Section: Anaesthesia

Original Research Article

QUANTITATIVE MEASUREMENT OF THE RIGHT INTERNAL JUGULAR VEIN DIAMETER BY ULTRASOUND IMAGING IN DIFFERENT POSITIONS

S. Shenbagarajan[1], Indrani Appikonda[2], M. Vasuki[3]

[1]Assistant Professor, Department of Anaesthesia, Tirunelveli Medical College, Tamilnadu, India
[2]Assistant Professor, Department of Anaesthesia, Government Chengalpattu Medical College, Tamilnadu, India
[3]Assistant Professor, Department of Emergency Medicine, Government Chengalpattu medical college, Tamilnadu, India

Received : *06/11/2023*
Received in revised form : *09/12/2023*
Accepted : *24/12/2023*

Keywords:
Right internal jugular vein, Conventional position, Modified position, Anteroposterior diameter, Transverse diameter.

Corresponding Author:
Dr. M.Vasuki,
Email: vasukimayilsamy2020@gmail.com

DOI: 10.47009/jamp.2023.5.6.283

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (6); 1374-1378

Abstract

Background: The right internal jugular vein (IJV) is a common route for central venous cannulation, with larger diameters making cannulation easier and faster. Positioning of the patient affects the IJV diameter, with a modified position increasing success and reducing puncture. This study aimed to determine whether alterations in patient position affect the diameter of the internal jugular vein and the relationship between the vein and the carotid artery. **Materials and Methods:** This pilot study was conducted with 40 volunteers from our medical and para-medical departments at the Christian Medical College, Vellore. A total number of Forty volunteers were included in the study. The initial 20 volunteers were placed in the conventional position and then 20 in the modified position. The next 20 volunteers were placed in the modified and conventional positions. Measurements were made of the largest internal anteroposterior and transverse diameters of the IJV on a frozen image and the depth of the vein from the skin. **Result:** A significant correlation was found between height and position 2 anteroposterior diameter. There was a correlation in height between position 1 transverse diameter but no correlation in weight and neck circumference. There was no correlation in height, weight, neck circumference, and sternohyoid distance between position 2 and transverse diameter. There was no correlation between neck circumference and depth of the IJV from the skin at positions 1 and 2. **Conclusion:** The modified position of the right internal jugular vein increased its diameter, potentially enhancing cannulation success and reducing carotid artery overlap; however, there was no consistent correlation.

INTRODUCTION

The right internal jugular vein (IJV) is one of the most common routes for central venous cannulation. Success and ease of cannulation correlate with vein diameter. It can be concluded that the larger the diameter of the IJV, the easier and quicker it is to perform cannulation.[1,2] There are different ways to position the patient for the cannulation. Different positions affect the diameter of the internal jugular vein differently.[1,3-6] One popular method is the central approach. The central approach usually involves placing a folded sheet under the shoulders, completely turning the head to the contralateral side, and placing a finger on the carotid pulse. This conventional position and approach have been reported to result in a decrease in the diameter of the IJV.[1,7]

A modified position with no folded sheet under the shoulders, flexion of the neck with a pillow under the head, and not palpating the carotid artery is more likely to increase the diameter of the internal jugular vein.[1] This, in turn, can increase the success rate of quick and first-pass cannulation and decrease the incidence of carotid artery puncture. In this study, we propose to quantitatively measure the diameter of the IJV using ultrasound imaging in both the conventional and modified positions and to determine whether there is a significant difference. As an extension of the study, the correlation between the weight, height, neck circumference, and sternohyoid distance on the one hand and the diameter of the IJV was also studied.

Aim

This study aimed to determine whether alterations in patient position affect the diameter of the internal jugular vein and the relationship between the vein and the carotid artery.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

MATERIALS AND METHODS

This pilot study was conducted with 40 volunteers from our medical and para-medical departments at Christian Medical College, Vellore. The study was performed in healthy volunteers in the radiology department under the supervision of a senior radiologist and an anaesthetist. All volunteers were given instructions regarding the procedure after obtaining approval and informed consent from the Hospital Research Committee.

The table used was the same as for digital subtraction angiographic procedures. All measurements were taken with a 5-degree head-down tilt and kept constant for all the volunteers. The materials used for the study were tape, a weighing machine, a pillow routinely used for intubation, and folded sheets. The same materials were used for all the volunteers. Neck circumference was measured at the level of the cricoid cartilage. The sternohyoid distance was measured from the hyoid bone's lower border to the sternum's uppermost palpable border, with the neck in a neutral position and the volunteer facing the observer. B-mode sonography (Siemens, Adara) with a 7-11 MHZ Transducer was used. The probe was placed horizontally at the level of the cricoid cartilage, corresponding to the most frequently used point for needle insertion into the IJV. The medial wall of the carotid artery was positioned at the medial end of the screen to standardise the placement of the ultrasound scanner probe.

One person palpated the carotid artery in a conventional position, and all volunteers identified the location of the carotid artery. Two fingers were applied over this region, taking care not to exert any pressure on deeper structures. The largest internal anteroposterior and transverse diameters of the IJV on the frozen images were measured at each position. The depth of the internal jugular vein from the skin was measured from the surface to the anterior outer wall of the internal jugular vein. The distance between the carotid artery and the internal jugular vein was measured in each position. However, when the study was performed, the carotid artery was very close to or overlapped the internal jugular vein. Therefore, the portion of the carotid artery overlapping the internal jugular vein in each position was measured.

A total number of Forty volunteers were included in the study. The first 20 volunteers were placed in the conventional position and then in the modified position. The next 20 volunteers were placed in the modified and conventional positions. In the first group, the volunteer initially assumed a conventional position for the measurements. Parameters such as the anteroposterior and transverse diameters of the internal jugular vein, the portion of the carotid artery covered by the internal jugular vein, and the depth of the internal jugular vein from the skin were assessed using frozen ultrasound images. The volunteer then transitioned to a modified position, and the same measurements were taken from the frozen ultrasound image.

The second group initially placed the volunteers in a modified position. In this position, various parameters, including the anteroposterior and transverse diameters of the internal jugular vein, the segment of the carotid artery overlapped by the internal jugular vein, and the depth of the internal jugular vein from the skin, were meticulously measured using frozen ultrasound images. The volunteer was then changed to the conventional position, and the same measurements were taken from the frozen ultrasound image.

Statistical Analysis

Data were analysed with the help of a statistician. NPar Tests, Wilcoxon Signed Ranks Test and Pearson's product-moment correlations for the analysis were used with SPSS software (version 11.0) for Windows. Statistical significance was set at $p < 0.05$.

RESULTS

A total number of Forty volunteers were included in the study. The mean anteroposterior diameter in position 1 was 5.1 mm (standard deviation of 3.93) in position 2 and 10 mm (standard deviation of 4.69). This difference was statistically significant ($p =0.001$). The mean transverse diameter at position 1 was 9.68 mm (standard deviation of 6.11 mm), and that at position 2 was 14.21 mm (standard deviation of 5.62). This difference was statistically significant ($p<0.001$).

The mean magnitude of overlap in position 1 was 1.49 mm (standard deviation of 1.96), and in position 2 was 4.43 mm (standard deviation of 2.49). This difference was statistically significant ($p<0.001$). The mean depth at position 1 was 11.05 mm (standard deviation of 1.88 mm), and that at position 2 was 10.06 mm (standard deviation of 2.12). This difference was statistically significant ($p<0.001$). There was no correlation in height, weight, neck circumference, and sternohyoid distance between position-1 anteroposterior diameter.

The Pearson correlation coefficient (r) was 0.378, with a p-value of 0.016, which was statistically significant. Therefore, there was a correlation in height between position 2 and anteroposterior diameter. There was no correlation between weight and neck circumference at position 2 anteroposterior diameter.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

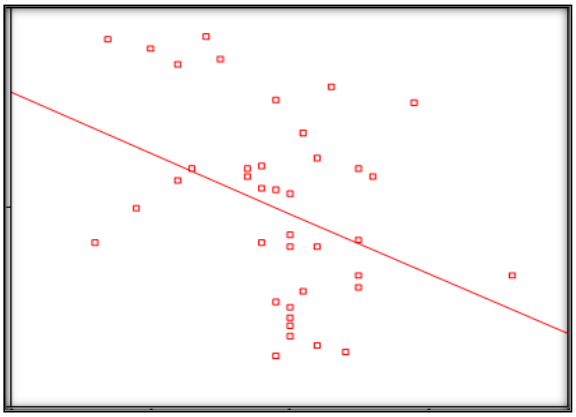

Figure 1. Correlation of height between position 2 anteroposterior diameter

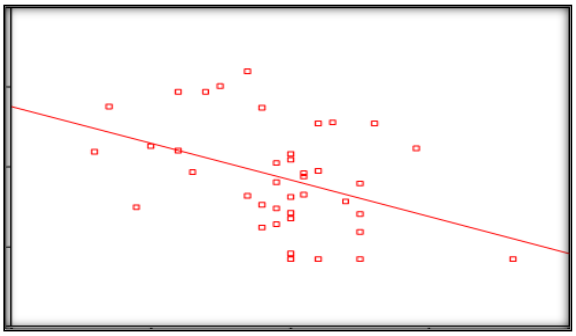

Figure 2: Correlation of sternohyoid distance between position 2 anteroposterior diameter.

The Pearson correlation coefficient (r) was -0.561, with a p-value of 0.000, which was statistically significant. Therefore, there was a correlation between sternohyoid distance and anteroposterior diameter at position 2 [Table 1, Figures 1 and 2].

The Pearson correlation coefficient (r) was -0.415 with a p-value of 0.008, which was statistically significant. There was a correlation in height between position 1 transverse diameter. There was no correlation between the weight and neck circumference at position 1 transverse diameter [Table 2 and Figure 3].

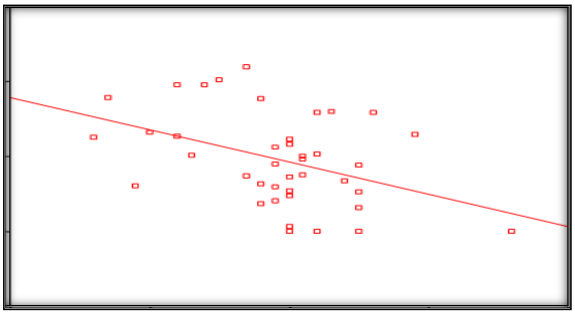

Figure 3: Correlation of height between position 1 transverse diameter

There was no correlation in height, weight, neck circumference, and sternohyoid distance between position 2 and transverse diameter. There was no correlation between neck circumference (neck-circ) and depth of IJV from the skin (SK-IJV) at positions 1 and 2.

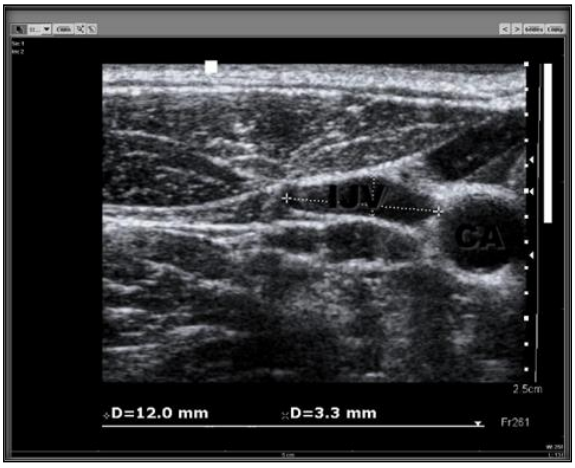

Figure 4: Conventional position

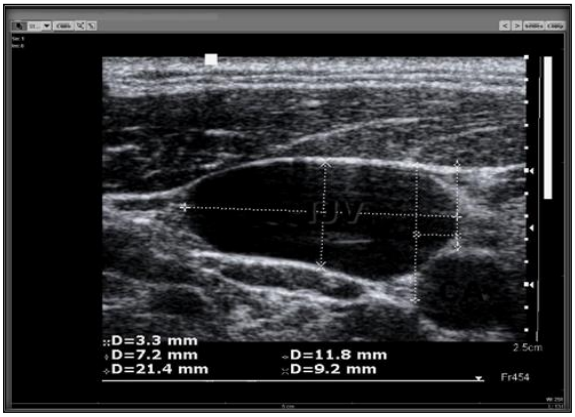

Figure 5: Modified position

Table 1: Correlation of height and sternohyoid distance between position-2 anteroposterior diameter

		AP_2	HT
AP_2	Pearson Correlation	1	-.378*
	Sig. (2-tailed)	.	0.016
	N	40	40
HT	Pearson Correlation	-.378*	1
	Sig. (2-tailed)	0.016	.
	N	40	40
		ST_HY_DI	AP_2
ST_HY_DI	Pearson Correlation	1	-.561**

ISSN (O): 2687-5365; ISSN (P): 2753-6556

	Sig. (2-tailed)	.	0
	N	40	40
AP_2	Pearson Correlation	-.561**	1
	Sig. (2-tailed)	0	.
	N	40	40

Table 2: Correlation of height between position 1 transverse diameter

		HT	TRANS_1
HT	Pearson Correlation	1	-.415**
	Sig. (2-tailed)	.	0.008
	N	40	40
TRANS_1	Pearson Correlation	-.415**	1
	Sig. (2-tailed)	0.008	.
	N	40	40

DISCUSSION

Cannulation of the IJV is commonly performed by using anatomical landmarks. Various techniques and patient positions have been used to access the IJV. If a particular technique and patient position increases the diameter of the IJV, it can be expected to increase the chance of first-pass cannulation. As it has been stated that an increase in the diameter of the IJV increases the chances of first-pass cannulation, we attempted to determine the position at which the IJV has a greater diameter.[1,3,5,6]

Our study revealed that the anteroposterior and transverse diameters of the IJV were significantly increased in position 2 [Figure 5], which is the modified position. In the modified position (position 2), the elimination of the stretch imparted to the IJV, the creation of neck flexion, and the absence of finger palpation could be the primary explanation for why this position results in a greater diameter of the IJV. This increase in diameter should increase the chances of first pass and quick cannulation of the IJV.[1]

The relationship of the IJV with the carotid artery showed that the overlap was greater in the modified position in which the head was slightly turned to the contralateral side. Sulek et al. showed a greater overlap between the IJV and carotid artery when the head was rotated to 80° compared to 0° and 40°.8 However, our study found a greater overlap in position 2, where the head was rotated less than in position 1. The significant increase in the diameter of the IJV at position 2 can explain this phenomenon. Their study did not compare the IJV diameter with overlap. This has been proven by Troianos et al., who stated that vein size was positively correlated with the overlap score in their study. Patients with larger veins tended to have greater scores.[9]

The IJV, anatomically described as lateral to the carotid artery, may increase the incidence of carotid artery puncture during cannulation. A posterolateral approach, puncturing the IJV sideways, is recommended rather than a vertical, perpendicular-to-the-skin approach to avoid this. Troianos et al. suggested that a needle directed towards a vein not overlying the CA has a lower risk of puncturing the CA. If the cannulating needle enters the IJV and aims at the CA, its entry into the IJV may be detected before exiting the lumen. The depth of the IJV from the skin showed a significant difference, but it may not be clinically significant.[9]

Our study initially proposed using a table with a 10° head-down tilt. The additional information we obtained in this study was that the conventional position with a 10-degree head-down tilt resulted in significant discomfort and heaviness of the head. Hence, the head-down tilt was reduced to 5° to reduce discomfort. This must be considered in an actual clinical scenario. The head-down tilt, excessive head rotation, and neck extension can all increase intracranial pressure. This can be dangerous in neurosurgical patients with reduced intracranial compliance. Position 2 can reduce this increase in intracranial pressure by avoiding neck extension and extreme head rotation.[10]

Our study found a negative correlation between the height and anteroposterior diameter of the IJV in the modified and conventional positions and between the sternohyoid distance and anteroposterior diameter in the modified position. However, it is impossible to comment on these inconsistent findings, as studies in different patient populations may yield different results. A study conducted by Schreiber et al. on the effects of prolonged head-down tilt on the internal jugular vein cross-sectional area concluded that the 10-degree head-down tilt manoeuvre in healthy volunteers causes an immediate, significant increase in the cross-sectional area of the right IJV. A longer tilt did not cause a further increase in the internal jugular vein cross-sectional area.[3]

To prevent measurement bias, the first 20 volunteers were placed in the conventional position, then in the modified position, and the next 20 in the modified position, followed by the conventional position. This study used 20 additional volunteers from a pilot study to determine the sample size because of the lack of literature on the topic. The main study was initially planned for patients undergoing open heart surgery. However, technical difficulties led to its being conducted with volunteers in the radiology department under the supervision of a senior anaesthetist and radiologist. Performing a study on a patient population, including cardiovascular and non-cardiovascular patients, may provide more informative results.

Ultrasound guidance has been proven to be superior to landmark-guided cannulation. There is an

ISSN (O): 2687-5365; ISSN (P): 2753-6556

increased success rate, increased rate of first-pass cannulation, fewer attempts, and avoidance of complications in several randomised, controlled studies.[10-12] But in a country like India, where resources are limited, we still have to rely more on the anatomical landmarks for cannulation. This modified position, which increases the diameter of the IJV, could be adopted during internal jugular vein cannulation for greater success, particularly in the absence of ultrasound guidance.

CONCLUSION

The anteroposterior and transverse diameters of the right internal jugular vein were significantly greater in the modified position than in the conventional position. A larger diameter of the internal jugular vein in this modified position can lead to a greater success rate in cannulation of the internal jugular vein. Overlap of the carotid artery by the internal jugular vein was greater in the modified position than in the conventional position. Theoretically, this could result in a higher incidence of carotid artery puncture if care is not taken. No significant, consistent correlation was found between height, weight, neck circumference, sternohyoid distance, and IJV diameter in the population studied.

REFERENCES

1. Parry G. Trendelenburg position, head elevation and a midline position optimise right internal jugular vein diameter. Can J Anaesth 2004;51:379–81. https://doi.org/10.1007/bf03018243.
2. English ICW, Frew RM, Pigott JF, Zaki M. Percutaneous catheterisation of the internal jugular vein. Anaesthesia 1969;24:521–31. https://doi.org/10.1111/j.1365-2044.1969.tb02905.x.
3. Schreiber SJ, Lambert UKW, Doepp F, Valdueza JM. Effects of prolonged head-down tilt on internal jugular vein cross-sectional area. Br J Anaesth 2002;89:769–71. https://doi.org/10.1093/bja/89.5.769.
4. Lieberman JA, Williams KA, Rosenberg AL. Optimal head rotation for internal jugular vein cannulation when relying on external landmarks. Anesth Analg 2004;99:982–8. https://doi.org/10.1213/01.ane.0000132908.77111.ca.
5. Mallory DL, Shawker T, Evans RG, McGee WT, Brenner M, Parker M, et al. Effects of clinical manoeuvres on sonographically determined internal jugular vein size during venous cannulation. Crit Care Med 1990;18:1269–73. https://doi.org/10.1097/00003246-199011000-00017.
6. Verghese ST, Nath A, Zenger D, Patel RI, Kaplan RF, Patel KM. The effects of the simulated Valsalva manoeuvre, liver compression, or Trendelenburg position on the cross-sectional area of the internal jugular vein in infants and young children. Anesth Analg 2002;94:250–4. https://doi.org/10.1097/00000539-200202000-00004.
7. Jonathen B, Mark, Thomas Slaughter F. Cardiovascular monitoring, In Miller's Anesthesia-6th edition, Ronald Miller D eds. Churchill Livingstone: Philadelphia, 2005;1286-1294.
8. Sulek CA, Gravenstein N, Blackshear RH, Weiss L. Head rotation during internal jugular vein cannulation and the risk of carotid artery puncture. Anesth Analg 1996;82:125–8. https://doi.org/10.1097/00000539-199601000-00022.
9. Troianos CA, Kuwik RJ, Pasqual JR, Lim AJ, Odasso DP. Internal jugular vein and carotid artery anatomic relation as determined by ultrasonography. Anesthesiology 1996;85:43–8. https://doi.org/10.1097/00000542-199607000-00007.
10. Schummer W, Schummer C. Patient positioning and ultrasound guidance are important in bilateral cannulation of internal jugular veins. Anesthesiology 2004;100:1624–5. https://doi.org/10.1097/00000542-200406000-00053.
11. Troianos CA, Kuwik RJ. Reply: Ultrasonography as an Aid to Internal Jugular Vein Cannulation: II. Anesthesiology 1996;85:1502-3. https://doi.org/10.1097/00000542-199612000-00048.
12. Denys BG, Uretsky BF, Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein. A prospective comparison to the external landmark-guided technique. Circulation 1993;87:1557–62. https://doi.org/10.1161/01.cir.87.5.1557.

ISSN (O): 2687-5365; ISSN (P): 2753-6556