Original Article

Assessment of the Internal Jugular Vein Position in Relation to the Common Carotid Artery in Neutral and Rotated Head Positions: A Cadaveric Observational Study

Meenakshi Parathasarathy[1], Sowmya S[2], Kotakonda Priyanka[3]

[1]Professor and Head, Department of Anatomy, SABVMCRI, Bengaluru, Karnataka, India. [2]Associate Professor, Department of Anatomy, SABVMCRI, Bengaluru, Karnataka, India. [3]Tutor, Department of Anatomy, SABVMCRI, Bengaluru, Karnataka, India

Abstract

Background: The anatomical relationship between the Internal Jugular Vein (IJV) and the Common Carotid Artery (CCA) is highly variable. This variability complicates the use of anatomical landmarks and head rotation for IJV cannulation, increasing the risk of accidental arterial puncture. The aim is to anatomical changing relationship between the IJV and CCA in cadavers in the neutral and head rotation positions. **Material and Methods:** An observational study was conducted on 50 cadavers. The position of the IJV in relation to the CCA at the level of the cricoid cartilage was recorded using a clock-face reference pertaining (segments 1–12) in three head positions: neutral, 15° contralateral rotations, and 45° contralateral rotations. Observations were made on both sides of the neck and statistics were calculated. **Results:** In the neutral head position, the internal jugular vein (IJV) lay predominantly lateral to the common carotid artery (CCA) (52% right, 74% left), with anterior and medial relations being less frequent. At 15° contralateral rotation, anterior positioning became more common (46% right, 52% left), with a notable rise in medial relations, especially on the left (40%). At 45° rotation, the IJV predominantly shifted medially (72% right, 64% left), while lateral positioning became least common. Overall, the IJV showed a progressive medial displacement relative to the CCA with increasing contralateral head rotation. **Conclusion:** The study demonstrates significant anatomical variation in the position of the IJV relative to the CCA. Excessive head rotation markedly increases IJV-CCA overlap, thereby elevating the risk of inadvertent arterial puncture—even with ultrasound guidance. To minimize this risk, IJV cannulation should be performed with the head and neck in a neutral or near-neutral position.

Keywords: Common Carotid Artery (CCA); Internal Jugular Vein (IJV); anatomical variation; head rotation; central venous cannulation.

Received: 30 September 2025 **Revised: 25 August 2025** **Accepted: 03 September 2025** **Published: 20 December 2025**

Introduction

The internal jugular vein (IJV) is frequently used for central venous access and typically courses within the carotid sheath in relation to the common carotid artery (CCA). While the IJV most often lies lateral or anterolateral to the CCA, considerable anatomical variation exists, with some studies reporting over half of patients demonstrating significant overlap of the IJV over the carotid artery. This variability increases the risk of inadvertent arterial puncture, especially when using landmark-based techniques.[1]

Numerous ultrasound-based investigations have explored how head rotation affects this relationship. For instance, head rotation from neutral to 45° significantly increases overlap of the IJV over the CCA—up to approximately 72% overlap in some studies—suggesting substantial positional changes as the head turns.[2] Similarly, rotation results in increased anteromedial positioning of the IJV relative to the CCA, particularly pronounced on the left side.[3] Prospective observational studies have demonstrated that even modest (15°) rotation yields a marked increase in overlap, with nearly all subjects showing overlap at 45°.[4] Corroborating these findings, Izumi et al. reported that overlap significantly increases at rotations ≥ 45° at 2 cm above the clavicle and ≥ 30° at 4 cm above the clavicle, limiting the safety margin for blind cannulation.[5]

Despite robust ultrasonographic data, cadaveric studies examining IJV–CCA positional dynamics across various degrees of head rotation remain sparse. Given that cadaveric anatomy can reflect subtle anatomical nuances often obscured in live subjects (e.g., compressibility, vessel collapse), there is value in this approach. Therefore, the present cadaveric observational study aims to map the relative positions of the IJV and CCA in neutral and rotated head postures systematically, thereby informing safer cannulation practices rooted in anatomical precision.

Aims and Objectives

The present cadaveric observational study aims to evaluate the

Address for correspondence: Dr. Kotakonda Priyanka, Tutor, Department of Anatomy, SABVMCRI, Bengaluru, Karnataka, India
E-mail: priyankaroyal225@gmail.com

DOI:
10.21276/amit.2025.v12.i3.259

How to cite this article: Parathasarathy M, Sowmya S, Priyanka K. Assessment of the Internal Jugular Vein Position in Relation to the Common Carotid Artery in Neutral and Rotated Head Positions: A Cadaveric Observational Study. Acta Med Int. 2025;12(3):1218-1222.

anatomical relationship of the internal jugular vein (IJV) to the common carotid artery (CCA) in neutral and rotated head positions.

Specifically, the objectives are to identify the positional variations of the IJV relative to the CCA, to assess the changes in its orientation with incremental contralateral head rotation, and to determine the pattern and frequency of lateral, anterior, and medial relationships. By systematically documenting these positional changes in cadavers, the study seeks to provide anatomical evidence that can enhance understanding of IJV variability, highlight potential risks during landmark-based central venous cannulation, and contribute to safer clinical practice.

Materials and Methods

Study Design:

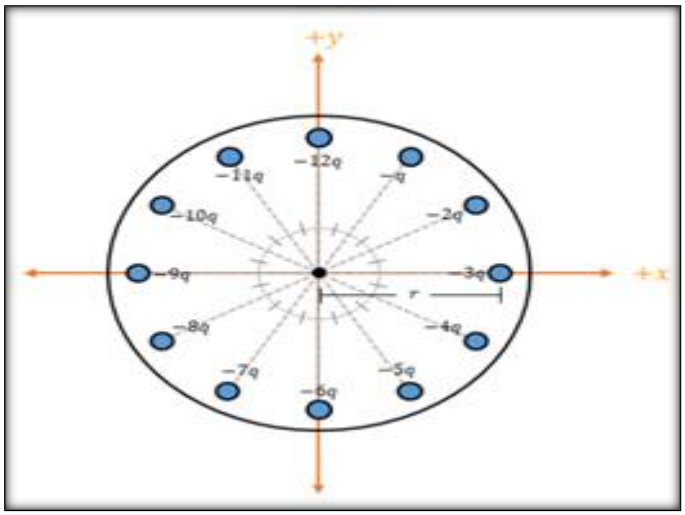
This observational, descriptive cadaveric study was conducted in the Department of Anatomy at SABVMCRI on 50 fresh adult human cadavers, yielding a total of 100 neck sides (50 right and 50 left) for examination. Cadavers with burns, external damage, or those below 15 years of age were excluded, while specimens with thin stature were preferred to facilitate clear anatomical visualization. The study systematically assessed the positional relationship of the internal jugular vein (IJV) to the common carotid artery (CCA) in both neutral and rotated head positions, ensuring that only cadavers without prior neck surgery or deformity were included to maintain anatomical accuracy.

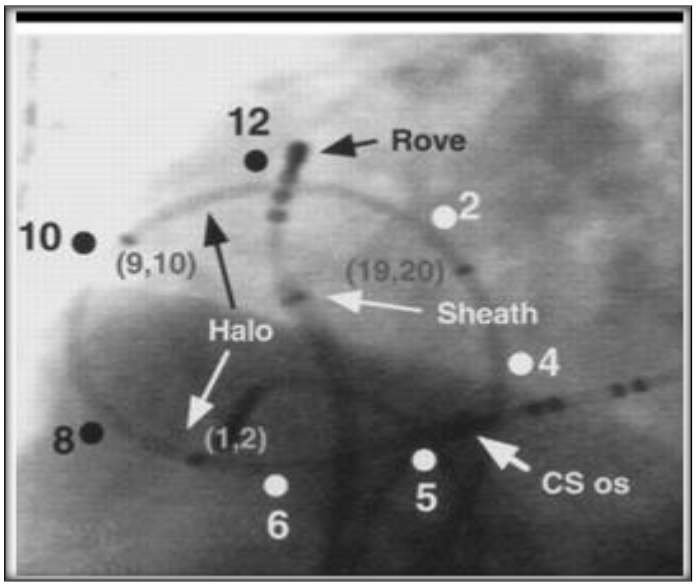
Inclusion and exclusion Criteria

The study included 50 fresh adult human cadavers with well-preserved neck regions, and cadavers with thin stature were preferred to facilitate better anatomical visualization of vascular structures. Cadavers with visible neck deformities, external damage, or burns, as well as those with a history of prior neck surgery, were excluded to avoid distortion of normal anatomical relationships. In addition, specimens below 15 years of age were not considered, as the study focused on adult anatomical patterns of the internal jugular vein in relation to the common carotid artery.

Data Collection Procedure

Dissection was carried out at the level of the cricoid cartilage to expose the internal jugular vein (IJV) and the common carotid artery (CCA), as this level provides consistent anatomical landmarks for evaluating vascular relationships.[1,6] The relative position of the center of the IJV to the center of the CCA was recorded using a clock-face reference system, where 12 o'clock corresponded to a medial position, 3 o'clock to anterior, and 6 o'clock to lateral alignment.[7] Measurements were taken in three standardized head positions—neutral, 15° contralateral rotation, and 45° contralateral rotation—since head rotation is known to significantly influence the spatial relationship between these vessels.[2,5] Observations were carefully documented for both right and left sides independently to capture side-specific variations, which have been highlighted in earlier anatomical and ultrasonographic studies.[8]





Statistical analysis: The degree of overlap between the internal jugular vein (IJV) and the common carotid artery (CCA) in

different head positions was analyzed using the Chi-square test to compare categorical variables. The test was applied to assess the association between head rotation angles (neutral, 15°, and 45° contralateral rotation) and the frequency of IJV-CCA overlap observed on both right and left sides. A p-value of less than 0.05 was considered statistically significant for all comparisons, indicating that differences in overlap patterns across head positions which were unlikely to have occurred by chance.

Results

Table 1: Head Position- straight, Right Side – IJV related to CCA. Left Side – IJV related to Left Side – IJV-related to CCA

S.I No	Head Position	Right side-IJV related to CCA			Left side –IJV related to left side – IJV related to CCA		
		9 o clock Lateral	12 o clock Anterior	3 o clock Medial	9 o clock Lateral	12 o clock Anterior	3 o clock Medial
1	Neutral	26/50 52%	23/50 46%	1/50 2%	37/50 74%	12/50 24%	1/50 0.5%
2	15 o Contralateral Rotation	15/50 30%	23/50 46%	12/50 24%	4/50 8%	26/50 52%	20/50 40%
3	45 o Contralateral Rotation	3/50 6%	11/50 22%	36/50 72%	6/50 12%	12/50 24%	32/50 64%

On the right side, the distribution of IJV positions relative to the CCA varied significantly across neutral, 15°, and 45° contralateral head positions ($\chi^2 = 62.32$, $p < 0.001$).

On the left side, a similarly significant association was observed between head position and IJV orientation ($\chi^2 = 79.20$, $p < 0.001$).

These results confirm that increasing contralateral head rotation leads to a statistically significant medial shift of the IJV relative to the CCA on both sides.

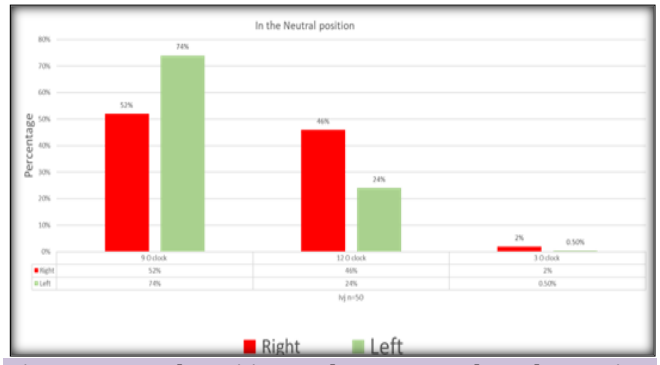


Figure 1: Head Position-15-degree contralateral Rotation, Right Side – IJV related to CCA, Left Side – IJV related to Left Side – IJV-reiated to CCA

Figure 2: Head Position-45-degree contralateral Rotation, Right Side – IJV related to Camlet Side – IJV related to Left Side – IJV-reiated to CCA

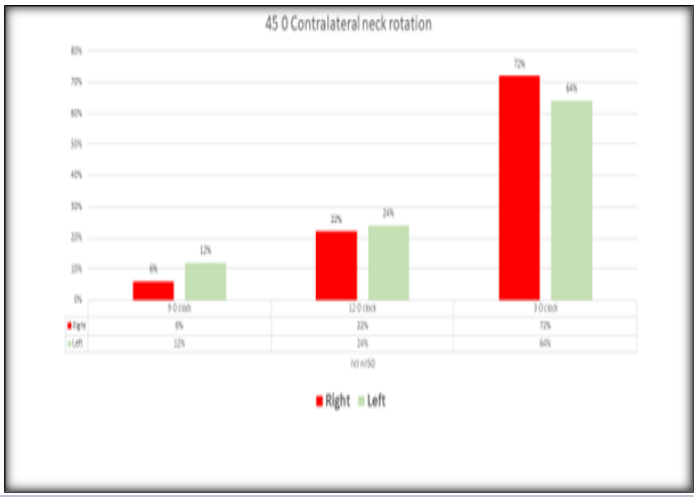


Figure 3: Effect of 45° Contralateral Neck Rotation on Right and Left Sides

IJV -12 O CLOCK POSITION- 15 0 Contralateral position

IJV -3 O CLOCK POSITION- 45 0 Contralateral position

Discussion

Our cadaveric study demonstrated a progressive medial displacement of the internal jugular vein (IJV) relative to the common carotid artery (CCA) with increasing contralateral head rotation. At neutral position, the IJV was lateral in 52% (right) and 74% (left) of cases, shifting to medial in 72% (right) and 64% (left) at 45° rotation. These findings align well with ultrasonographic observations in live subjects, reaffirming this as a clinically relevant effect.

Troianos et al. reported that greater head rotation significantly increases IJV–CCA overlap, thereby raising the risk of carotid puncture during cannulation.[9] Similarly, Sulek et al. demonstrated that head rotation ≥40° markedly increased the likelihood of IJV lying anterior to the CCA, thus heightening the risk of arterial puncture.[10] These clinical observations support our cadaveric findings of increased medial positioning with progressive head rotation.

Miki et al. conducted an ultrasonographic study and observed that head rotation ≥45° resulted in a significant medial shift and overlap of the IJV over the CCA, both near the clavicle and more cranially.[5] This closely parallels our findings, which documented maximal medial displacement at 45° contralateral rotation. Likewise, Wang et al. noted that even 15° of head rotation altered the IJV–CCA relationship, though extreme overlap was more pronounced at 45°.[2]

Real-world procedural studies echo these anatomical insights: a randomized trial by Lamperti et al. found no difference in complication rates between neutral and 45° rotated head positions during ultrasound-guided cannulation, suggesting that a neutral position may be safer when overlap is identified beforehand.[11] Feller-Kopman recommended using ultrasound to assess vessel overlap before needle insertion, adjusting head position accordingly to optimize safety.[12]

Our findings corroborate this trend, emphasizing that rotation reduces the safety margin for landmark-based cannulation.

Compared to ultrasonographic studies, which quantify overlap, our cadaveric study adds precision by documenting IJV position using a clock-face reference system. This anatomical perspective eliminates confounders such as vessel compressibility or probe pressure, underscoring the inherent anatomical risk associated with excessive head rotation. Collectively, these findings reinforce prior recommendations to maintain a neutral or near-neutral head position during IJV cannulation to minimize overlap and avoid arterial injury.[9,10]

Unique to our cadaveric analysis, we used a precise clock-face reference to document the IJV–CCA relationship, which avoids confounders like probe pressure or vessel compressibility inherent in live studies. This anatomical clarity supports the growing emphasis on real-time ultrasound assessment prior to cannulation and underscores that minimizing head rotation reduces overlap and enhances procedural safety.

Conclusion

Excessive head rotation during IJV cannulation significantly increases the overlap of the IJV over the CCA, thereby increasing the risk of arterial puncture. Performing the procedure with the head and neck in a neutral or near-neutral position is advisable to enhance safety.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Denys BG, Uretsky BF. Anatomical variations of internal jugular vein location: impact on central venous access. Crit Care Med. 1991;19(12):1516-9.
2. Wang R, Snoey ER, Clements RC, Hern HG, Price D. Effect of head rotation on vascular anatomy of the neck: an ultrasound study. J Emerg Med. 2006;31(3):283-6.
3. Maecken T, Marcon C, Bomas S, Zenz M, Grau T. Relationship of the internal jugular vein to the common carotid artery: implications for ultrasound-guided vascular access. Eur J Anaesthesiol. 2011 May;28(5):351-5. doi: 10.1097/EJA.0b013e328341a492. PMID: 21150630.
4. Purohit G, Setlur R, Dhar M, Bhasin S. Assessment of head and neck position for optimal ultrasonographic visualisation of the internal jugular vein and its relation to the common carotid artery: A prospective observational study. J Anaesthesiol Clin Pharmacol. 2020 Jan-Mar;36(1):62-65. doi: 10.4103/joacp.JOACP_330_18. Epub 2020 Feb 18. PMID: 32174660; PMCID: PMC7047683.
5. Miki I, Murata S, Nakazawa K, et al. Anatomical relationship between the common carotid artery and the internal jugular vein during head rotation. J Ultrason. 2014;22(2):99-103.
6. Lorchirachoonkul T, Ti LK, Manohara S, Lye ST, Tan SA, Shen L, Kang SC. Anatomical variations of the internal jugular vein: implications for successful cannulation and risk of carotid artery puncture. Singapore medical journal. 2012 May 1;53(5):325.
7. Umaña M, Castillo JL, Bustamante L, Martínez JS. Variations in the

anatomical relationship between the common carotid artery and the internal jugular vein: An ultrasonographic study. Colomb Med (Cali). 2015;46(2):54-9.
8. Hong JY, Koo BN, Kim WO, Choi E, Kil HK. Effect of head rotation on overlap and relative position of internal jugular vein to carotid artery in infants and children: a study of the anatomy using ultrasonography. J Crit Care. 2010;25(2):360.e9-13.
9. Troianos CA, Jobes DR, Ellison N. Ultrasound-guided cannulation of the internal jugular vein: a prospective, randomized study. Anesth Analg. 1991;72(6):823–6.
10. Sulek CA, Blas ML, Lobato EB. A randomized study of head rotation and position for internal jugular vein cannulation. Anesth Analg. 1996;82(1):125–8.
11. Lamperti M, Subert M, Cortellazzi P, Vailati D, Borrelli P, Montomoli C, D'Onofrio G, Caldiroli D. Is a neutral head position safer than 45-degree neck rotation during ultrasound-guided internal jugular vein cannulation? Results of a randomized controlled clinical trial. Anesth Analg. 2012 Apr;114(4):777-84. doi: 10.1213/ANE.0b013e3182459917. Epub 2012 Jan 17. PMID: 22253269.
12. Kara I, Apiliogullari S, Duman A, Celik JB. Seeing Is Believing: Ultrasound Guided Internal Jugular Vein Cannulation. Anesth Analg. 2012 Dec;115(6):1471-2.