2, (p value < 0.000) i.e. a 15° Trendelenburg tilt of the table with the head in midline on a pillow significantly improved when compared to without tilt. The diameter was comparable in positions P3 and P4 i.e. turning the head 45° to the left did not improve the RIJV diameter when compared with head in midline position. ($p=0.75$).The diameter was worsened in position P_5 when compared with position P_4, so placing a shoulder pad can decrease the IJV diameter ($p<0.0000$). The diameter again decreased in position P_6 (15° Trendelenburg tilt, subject supine and head on a pillow and rotated 45° left, with shoulder pad below and carotid artery gently palpated), when compared to position P5 (15° Trendelenburg tilt, subject supine and head on a pillow and rotated 45° left, with shoulder pad, $p < 0.0000$). So carotid artery palpation could worsen the RIJV diameter.

Figure 4

Table No. 3: Relationship between Age, Weight, and Height with RIJV diameter in different positions P to P (Karl Pearson's Coefficient (r))

	P1	P2	P3	P4	P5	P6
Age	0.124	0.0627	0.0562	0.0019	0.1695	0.0257
Weight	0.0270	0.0619	0.139	0.0579	0.0342	0.0087
Height	0.1568	0.1205	0.1257	0.1913	0.1761	0.1579

. None of the Karl Pearson's coefficients in various positions (P_1 to P_6) was significant.

The data showed that there was no significant difference between either sex with respect to diameter of RIJV in different positions ($p > 0.05$). Age in both the sexes was comparable.

DISCUSSION

Central venous access for both surgical procedures and non surgical reasons has become a valuable adjunct to patient care. Placement of central venous catheter via right internal jugular vein has become one of the most popular routes.12 The internal jugular vein cannulation is commonly performed procedure in the practice of anaesthesiology.

External anatomic landmarks have traditionally been used to approximate the location of the neck blood vessels to optimise IJV cannulation. Although there are many effective methods to achieve IJV cannulation, there are very few quantitative data that identify the optimal conditions for successful placement. Though the visual surface landmarks to guide cannulation were found to be clinically reliable and safe, it is not without complications like carotid artery puncture, haematoma, pneumothorax, haemothorax.3,9 Carotid Artery puncture is the most frequently encountered complication. The risk is increased in association with several characteristics.17

Abnormal patient anatomy (Obesity, Local scarring)

Emergency clinical setting

Co-morbidity

Operator inexperience

Improper positioning

Which cannulation approach is the best is often a point of controversy and supporting arguments are not often based on

data. The variables in the control of the anaesthesiologist include the patient position, amount of head rotation to the contra lateral side, the degree of Trendelenburg tilt of the table and the point of entry of the needle. In 2002 National Institute for Clinical Excellence (NICE) of United Kingdom has issued guidelines on the use of ultrasound for IJV cannulation.18.

A variety of manoeuvres and body positions were used in the past to maximize the RIJV diameter. It has been shown that the larger the diameter of the RIJV, the more likely one is to achieve first pass cannulation.10In our study the dependent variables are pillow, shoulder pad, Trendelenburg tilt and carotid artery palpation. We have chosen to measure the diameter of RIJV as cannulation is more often done on the right side. CSA of RIJV is more than LIJV. In the study height, weight, age and sex did not influence the diameter of RIJV. These findings are consistent with previous studies4,5 19

In position P_1 i.e. table flat subject supine and head in neutral position, the mean IJV diameter was 12.7 mm which increased to 13.3 mm on placing a small pillow under the head (Table No. 3). The observations made in our study agree with the findings of a study conducted on 21 volunteers, where in the CSA of IJV significantly rose from 9.2 mm to 10.2 mm on placing a pillow.15 Many authors recommend the use of pillow as it causes slight flexion of the neck, which may allow for greater relaxation of the neck musculature and reduced anxiety.16

On placing the subject on 15° Trendelenburg table tilt with head on a pillow in midline position there was significant increase in diameter compared to that of table in flat position P_2 and P_3. The Trendelenburg position has been shown to distend the internal jugular vein due to increase in venous pressure.20 A similar increase in the IJV was seen in the previous studies.4,11,14 In an ICU population group the diameter increased by greater than 37% from table flat to Trendelenburg tilt position.5 Even a 10° Trendelenburg tilt is efficient and tilt of more than 25° is of little help.13

IJV cannulation is usually performed by rotating the head to contralateral site we noted that on rotation of head by 45° there was no change in CSA compared to that of position P_3, (p value 0.75).The rotation of the head causes stretching of the neck musculature which may compress the vein. The stretching of the neck on rotation may be countered by placing a pillow under the head.

Interestingly Suarez T, Baerwald JP 12et al observed opposite effects i.e. the CSA of RIJV increased on rotation of head by more than 20° to the opposite side. The mean CSA in 0°, 20° and maximum head rotations were 1.18 to 1.29 and 1.32 sq cms respectively.

We speculate that this difference can be attributed to a small sample size. However our study is adequately powered. Significant overlap of carotid artery and the IJV can result when the head is tilted beyond 40°. Few authors have even recommended to position the head as neutral as possible.21,22

Placing a shoulder pad with patient positioned in Trendelenburg tilt with head on a small pillow and rotated 45° to left (P_5) significantly reduced the diameter on comparison with position P_4 . This is due to the extension of the neck caused by use of shoulder pad and compression of the surrounding structures.4,15 Traditionally carotid artery is palpated during cannulation which guides the direction of the needle and avoid inadvertent puncture of carotid artery during IJV cannulation. In our study a significant reduction in the vein size was observed while palpating the carotid artery in position P_6 on comparing with P_5 position. Palpation of the carotid artery exerts pressure over the vein and compresses it. There is mounting evidence of literature that carotid artery palpation reduces the diameter.7,15

CONCLUSION

Positioning the subject supine in 15° Trendelenburg tilt with head resting on a small pillow and in neutral position or rotated to not more than 45° to left maximized the RIJV diameter. Carotid artery palpation and use of shoulder pad should be avoided.

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