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Original Article

How reliable is carotid artery guidance for internal jugular vein cannulation?

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Abstract

Aim: Because of the proximity between the common carotid artery (CCA) and internal jugular vein (IJV), determination of carotid localization by palpation has an important role in central vein cannulation (CVC) using the anatomical marking method. Changes in the location of the CCA and IJV may cause complications during CVC. We aimed to demonstrate the anatomical relationship between the CCA and IJV to help reduce the possibility of complications during IJV cannulations by using the anatomical landmarks.
Material and Methods: Images of 79 adult patients who underwent neck CT angiography were retrospectively analyzed from the hospital database. Anatomical relationships, tissue depth and diameters of CCA and IJV were measured and then analyzed from three anatomical segments (second tracheal ring, cricoid cartilage, and superior border of the thyroid cartilage) determined on CT.
Results: A total of 158 IJVs and CCAs from 79 subjects were analyzed. As anticipated, in the majority of cases, the IJV was found lateral to the CCA. (101 out of 158, or 64%). However, in a significant portion of cases (57 out of 158, or 36%), the IJV was not found lateral to the CCA. The location of the IJV relative to the CCA was observed as follows: in 31 cases (20%), it was located anterolaterally; in 19 cases (12%), it was located posterolaterally; and in 7 cases (4%), it was situated directly anteriorly, causing complete overlap.
Conclusion: Variations in the anatomical relationship of the IJV and CCA are not uncommon. Therefore, anatomical landmark-guided cannulation with only CCA palpation may not always provide accurate anatomical guidance. If the first attempt at IJV cannulation with CCA palpation is unsuccessful, anatomical variation should be considered, and instead of repeating attempts, we believe it would be more accurate to proceed with imaging-guided procedures.

Keywords: Central venous catheter, anatomical landmark, internal jugular vein cannulation

INTRODUCTION

Central venous catheterization (CVC) is a frequently used intervention for monitoring of hemodynamic parameters, rapid therapeutic treatment and administration of phlebotoxic drugs in intensive care and perioperative patients [1]. The internal jugular vein (IJV) is a commonly preferred vein for CVC. In clinical practice, the anatomical landmark is the most used method to locate and cannulate the IJV [2]. Anatomical landmark techniques include anterior, central, and posterior approaches. In the frequently used central approach, the Sedillot triangle [3] is the anatomical landmark formed by the medially, the sternal head of the sternocleidomastoid; laterally, the head of the clavicle; and inferiorly, the superior border of the middle third of the clavicle. (Figure 1).

However, in many cases, the borders of the Sedilot triangle are not visible due to factors such as advanced age, obesity, and short neck. In this case, palpation of the carotid artery becomes the primary anatomical reference point for the procedure. [3,4]. Generally, the IJV is positioned lateral to the common carotid artery (CCA), however, in some anatomical variations, the IJV may be located anterior, anterolateral, or posterolateral to the CCA [5,6]. For this reason, the success rate of catheterization

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with the anatomical landmark method decreases to 55% and the complication rate due to puncture increases to 16.9% [7,8]. Although ultrasonography (USG) assisted IJV cannulation has been reported to increase success rates and decrease complication rates, portable USG equipment is still not commonly used, particularly in emergencies or bedside interventions [9]. Therefore, knowing the exact anatomical variations between IJV and CCA will contribute to the prevention of possible complications.

This study aimed to demonstrate the anatomical relationship between the IJV and the CCA in order to minimize the risk of complications during IJV cannulation using the anatomical landmark technique.

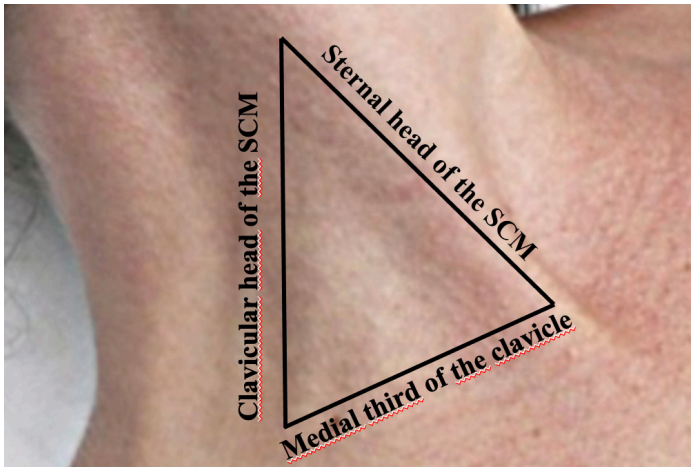

Figure 1. Anatomic boarders of Sedillot triangle

MATERIAL AND METHODS

Approval for this retrospective cross-sectional study was obtained from the Local Ethics Committee in accordance with the principles of the Declaration of Helsinki (2025/14). Images of all adult patients who underwent contrast-enhanced neck computed tomography angiography between September 2020 and January 2025 were analyzed retrospectively from the hospital database. The radiological measurements in the study were performed by the radiologists of our institution. Contrast enhanced CT Images of 112 patients were retrospectively analyzed. 33 patients with head and neck mass, goiter, lymphadenopathy or superior vena cava syndrome were excluded from the study. Demographic data such as age and gender of the cases who met the study criteria were recorded. This study investigated the distances of the IJV and CCA to the skin, their diameters, their anatomical relationship to each other, and the differences observed between male and female subjects.

The patient images were acquired using a 64-slice CT device (GE Optima CT 660) at a speed of 0.5 seconds, in soft tissue algorithm, with a helical scan type with a slice thickness of 5 mm. 1 mg/kg intravenous iodinated contrast agent was given as a bolus to the supine patient. Images obtained by axial scanning, parallel to the infraorbital-meatal line of the region from the skull base level to the thoracic inlet, in a neutral head position and without a support pillow were examined. The Sectra IDS 7 PACS (Sectra AB, Linköping, SWEDEN) was used to view and evaluate images. Using computer-assisted scales, all measurements were made in three segments: second tracheal ring, cricoid cartilage, and superior border of the thyroid cartilage.

The vertical length between the skin and the most anterior point of the IJV and CCA was measured as the distance to the skin. The longest diameters of the IJV and CCA at the measuring points were recorded. The center points of both vessels were found with the intersection point of the lines drawn on the longest vertical and horizontal axes of IJV and CCA. A line was drawn from the center point of the CCA to the center point of the IVJ. Using the angle of this line, as shown in Figure 2, the position of the IJV to the CCA was determined and recorded as anterior, anterolateral, lateral and posterolateral.

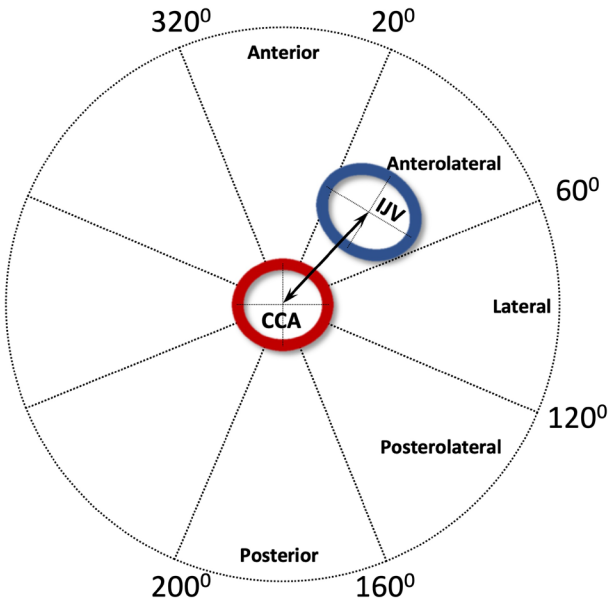

Figure 2. Definition of anatomical positions of the internal jugular vein (IJV) relative to the common carotid artery (CCA)

Statistical Analysis

Statistical analysis was conducted using SPSS (Statistical Program in Social Sciences, version 25.0, IBM Corp., Armonk, NY, USA) software for Windows. Normality tests were performed to determine the appropriate statistical methods, parametric or non-parametric. The normality of the variables was checked using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Homogeneity of variance was also assessed. While frequencies and percentages were calculated for qualitative data, mean and standard deviation values were calculated for quantitative data. Categorical variables were evaluated using the Chi-square test. The Mann-Whitney U test and unpaired Student's T test were used to compare continuous variables. A p value of 0.05 or less was considered to be statistically significant.

RESULTS

A total of 158 IJVs and CCAs from 79 subjects were analyzed. 51 of the cases were male and 28 were female. The mean age was 53.24±17.16 years.

The point where the IJV is closest to the skin was on the thyroid cartilage, and it was observed that the distance of the IJV to the skin increased in more proximal measurements. The distance of the IJV to the skin was measured as 10 mm at the closest and 34 mm at the farthest. The distance of the IJV over the thyroid cartilage to the skin was 18.7±7.1 mm on the left and 18.3±7.1 mm on the right. Table 1 shows detailed measurements of the distance of the IJV and CCA to the skin. There was no significant difference between gender and side in terms of the distance of the IJV to the skin (Table 2).

Table 1. Distance to skin and diameter measurements of IJV and CCA

		Upper border of the thyroid cartilage			Cricoid cartilage			Second tracheal ring		
n=79		Left	Right	p	Left	Right	p	Left	Right	p
Distance to skin (mean±SD)	IJV	18.7±7.1	18.3 ±7.1	0.719	18.8 ±6.5	18.1± 6.9	0.530	20.1±7.9	18.8±7.4	0.309
	CCA	26.6 ±8.6	25.9±8.2	0.644	26.3±8.1	26.1 ±8.2	0.800	27.2±8.5	26.5 ±7.9	0.596
Diameter (mean±SD)	IJV	15.1±4.1	17.6 ±5.8	0.001	15.2±3.4	17.7 ±5.4	0.001	15.5±3.2	18.3±6.4	0.001
	CCA	10.4±2.9	10.5±2.9	0.829	10.5±2.8	10.6±2.8	0.866	10.5±2.9	10.6 ±2.8	0.888

Table 2. Relationship between IJV, CCA and skin according to gender (mean±SD)

	Distance between IJV and skin (mm)			
Measurement level	Male (n=51)		Female (n=28)	
	Left	Right	Left	Right
Upper border of the thyroid cartilage	18.5±7.2	18.2±7.3	18.9±7.1	18.5±6.8
Cricoid cartilage	18.9±6.2	18.1±7.1	18.6±6.9	18.1±6.8
Second tracheal ring	19.9±6.8	18.9±7.6	20.2±9.8	18.5±7.4
No significant difference between gender and side in terms of the distance of the IJV to the skin p>0.05				
	Distance between CCA and skin (mm)			
Upper border of the thyroid cartilage	27.3±9.2	26.5±8.5	25.3±7.3	25.1±7.8
Cricoid cartilage	27.3±8.4	26.8±8.5	24.5±7.2	24.6±7.8
Second tracheal ring	28.1±9.3	27.1±8.5	25.6± 6.8	25.5±6.9
No significant difference between gender and side in terms of the distance of the CCA to the skin p>0.05				

IJV diameters were measured as 15.1±4.1 mm, 15.2±3.4 mm, and 15.5±3.2 mm on the left side, and 17.6±5.8 mm, 17.7±5.4mm, and 18.3±6.4mm on the right side, respectively. IJV diameter was significantly larger on the right side (p<0.001), however, no difference was found between CCA diameters (p=0.888), (Table 1). Although IJV and CCA diameters were measured larger in males at all measurement points, no significant difference was found in terms of gender (p>0.05). Table 3 shows IJV and CCA diameter measurements according to gender.

Table 3. The diameters of IJV and CCA according to gender, (mean ± SD).

	The diameter of IJV (mm)			
	Male (n=51)		Female (n=28)	
	Left	Right	Left	Right
Upper border of the thyroid cartilage	15.5±4.3	17.8±5.8	14.1±3.3	17.3±5.8
Cricoid cartilage	15.7±3.4	18.1±5.3	14.3±3.3	17.3±5.6
Second tracheal ring	15.9±3.3	18.8±7.1	14.9±3.1	17.5±5.2
	The diameter of CCA (mm)			
Upper border of the thyroid cartilage	10.5±2.9	10.5±2.9	10.2±3.1	10.5±2.9
Cricoid cartilage	10.5±2.9	10.5±2.9	10.6±2.8	10.8±2.7
Second tracheal ring	10.5±2.9	10.5±2.9	10.6±2.9	10.9±2.5

Considering the position of the IJV relative to the CCA, it was seen that the IJV was located lateral to the CCA (101/158, 64%), as expected in most of the cases. However, IJV was anterior to the CCA in 7 (4%) cases, and the IJV completely overlapped with the CCA. In 31 (20%) cases, the IJV was located anterolateral to the CCA. In 19 other cases, the IJV was located posterolateral to the CCA. There was no significant difference between the right and left side positions (Table 4, Figure 3). Likewise, there was no difference in terms of gender.

Table 4. Anatomic relation of internal jugular vein relative to common carotid artery

	Left n (%)	Right n (%)	Total n (%)
Anterior	4 (5)	3 (4)	7 (4)
Anterolateral	18 (23)	13 (16)	31 (20)
Lateral	47 (59)	54 (69)	101 (64)
Posterolateral	10 (13)	9 (11)	19 (12)
Total	79 (100)	79 (100)	158

No significant difference between the right and left side positions of IJV relative to CCA (P=0.69)

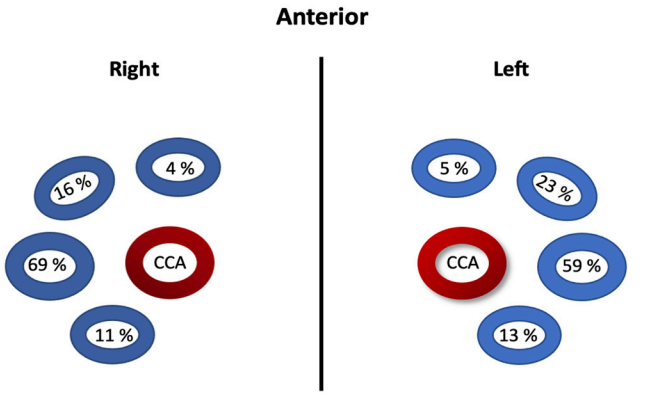

Figure 3. Position of the internal jugular vein relative to the common carotid artery

DISCUSSION

The most important finding of our study is the determination of the positioning of the IJV to the CCA. The presence of the IJV anterior to the CCA increases the risk of possible complications in the traditional anatomical method. In our study, it was found that IJV was located in the anterior of the CCA in 20% of the right and 28% of the left. In other words, in only 69% of cases, the IJV was located lateral to the CCA as expected. Umana M et al. [10] found this rate to be 30.7% on the right and 41.1% on the left. Furthermore, they reported that with the head turned 30 degrees to the opposite side while determining the Sedillot triangle, the anterior location of the IJV increased further, reaching 37.3% on the right and 46.6% on the left. These findings suggest that CCA palpation is not a very reliable anatomical marker for finding IJV. Although there was no statistical difference, it was observed that the IJV was smaller in diameter and more anteriorly located on the left side. In daily practice, when right side IJV catheterization is not successful, it is switched to the left side. However, in this case, it should be kept in mind that the left IJV is relatively smaller and more often anteriorly located.

The most common complications associated with IJV cannulation are arterial puncture and pneumothorax [11]. Especially in patients with pulmonary emphysema and COPD, advancing the needle deeply may cause lung perforation and pneumothorax [12]. In our study, the distances of the IJV and CCA to the skin were measured and the longest distance was found to be 34 mm and 45 mm for the IJV and CCA, respectively. Knowing this distance gives an idea of how deep the needle tip can be safely advanced to avoid potential complications during catheterization.

IJV is used not only for catheterization, but also for cannulation during heart surgeries and ECMO cannulation. Knowing these diameters is important for selecting the correct diameter of catheter. Qin XH et al. [13] reported that IJV diameters at the level of the second tracheal ring in the Chinese population were 10.1±2.4 mm on the left and 11.8±2.7 mm on the right. In our study, we found the results as 15.5±3.2 mm on the left and 18.3±6.4 mm on the right at the same level in the Turkish population. This finding shows that vessel diameters may differ between populations.

The study has potential limitations. The first of these is the relatively small number of cases in our study. Larger population studies will provide more precise information. Another issue is that although USG is used as an imaging method in similar studies, our use of CT for measurements can be considered as a limitation. Most of the obtained data could have also been acquired through ultrasonography. However, given the retrospective nature of the study, we consider CT to be more appropriate to minimize the influence of the operator factor.

CONCLUSION

In conclusion, variations in the anatomical relationship of the IJV and CCA are not uncommon. Therefore, anatomical landmark-guided cannulation with only CCA palpation may not always provide accurate anatomical guidance. If the first attempt at IJV cannulation with CCA palpation is unsuccessful, anatomical variation should be considered, and instead of repeating attempts, we believe it would be more accurate to proceed with imaging-guided procedures.

Ethics Committee Approval: Approval for this retrospective cross-sectional study was obtained from the Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee (Date And Number: 26/2025-622426) in accordance with the principles of the Declaration of Helsinki.

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REFERENCES

1. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. Cochrane Database Syst Rev. 2015;1:CD006962.
2. Shoja MM, Ardalan MR, Tubbs RS, Loukas M, Vahedinia S, Jabbary R, Jalilvand M, Shakeri A. The relationship between the internal jugular vein and common carotid artery in the carotid sheath: the effects of age, gender and side. Ann Anat. 2008;190:339-43.
3. Turba UC, Uflacker R, Hannegan C, Selby JB. Anatomic relationship of the internal jugular vein and the common carotid artery applied to percutaneous transjugular procedures. Cardiovasc Intervent Radiol. 2005;28:303-6.
4. Asouhidou I, Natsis K, Asteri T, Sountoulides P, Vlasis K, Tsikaras P. Anatomical variation of left internal jugular vein: clinical significance for an anaesthesiologist. Eur J Anaesthesiol. 2008;25:314-8.
5. Dolla D, Cavatorta F, Galli S, Zollo A, Ervo S. Anatomical variations of the internal jugular vein in non-uremic outpatients. J Vasc Access. 2001;2:60-3.
6. Katrancioglu N. Unusual mechanical complications of central venous catheterization. Saudi Med J. 2019;40:287-91.
7. Mehta N, Valesky WW, Guy A, Sinert R. Systematic review: is real-time ultrasonic-guided central line placement by ED physicians more successful than the traditional landmark approach?. Emerg Med J. 2013;30:355-9.
8. Leung J, Duffy M, Finckh A. Real-time ultrasonographically-guided internal jugular vein catheterization in the emergency department increases success rates and reduces complications: a randomized, prospective study. Ann Emerg Med. 2006;48:540-7.
9. Troianos CA, Hartman GS, Glas KE, Skubas NJ, Eberhardt RT, Walker JD, Reeves ST; Councils on Intraoperative Echocardiography and Vascular Ultrasound of the American Society of Echocardiography; Society of Cardiovascular Anesthesiologists. Special articles: guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. Anesth Analg. 2012;114:46-72.
10. Umana M, García A, Bustamante L, Castillo JL, Sebastián Martínez J. Variations in the anatomical relationship between the common carotid artery and the internal jugular vein: an ultrasonographic study. Colomb Med (Cali). 2015;46:54-9.
11. Brescia F, Pittiruti M, Ostroff M, Spencer TR, Dawson RB. The SIC protocol: a seven-step strategy to minimize complications potentially related to the insertion of centrally inserted central catheters. J Vasc Access. 2023;24:185-90.
12. Rabadi DK, Abubaker AK, Almasarweh SA. Lung deflation while placing a subclavian vein catheter: our experience in minimizing the risk of pneumothorax. PLoS One. 2023;18:e0281300.
13. Qin XH, Zhang H, Mi WD. Anatomic relationship of the internal jugular vein and the common carotid artery in Chinese people. Chin Med J (Engl). 2010;123:3226-30.