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Original Article

Anatomy Section

Anatomical Correlation Between the External Diameters of the Internal Jugular Vein and the Common Carotid Artery: A Cross-sectional Study

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ABSTRACT

Introduction: The Internal Jugular Vein (IJV) and the Common Carotid Artery (CCA) are vital vascular structures in the neck, frequently encountered during diagnostic and interventional procedures. While their physiological interdependence is well established, evidence on the morphometric correlation between their external diameter is limited. Most earlier studies are imaging-based, and there remains limited cadaveric evidence correlating their external vessel diameters.

Aim: To assess the correlation between the external diameters of IJV and CCA.

Materials and Methods: This cross-sectional cadaveric study was conducted in the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India, from June 2011 to Jan 2013, on 50 embalmed adult cadavers (100 sides). Measurements were taken at the level of the arch of the cricoid cartilage using a sliding vernier calliper. Data were analysed to compare right- and left-sided differences, categorise vessel sizes, and assess associations between the external diameters of the IJV and CCA. Parameters evaluated included the external diameters of the right and left IJV and CCA, side differences, vessel size categories, and inter-vessel correlations. All readings were made by a single observer to avoid inter-observer variability, and statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 20.0 with paired t-test, Chi-square test, and Pearson's correlation coefficient (p-value <0.05 considered significant).

Results: Significant differences were observed between the mean diameters of the IJV and CCA on both right and left sides. The mean external diameter of the right IJV was 12.94±2.85 mm and that of the right CCA was 8.92±1.45 mm (p-value <0.001); on the left, the IJV measured 11.33±2.60 mm and the CCA 8.51±1.37 mm (p-value <0.001). Categorisation revealed that 40% of large CCAs were associated with large IJVs, while 35% of small CCAs corresponded with small IJVs. Overall, statistical analysis demonstrated a modest yet statistically significant positive correlation between the external diameters of the IJV and CCA (r-value=0.278, p-value=0.005). Paired t-test, Chi-square test, and Pearson's correlation were applied, with p-value <0.05 considered statistically significant.

Conclusion: This study demonstrates a weak positive correlation between the external diameters of the IJV and CCA, providing anatomical support for previous imaging-based observations. Recognising this morphometric relationship enhances anatomical understanding and may offer a supportive context for vascular imaging, central venous access, and surgical planning; however, the findings should be interpreted with caution.

Keywords: Cadaver, Dissection, Morphology, Neck, Variation

INTRODUCTION

The IJV is a major vessel in the neck that drains blood from the brain, face, and neck. The CCA is a major vessel in the neck that supplies blood to the head and neck. It typically bifurcates into the internal and external carotid arteries at the level of the upper border of the thyroid cartilage (approximately the C4 vertebra). The IJV typically runs lateral to the common carotid artery and receives several tributaries [1]. Their close anatomical relationship makes them key landmarks for diagnostic imaging, surgical approaches, and vascular access procedures. Recent studies [2-4] have improved the understanding of IJV anatomy and its clinical significance. Advances in imaging and technology-based assessment have enhanced the accuracy of venous evaluation [5,6].

Measuring the external diameters of the vein and artery minimises the influence of physiological variations, such as pressure or posture, and yields more consistent and reproducible morphometric data [7].

Most previous studies [8-12] have used ultrasound or imaging to describe the size and position of the IJV and CCA. However, there is very little cadaver-based data [13] showing a direct anatomical correlation between the two. This study helps fill that gap by providing stable morphometric measurements that support and complement imaging findings, offering a clearer anatomical basis for clinical practice. Hence, the present study aimed to assess whether a correlation exists between the external diameters of the IJV and the CCA. Based on their close anatomical relationship, it was hypothesised that the two vessels would show a measurable association that may have clinical relevance during vascular access procedures.

MATERIALS AND METHODS

This cross-sectional cadaveric study was conducted in the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India. The study was conducted from June 2011 to Jan 2013 in accordance with Institutional guidelines for cadaveric research, following standard ethical practices.

Inclusion criteria:

- Adult cadavers irrespective of gender.
- Intact bilateral cervical regions, including the termination of the IJV.

Exclusion criteria:

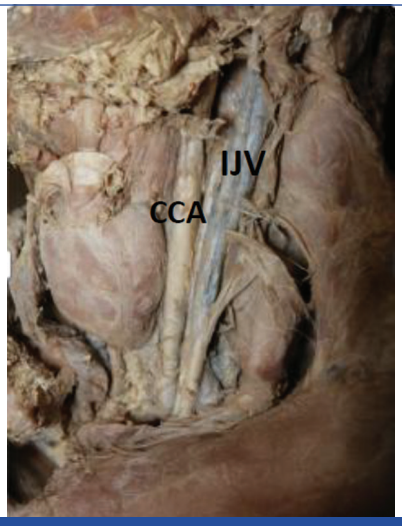
- Mutilated cervical regions as a result of injury.
- Disrupted cervical region structures associated with any pathology or following surgery.

Sample size: The study included 50 embalmed adult human cadavers, constituting 100 sides (50 right and 50 left sides of the neck). The sample size was based on the availability of cadavers fulfilling inclusion criteria during the study period, representing the Indian adult population.

Study Procedure

Gross dissection was performed according to Cunningham's Manual of Practical Anatomy. The anterior triangle of the neck was exposed, and fat and fascia were carefully removed in the carotid triangle to identify the carotid sheath. The superficial layer of the fascial sheath enclosing the IJV, CCA, and vagus nerve was excised to visualise these structures clearly.

The external diameters of the IJV and CCA were measured using a sliding calliper with Vernier attachment at the level of the arch of cricoid cartilage [Table/Fig-1]. Measurements were taken at this level because of its high anatomical and clinical relevance, especially during central venous cannulation and neck vascular procedures, making it a reliable and reproducible landmark [4,6].



[Table/Fig-1]: Dissection photograph showing the Internal Jugular Vein (IJV) and Common Carotid Artery (CCA) in the neck.

The measurements were taken with the cadavers placed horizontally on the table, ensuring that the vessels and their tributaries remained in-situ without displacement. The external diameters of the IJV and CCA were classified into small, intermediate, and large categories based on the statistical distribution of values (values < mean-SD as small, values between mean±SD as intermediate and mean+ SD as large) obtained in the present study.

All measurements were performed by a single trained observer using a standardised dissection and measurement protocol. The same calibrated sliding calliper (accuracy ±0.02 mm) was used throughout the study to maintain measurement consistency. Uniform methodology and careful technique were followed for all specimens to ensure reliability and minimise observer-related variation.

STATISTICAL ANALYSIS

Data was compiled in Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS version 20.0). Descriptive statistics such as mean, Standard Deviation (SD), and percentages were used to summarise the findings. The paired t-test was applied to compare the external diameters of veins and arteries on both sides. The Chi-square test (χ^2) was used to determine associations between categorical parameters, and Pearson's correlation coefficient was applied to study the relationship between the external diameters of the IJV and CCA. A p-value of <0.05 was considered statistically significant.

RESULTS

The observations of the external diameters of the IJV and CCA are summarised in [Table/Fig-2]. There was significant difference between the means vales of IJV when compared between the two sides (p-value=0.004) [Table/Fig-2].

Parameters	Mean±Std	SE of Mean	Mean Difference	t-value	p-value
IJV - Right	12.94±2.85	0.40	1.609	2.946	0.004*
IJV - left	11.33±2.60	0.37			
CCA - Right	8.92±1.45	0.21	0.403	1.430	0.156
CCA - Left	8.51±1.37	0.19			

[Table/Fig-2]: Comparison of external diameters of IJV and CCA on both sides. Data expressed as Mean±SD. Paired t-test applied; *p-value <0.05 considered statistically significant.

The comparison of the different categories of each of IJV and CCA is depicted in [Table/Fig-3], wherein the association between different categories was found to be statistically significant (p-value=0.028). The results show that 40% of the large CCA had large IJV and 35.29% of small CCA had small IJV.

IJV category	CCA category			Total	χ^2	p-value
	Small n (%)	Intermediate n (%)	Large n (%)			
Small	12 (35.29%)	9 (14.75%)	1 (20.00%)	22	10.864	0.028*
Intermediate	21 (61.76%)	41 (67.21%)	2 (40.00%)	64		
Large	1 (2.94%)	11 (18.03%)	2 (40.00%)	14		
Total	34 (100%)	61 (100%)	5 (100%)	100		

[Table/Fig-3]: Association between IJV and CCA categories. Chi-square test applied; *p-value <0.05 considered statistically significant.

There was a weak but statistically significant positive correlation between the external diameters of the IJV and the common carotid artery, as assessed by Pearson's correlation coefficient (r-value=0.278, p-value=0.005). Taken together, these findings show that the IJV and CCA exhibit a measurable morphometric association, supported by both categorical analysis and a statistically significant positive correlation between their external diameters.

DISCUSSION

The present study assessed the external diameters of the IJV and CCA in 50 cadavers (50 right and 50 left sides). A weak positive correlation was found between the external diameters of the IJV and the common carotid artery. The mean diameter has been consistently higher on the right side compared to the left side [Table/Fig-4] [8-12]. In the present study, the mean diameter of the IJV was consistently higher on the right side compared to the left, consistent with previous anatomical and imaging-based studies. This asymmetry can be explained by developmental and anatomical patterns of venous drainage: the right IJV predominantly drains the superior sagittal sinus through the right sigmoid sinus, while the left IJV mainly drains the straight sinus via the left sigmoid sinus, resulting in a smaller caliber. This right-sided dominance has also been described in Gray's Anatomy [1]. The right IJV is generally preferred for cannulation because it has a more direct path to the right atrium, does not cross the thoracic duct, and lies lower than the pleural dome [13]. The discrepancies in the diameter of the IJV observed in the above [Table/Fig-4], could be a result of different methods used to study it. This could have an influence on the parameter studied, resulting in higher values observed using Computed Tomography (CT) and lower values in the case of Ultrasonography (USG) and

Authors	Place of study	Mean±SD (mm)		Method
		Right	Left	
Lin BS et al., (1998) [8]	Taiwan	10.2±3.8	9.1±3.0	USG
Hui QX et al., (2010) [9]	China	10.9±2.7	9.2±2.7	USG
Lorchirachoonkul T et al., (2012) [10]	Singapore	13.4±4.5	11.0±4.4	USG
Lim CL et al., (2006) [12]	Australia	14.1	11.74	CT
Chandrasekaran S and Chandrasekaran VP (2011) [11]	India	8.72±1.78	8.61±1.70	Colour Doppler
Present study	India	12.94±2.85	11.33±2.60	Dissection

[Table/Fig-4]: Comparison of the diameter of IJV visualised by different methods [8-12].

Colour Doppler methods when compared with the present study. The method in which the diameter of the IJV is taken in these different methods i.e., external or internal diameter would probably explain the difference.

Lin BS et al., explained that the lower values obtained in their study could arise from the lack of manoeuvres to increase the size of the IJV [8]. Hui QX et al., reasoned that the difference to the Chinese population they studied resulted in the lower values [9]. Though the method remained the USG, the higher values obtained by Lorchirachoonkul T et al., were possibly the result of patients placed in the Trendelenburg position [10]. Hui QX et al., [9] demonstrated that measurement level significantly influences IJV diameter, with a gradual bilateral increase observed when assessed at the upper border of the thyroid cartilage, the cricoid cartilage, and the second tracheal ring. As per the study by Lorchirachoonkul T et al., (2012), head rotation did not have any influence on the diameter of the IJV [10]. Chandrasekaran S and Chandrasekaran VP attributed the lower values obtained in their study to the younger population (16-38 years) unlike the elderly population in some other studies [11]. According to Lim CL et al., although USG is the imaging method of choice for jugular access, the anatomical studies based on USG have shown wide variations in their results [12].

From the comparison, it is observed that unlike in the case of the IJV, there is no significant difference between the mean diameters of CCA on the right and left sides in different studies [Table/Fig-5] [8-11]. Magnetic Resonance Imaging (MRI)-based morphometric studies by Ertem O et al., (2020), noted gender-based differences in vascular dimensions [14].

Author	Place of study	Mean Diameter CCA (Right Side) (mm)	Mean Diameter CCA (Left Side) (mm)	Method of Study
Lin BS et al., (1998) [8]	Taiwan	8.1±1.5	8.0±1.5	USG
Hui QX et al., (2010) [9]	China	7.6±1.2	7.7±1.1	USG
Lorchirachoonkul T et al., (2012) [10]	Singapore	6.5±1.5	6.4±1.3	USG
Chandrasekaran S and Chandrasekaran VP (2011) [11]	India	6.58±0.74	6.53±0.70	Color Doppler
Present study	India	8.92±1.45	8.51±1.37	Dissection

[Table/Fig-5]: Comparison of mean diameter of right and left CCA visualised by different methods[8-11]

The significant positive correlation observed between the external diameters of the IJV and the CCA can be interpreted from a functional anatomical perspective. The CCA delivers arterial blood to the head and neck, which is subsequently drained by the IJV. A greater arterial inflow may thus correspond to a proportionately larger venous outflow channel, reflecting a physiological balance between supply and drainage in this region [1].

The correlation strength observed in the present study was weak (r-value=0.278), which may be attributed to several factors such as embalming-induced vessel shrinkage, inter-individual variability, and minor differences in the exact measurement level. This mild correlation suggests that while the relationship between the IJV and CCA diameters is statistically significant, it is physiologically limited and may vary under in-vivo conditions. Similar weak correlation patterns have been reported in two independent ultrasonographic studies [2,15]. These findings indicate that vessel diameter correlation, though present, is influenced by methodological factors and biological variability rather than a direct one-to-one anatomical relationship.

Recent imaging work by Iankovitch A et al., (2023) demonstrated that while depth-related parameters of the IJV and CCA correlate with body mass index, their diameters do not show a strong relationship, reaffirming that vessel geometry is influenced by individual factors rather than a constant anatomical pattern [16]. The assessment of volume status through ultrasound measurement of the IJV and CCA diameters, and the use of the IJV/CCA diameter ratio as a non invasive alternative for central venous catheterisation, has been studied [15]. Johnson F et al., (2022) demonstrated that head rotation and procedural positioning can significantly alter the relative anatomy of the IJV and CCA, a factor absent in cadaveric settings but clinically relevant when explaining modest morphometric correlations [4]. Morphometric features of the IJV —such as cross-sectional area and diameter— are vital for selecting safe cannulation techniques. Variations due to age, gender, and side influence these metrics and the IJV-CCA relationship [2].

Understanding anatomical variations of the IJV and CCA supports safer and more individualised approaches in neck-related procedures. In this cadaveric study, a positive correlation between their external diameters suggests a structural relationship reflecting the physiological balance between arterial inflow and venous drainage. Similar associations reported in imaging-based studies are supported here through anatomical confirmation, adding clarity to existing knowledge. This understanding can help clinicians anticipate venous caliber from arterial dimensions, aiding precise vascular access and surgical planning. Further studies with larger and more diverse samples incorporating imaging and hemodynamic evaluation could strengthen these observations and enhance clinical relevance.

Limitation(s)

The present study was performed on embalmed cadavers, which may not accurately reflect in-vivo vascular tone or vessel distensibility. Measurements were taken only at the level of the cricoid cartilage, and demographic information such as age and sex was not available for subgroup analysis. These factors should be considered, as they may affect the broader applicability of the findings. Although conducted earlier, the data remained unpublished due to academic constraints; however, the present study is a cadaveric morphometric study, the anatomical relationships assessed are not time-dependent and remain scientifically valid.

CONCLUSION(S)

The present study provides useful anatomical insight into the relationship between the IJV and the common carotid artery. The weak but statistically significant positive correlation observed between their external diameters reflects an anatomical association relevant to central venous catheterisation and related head-and-neck procedures and should be interpreted with caution. These findings add to existing anatomical knowledge and may help improve procedural safety. Future studies with larger samples and imaging correlation are needed to further validate these observations.

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