



ANATOMICAL VARIATIONS OF THE INTERNAL JUGULAR VEIN IN CADAVERIC STUDIES AND THEIR CLINICAL IMPLICATIONS

KADAVRA ÇALIŞMALARINDA İÇ JUGULER VENİN ANATOMİK VARYASYONLARI VE KLİNİK ETKİLERİ

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Abstract

Objective, this review was conducted the variations of the internal jugular vein (IJV), responsible for collecting a significant portion of the venous blood from the brain, as detected in cadaver dissections, and to shed light on clinical and surgical sciences with the results obtained, with the goal of minimizing the risk of possible complications during interventions. Materials and Methods, variations in IJV reported in cadaver studies between 1960 and 2026 were examined using Google Scholar, PubMed, and Web of Science databases. Approximately 14.100 articles were accessed. A total of 126 articles have been downloaded. Of the 126 articles initially identified, 81 were excluded (Computed Tomography, Magnetic Resonance Imaging, Ultrasonography, surgery, clinical, review, duplicate studies, and irrelevant studies). The remaining 45 articles comprised 39 cadaver studies, 2 letters to the editor (rare variation), and 4 clinical studies. Results, IJV duplication and fenestration variations were defined as IJV duplication in 2017. Variations were classified into three categories based on their level: Type A, Type B, and Type C. The studies reviewed included approximately 8 duplications, 6 fenestrations, 2 bifurcations, 8 anastomoses, 1 drainage variation, 2 accessory branches, 6 studies related to valve variations, and 7 studies related to IJV diameters. In 2 duplication cases, 2 fenestration cases, and 1 bifurcation case, the portion of the accessory nerve arising from the spinal cord was reported to pass through these venous variations. The present study identified a total of 27 variations of VJI, with the majority of these variations located on the right side. Conclusion, clinically, radiological imaging is important to identify variations in the internal jugular vein neck region prior to surgery on the IJV. In particular, vein diameter assessment is recommended before central venous catheterization to prevent unwanted complications. Variations affecting the IJV can occur not only in the IJV itself but also in adjacent structures.

Keywords: Variation, duplication, , cadaveric, fenestration

Özet

Amaç: Bu derleme, beyinden gelen venöz kanın önemli bir kısmını toplayan internal juguler venin (IJV) kadavra diseksiyonlarında saptanan varyasyonlarını incelemek ve elde edilen sonuçlarla klinik ve cerrahi bilimlere ışık tutarak, müdahaleler sırasında olası komplikasyon riskini en aza indirmeyi amaçlamıştır. Materyaller ve Yöntemler: 1960 ile 2026 yılları arasında kadavra çalışmalarında bildirilen IJV varyasyonları Google Scholar, PubMed ve Web of Science veritabanları kullanılarak incelenmiştir. Yaklaşık 14.100 makaleye erişilmiş ve toplam 126 makale indirilmiştir. Başlangıçta belirlenen 126 makaleden 81'i dışlandı (Bilgisayarlı Tomografi, Manyetik Rezonans Görüntüleme, Ultrasonografi, cerrahi, klinik, derleme, mükerrer çalışmalar ve ilgisiz çalışmalar). Geriye kalan 45 makale, 39 kadavra çalışması, 2 editöre mektup (nadir varyasyon) ve 4 klinik çalışmadan oluşuyordu. Sonuçlar, IJV duplikasyonu ve fenestrasyon varyasyonları 2017 yılında IJV duplikasyonu olarak tanımlandı. Varyasyonlar, seviyelerine göre üç kategoriye ayrıldı: Tip A, Tip B ve Tip C. İncelenen çalışmalar yaklaşık 8 duplikasyon, 6 fenestrasyon, 2 bifurkasyon, 8 anastomoz, 1 drenaj varyasyonu, 2 aksesuar dal, kapak varyasyonlarıyla ilgili 6 çalışma ve IJV çaplarıyla ilgili 7 çalışma içeriyordu. 2 duplikasyon vakasında, 2 fenestrasyon vakasında ve 1 bifurkasyon vakasında, omurilikten kaynaklanan aksesuar sinirin bir kısmının bu venöz varyasyonlardan geçtiği bildirildi. Bu çalışmada, çoğunluğu sağ tarafta olmak üzere toplam 27 VJI varyasyonu tespit edilmiştir. Sonuç olarak, klinik olarak, internal juguler ven (IJV) ameliyatından önce boyun bölgesindeki varyasyonları belirlemek için radyolojik görüntüleme önemlidir. Özellikle, istenmeyen komplikasyonları önlemek için santral venöz kateterizasyondan önce ven çapı



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değerlendirmesi önerilir. IJV'yi etkileyen varyasyonlar sadece IJV'nin kendisinde değil, aynı zamanda komşu yapılarda da meydana gelebilir.

Anahtar kelimeler: varyasyon, duplikasyon, internal juguler ven, kadavra, fenestrasyon

INTRODUCTION

The internal jugular vein (IJV) represents a major venous channel within the deep cervical region. It plays an essential role in the drainage of venous blood from intracranial structures, as well as the tongue and thyroid gland. It starts at the jugular foramen (JF) and continues as a continuation of the sigmoid sinus. This vein shows dilation in two places along its course: the first at the beginning and the second at the end. The first dilated portion is called the superior jugular vein bulb, and the second dilated portion is called the inferior jugular vein bulb. At its termination point, anterior to the clavicle, it connects with the subclavian vein (SV) to form the brachiocephalic vein, creating the venous angle. (Arıncı, Elhan, 2025: 88). The venous valve is located just before the junction of the IJV. Postmortem studies have found that valves are present in the proximal IJV in approximately 93% of cases. Using ultrasonography, at least one IJV valve was detected in approximately 90% of cases (Al-Omari, Al-Bashir, 2012).

The accessory nerve (CN XI) runs dorsally obliquely either superficially or deep to the IJV (Arıncı, Elhan, 2025: 89). Literature evaluating the spatial relationship of the accessory nerve to the IJV demonstrates that the nerve's lateral branch remains invariably anterior and lateral to the vein. Thus, it has been emphasized that the likelihood of IJV damage during surgical procedures in the cervical region is low. If the accessory nerve is located medial or posterior to the vein, the risk of damage during surgery is high (Lçvy et al., 2001). The right side of this vein is located slightly away from the common carotid artery (CCA), while the left side completely covers it. The vein on the right side has a larger diameter than that on the left side (Arıncı, Elhan, 2025: 89).

The internal jugular vein (IJV) develops from the anterior and precardinal veins, which are responsible for draining blood from the pars cranialis of the fetus during its embryological development. These vessels are supported by an extensive capillary network that facilitates the rapid growth of the brain and head. This vascular structure completes its final development through a combination of several factors, including hemodynamic, genetic, growth, mechanical, and neural factors (Williams et al., 1995; Augustin, 2001; Djonov et al., 2002, 2003; Moore, Persaud, 2003; le Noble et al., 2004, 2005; Autiero et al., 2005; Downie et al., 2007). In the literature, the division of the IJV into two branches is expressed using two terms: duplication and fenestration (Downie et al., 2007). Duplication results from the division of the IJV into two separate veins, each draining into the SV. In fenestration, the IJV initially splits into two branches, and then these two fenestrated branches reconnect and drain into the SV as a single vein (Downie et al., 2007).

To our knowledge, no IJV classification has been found in the literature. Only the classification of IJV duplication (IJVD) was observed (Nayak et al., 2017). In the current literature, Nayak et al. (2017) classified duplication and fenestration and defined IJVD accordingly. The variations were classified into three categories based on their level: Type A, B, and C. In type A, the IJV originates from the inferior margin of the posterior belly of the digastric muscle. These two duplicated veins unite at the level of the central tendon of the omohyoid muscle or at a more cranial level, and along their course they are found within the carotid sheath. This type has been described in the literature with different names such as partial duplication, fenestrated IJV, and incomplete duplication. The only difference between Type B and Type A is the course of the caudal segment. These duplicated veins follow a course extending beneath the omohyoid muscle tendon. It was previously referred to as complete or total IJVD in the literature. Duplication of type C duplication arises near the level of the hyoid bone. The lateral component runs external to the carotid sheath and lateral to the omohyoid muscle, passing through the posterior triangle of the neck; it then curves at the root of the neck and returns to the carotid sheath. The most commonly reported type of IJVD is Type A; it accounts for approximately 68% of cases and is known as the simplest form. Type B and especially Type C require more attention during surgical and invasive procedures; otherwise, they can lead to serious complications. Type C is considered the most complex form of IJVD (Nayak et al., 2017). Nayak et al. (2017) reported taht Type A



IJVD was detected in approximately 75% of their studies. In the study carried out by Buescher et al. (2024), Type A was reported as the most prevalent form of duplication and that it occurs in approximately 68% of cases.

The objective of our research is to examine the variations of the IJV detected in cadaver dissections and to minimize the risk of possible complications during interventions by shedding light on clinical and surgical sciences with the results obtained.

MATERIALS VE METHODS

Between January 1960 and February 2026, 14.100 articles were found on Google Scholar, PubMed, and Web of Science using the keywords '[internal jugular vein cadaver]', '[vena jugularis interna cadaveratis]', '[internal jugular vein]', '[vena jugularis interna ve varyasyonları]', '[vena jugularis interna kadavra]', '[the internal jugular vein and its variations]', '[iç boyun damarı kadavra]', '[iç boyun damarı]', '[vena jugularis interna]', and '[internal jugular vein variation]'. The search strategy combined these terms using the Boolean operators AND/OR. Only studies published in English and Turkish were considered eligible. Duplicate records across databases were identified and removed manually. A total of 126 articles related to the topic have been downloaded. The inclusion criteria were studies investigating anatomical variations of the IJV, cadaveric studies, and other eligible publication types reporting relevant variations, with language restrictions applied to English and Turkish. Of the 126 articles initially identified, 81 were excluded (Computed Tomography, Magnetic Resonance Imaging, ultrasonography, surgery, clinical, review, duplicate studies, and irrelevant studies). Following the inclusion and exclusion criteria, the remaining 45 articles comprised 39 cadaver studies, 2 letters to the editor (rare variation), and 4 clinical studies.

RESULTS AND DISCUSSION

Neck dissections are frequently used in the treatment of many diseases, and the IJV in the neck is commonly preferred in central venous catheterization procedures. Although this procedure is commonly performed by anesthesiologists, various anatomical variations of the IJV may be encountered by surgeons, radiologists, and other clinicians during surgical and invasive procedures. Introducing these variations into the literature can significantly reduce the risks of life-threatening complications in central venous catheterization, surgical procedures, and invasive interventions, and can prevent patient morbidity and mortality. To our knowledge, this study is the first literature review to examine IJV variations detected solely in cadavers.

In an adult cadaver, the IJVD formed a double vein in the right IJV, 2.5 cm inferior to the JF, and this duplication rejoined approximately midway between the distal end of the styloid process in the temporal bone and the point of termination of the central artery. It was observed that the spinal portion of the accessory nerve passed between these duplicated veins during its extension to the sternocleidomastoid muscle (Setty, 1960). A study in the literature found that an anastomosis between the IJV and the external jugular vein (EJV) was located 6.98 cm above the angulus venosus and posterior to the muscle, at the point where the EJV crosses the sternocleidomastoid muscle, measuring 1.04 cm in length and 2.04 mm in diameter (Kavaklı et al., 1999). Dissection studies conducted in 2006 revealed a partial and duplicated IJV on the right side, and it was noted that it branched into medial and lateral branches (of similar thickness to the IJV) at the C5 level, draining into the SV. It has been reported that the inferior venter of the omohyoid muscle and the inferior root of the right ansa cervicalis traverse the space formed between the two branching branches (Uemura et al., 2006) (Table 1).

In one case study, the right side showed no variation, whereas duplication of the IJV was observed on the left side above the level of the hyoid bone, with the spinal part of the accessory nerve traversing the space between the two branches. It has also been noted that there is a substantial connecting vein between the anterior jugular vein (VJA) and the anterior branch of the IJV (Nayak, 2006). Another study, it was determined that on the left, between the IJV and the VJE, the sternocleidomastoid muscle, originating from the VJE, crosses its anterior edge, passes deep within the muscle, and opens into the IJV (Lalwani et al., 2006). In a study examining 15 cadavers, it was observed that in a male cadaver, the VJE, which would normally drain directly into the SV in normal anatomy, actually drained into the IJV (Prakash et al., 2006). One study



determined that after a single IJV descends bilaterally from the JF, it divides into two: the medial IJV, which follows a typical course, and the lateral IJV, which courses outside the carotid sheath (Downie et al., 2007). During the dissection of a 58-year-old male cadaver, unilateral fenestration was identified in the right IJV. The spinal accessory nerve was found to pass between the fenestrated branches, subsequently piercing the carotid sheath and reached the sternocleidomastoid muscle (Öztürk, Talas, 2010) (Table 1).

Dogan et al., in 2010, reported an IJVD on the left side of the neck in a 65-year-old male cadaver, with the ansa cervicalis and the inferior belly of the omohyoid muscle passing between the duplicated veins. Prades et al., in their study of duplication incidence in 1000 unilateral neck dissections, identified only four types (Prades et al., 2002). In a female cadaver approximately 50 years old, dissected for educational purposes at Narayana Medical School, the IJV fenestration was reported to be approximately 2.7 cm long, situated at the hyoid level, lateral to the hyoid and within the carotid sheath, with no anatomical structures passing through it (Sankar, Bhanu, 2011). In a study investigating the anatomical relationship between the spinal part of the accessory nerve and the IJV, a total of 61 cadavers were examined; only one cadaver (1/61) had an IJV bifurcation detected. In this cadaver, it was reported that the spinal part of the accessory nerve passed between the bifurcated branches of the IJV. (Saman et al., 2011) (Table 1).

Cvetko (2015) detected a fenestration variation in the left IJV during the routine dissection of a 75-year-old male cadaver. It was stated that 1 cm inferior to the angulus mandibulae, the IJV divides into two branches of equal diameter, medial and lateral, and reunites at the level of the hyoid bone, and the fenestration segment is 3.5 cm long (Cvetko, 2015). Cvetko et al. (2017) identified a 2.5-cm-long fenestration in the right IJV of a 70-year-old male cadaver, situated in the upper part of the carotid triangle, with significant widening (phlebectasia) in the non-fenestration segment. Phlebectasia measuring 4 cm in diameter and approximately 7 cm in length has not been documented in previous studies (Table 1).

In a 60-year-old male cadaver dissected for educational purposes, the left IJV was observed to bifurcate into two branches after extending approximately 5 cm lateral to the CCA and within the carotid sheath. It was determined that both branches of the IJV rejoin to form a single IJV after a 5 cm course lateral to the CCA (Nayak. 2017) (Table 1).

Souza et al. (2018) observed an unusual anatomical variation involving the right IJV in an 83-year-old male cadaver during anatomical dissection. A collateral branch associated with the right IJV was identified, located parallel to and medial to the main vein. Previous studies have reported that this branch of the IJV lies between the transverse processes of the C3 and C4 vertebrae and drains into the junction between the right IJV and the brachiocephalic vein. The variant measured approximately 6.5 cm in length and originated from the transverse processes of the cervical vertebrae and follows a course to the point where the IJV and the brachiocephalic vein join. This branch continues downwards in a dorsal relationship with the vagus nerve and the CCA. In 2018, Sakthivel and Verma reported a fenestration of the left IJV in a 50-year-old male cadaver during routine dissection. At the level of the digastric muscle tendon, the IJV separated into two branches, with the medial branch being smaller than the lateral one. The two branches subsequently rejoined at the level of the omohyoid muscle tendon (Table 1).

According to a case report by Nayak (2019), during a dissection conducted on medical students in 2019, an anatomical variation of the right IJV was observed. This finding has not been documented in the previously available literature. A thin vein measuring approximately 4 mm in diameter, was found to arise from the junction of the IJV and the common facial vein (CFV). This vein is approximately 3 cm long, runs parallel to the IJV, and extends downwards before rejoining the IJV. It is called the "jug handle" because of its resemblance to a pitcher handle. In their study, Kumar et al. (2019) detected fenestration of the IJV during dissection performed for JF training purposes, and the spinal accessory nerve passes between the two branches of the fenestrated vein. It is important to know the IJV fenestration variation, especially in various neurosurgical procedures. Normally, the neurosurgeon expects the spinal portion of the accessory nerve to pass anterior to the IJV, then cross the IJV inferolaterally and continue laterally to the IJV at the level of the posterior belly of the digastric muscle. Knowledge of this anatomical variation reduces the risk of complications during upper cervical exposure (Kumar et al., 2019) (Table 1).



In a case report published in 2020, standard anatomical dissection of a male cadaver revealed that the FV on the right side of the neck did not drain directly into the IJV as expected; instead, it first formed an anastomosis with the IJV and subsequently drained primarily into the EJV (Çini et al., 2020). In their educational research, Patera and Alashkham identified a connecting vein between the VJE and IJV. Of the 5 cadavers (2 male, 3 female), they only found a 1.5 cm long, 3.82 mm diameter connection between the right VJE and the right IJV via a connecting vein in the posterior aspect of the sternocleidomastoid muscle, positioned lower than the bottom border of the thyroid cartilage and superior to the top rim of the cricoid cartilage, within a female subject aged 58 (Patera, Alashkham, 2021) (Table 1).

One study found bilateral duplication of the IJV, divided into two branches on both sides, observed within an 85-year-old female specimen. It is reported that the anterior belly of the omohyoid muscle passes bilaterally interposed between the duplicated channels of the IJV, and along the left side, the superior laryngeal nerve travels directly through the duplications (Buescher et al., 2024). Bekyarova et al. (2024) measured the anastomosis between the IJV and VJE during a routine dissection as approximately 1 cm long and with a lumen diameter of 0.3 mm, located corresponding to the plane of the cricoid cartilage. They noted that this vascular connection had an oblique course and that venous blood drained starting from the IJV towards the VJE. Young et al. (2024) detected a variation within a male specimen aged 78. Sinistrally (left-sided), the IJV was hypoplastic with a diameter smaller than normal, approximately 3.82 mm, and the VJA was 5 mm wider than the IJV, revealing an anastomosis connecting these two veins. Contralaterally on the right, they identified an anastomosis between this internal jugular vein and VJA, and the IJV was reported to have a diameter of approximately 15.92 mm, which is larger than normal (Table 1).

Table 1. Duplication, fenestration, anastomosis, and other variations.

Authors	Cadaver count	Age	Variation Type	Side	Country
Setty, 1960	1 M	Adult	Duplication *	Dexter	USA
Kavaklı et al. 1999	1 F	26	Anastomosis (IJV-VJE)	Dexter	Türkiye
Uemura et al., 2006	1 F	86	Duplication + # + ansa cervicalis	Dexter	Japan
Nayak, 2006	1 M	50	Duplication + Anastomosis (VJA-IJV) *	Sinister	India
Lalwani et al., 2006	1 M	45	Anastomosis (IJV-VJE)	Sinister	India
Prakash et al., 2006	1 M	Middle age	VJE, drainage to IJV.	Dexter	India
Downie et al., 2007	1 F	54	Duplication	Bilateral	USA
Öztürk, Talas, 2010	1 M	58	Fenestration *	Dexter	Türkiye
Dogan et al., 2010	1 M	65	Duplication + # + ansa cervicalis	Sinister	Türkiye
Sankar, Bhanu, 2011	1 F	50	Fenestration	Sinister	India
Saman et al., 2011	61 (27M,34F)	-	Bifurcation *	-	USA
Cvetko, 2015	1 M	75	Fenestration	Sinister	Slovenia
Cvetko, Meznarič, 2017	1 M	70	Fenestration + flebektazi	Dexter	Slovenia
Nayak, 2017	1 M	60	Bifurcation	Sinister	India
Souza et al., 2018	1 M	83	An accessory tributary of the IJV	Dexter	Brazil
Sakthivel, Verma, 2018	1 M	50	Fenestration	Sinister	India
Nayak, 2019	1 M	70	Jug handle	Dexter	India
Kumar et al., 2019	1	-	Fenestration *	-	-



Çini et al., 2020	1 M	65	Anastomosis (IJV-VF)	Dexter	Türkiye
Patera, Alashkham, 2021	5 (2 M, 3 F)	58-101	Anastomosis (VJE-IJV)	Dexter	UK
Buescher et al., 2024	1 F	85	Duplication + superior laryngeal nerve + bilateral #	Bilateral	USA
Bekyarova et al., 2024	1 F	Adult	Anastomosis (VJE-IJV)	Dexter	Bulgaria
Young et al., 2024	1 M	78	Anastomosis (VJA-IJV) + diameter variation	Bilateral	USA

* The accessory nerve passes between them. # The omohyoid muscle passes between them.

- Studies on Caliber Variations

In a study where 93 cadavers were dissected bilaterally, the left IJV was found to be hypoplastic (diameter <6 mm) in 3 cases, while the ipsilateral left EJV was measured to be larger (Asouhidou et al., 2008). An investigation performed using 91 Japanese specimens to examine the relationship between right and left IJV diameter differences and dural sinus flow directions found that dextral IJV lumen exceeded that of the left side by 81.3%. The reason why this vessel displays an 81.3% greater caliber on the right compared to its contralateral counterpart can be attributed to the tendency of the brain's veins to drain towards the dextral side (Saiki et al., 2013). An anatomical evaluation involving 28 specimens (12 female, 16 male) indicated a statistically significantly greater diameter for the right IJV (Khan, Altaf, 2016). A study conducted on 50 cadavers in the literature measured greater right IJV width relative to the left (ShobhA, ShubhA, 2026). A study conducted in China that examined the anatomy of central venous catheterization in 31 adult cadavers indicated that right IJV access was safer than left access (Yongzheng et al., 2024) (Table 2).

A study performed on a 54-year-old male specimen indicated that the IJV was large and had thin walls. While the VJE was expected to drain into the SV, it was observed to drain into the IJV, and the CFV also drained at the drainage point. At this junction, the caliber of the IJV was recorded as 3.3 cm and its segmental length as 2 centimeters (Shetty et al., 2020). In one study, a 70-year-old male cadaver showed hypoplasticity (< 6 mm) along the left-sided IJV course and no venous side branch drainage (Dhakshnamoorthy, Sakthivel, 2024) (Table 2).

Table 2. Cadaver studies examining diameter variations.

Authors	Cadaver count	Age	Diameter variation	Rate of variation % (n)	Side	Country
Asouhidou et al., 2008	93	Adult	-Left IJV hypoplasia (<6 mm) -Diameter difference	3/93	Sinister	Greece
Saiki et al., 2013	91 (47 M, 44 F)	35-98	- The difference in diameter between the right and left IJVs.	Right IJV has 81.3% larger diameter than left IJV	Bilateral	Japan



Khan, Altaf, 2016	28 (16 M, 12 F)	46-74	- Right-left IJV diameter difference	81.25% in male 66.6% in female	Bilateral	Saudi Arabia
Shetty et al., 2020	1 M	54	-The IJV is 3.3 cm wide	-	Dexter	India
Yongzheng et al., 2024	31 (24 M, 7 F)	Mean (62)	-Right-left IJV diameter difference	-	Bilateral	China
Dhakshnamoorthy, Sakthivel, 2024	1 M	70	-IJV hypoplasia	-	Sinister	India
ShobhA, ShubhA, 2026	50 (100 sides)	Adult	-Right-left IJV diameter difference	-	Bilateral	India

- Studies on Valvular Variations

In a study examining the anatomy of the IJV valves, a total of 14 IJV valves from 7 cadavers were examined during autopsy within 24 hours of death. The right IJV had a larger diameter than the left IJV in 6 cadavers, whereas the left IJV had a larger diameter in 1 cadaver. Valvular evaluation revealed a bicuspid configuration in 5 cadavers and a tricuspid configuration in 2 cadavers (Dresser, McKinney, 1987) (Table 3).

In their study on 20 cadavers, Imai et al. (1994) reported that 16 of the 19 valves were bicuspid and semilunar, 2 were monocuspid, and 1 was tricuspid. It has been reported that the valves of the IJV are located just above the end point where they open into the inferior bulb. In the literature review, Sanchez-Hanke et al. examined 100 cadavers (55 male and 45 female) in a cadaver study investigating the diversity of IJV valve anatomy. In this study, most of the variations identified were on the right side, with 92% among right sided located valves being bicuspid versus 64% along the left side being tricuspid, and normally located approximately 2 cm above the subclavian-jugular bifurcation (Sanchez-Hanke et al., 2000) (Table 3).

An investigation performed by Furukawa et al. in 2012 on 60 cadavers, IJV valves were found to be bilateral in 58 cadavers (96.7%) and unilateral in 2 cadavers (3.3%). The study reported that 72% of evaluated valves had a bicuspid form, 26.3% were unicuspid, and 1.7% showed a tricuspid structure. In a 2015 study examining the morphology of IJV valves, 62 cadavers were dissected. IJV valves were detected in 76.62% of cases. The vast majority of valves are bicuspid (68.54%), while unicuspid valves account for 7.25% and tricuspid valves for 0.80%. Unicuspid valves are more commonly located along the right side in men and along the left side in women, and among the most frequent locations for these valves are the inferior (54.73%), posterior (38.94%), and superior (6.31%) of the clavicle (Khan et al., 2015). A cascaded arrangement of three unicuspid valves in the IJV was documented by Khan et al. (2016) as an incidental finding during routine dissection, representing the first such description. The valves displayed distinct dimensional variation, diminishing in size from top to bottom, which holds critical relevance for clinicians operating at the IJV (Table 3).

In one study, various termination patterns regarding the facial vein (FV) were examined across 52 adult cadavers (104 sides). 92.3% of the FV showed a normal termination pattern, but in 8 sides (7.7%), the FV emptied into the EJV. Additionally, in 1 of the 8 evaluated sides, the retromandibular vein was observed draining into the EJV prior to branching, representing a novel anatomical variation (Pai et al., 2008). In a study of 10 cadavers and 30 patient records Li et al. observed a posteromedial IJV course in 65% of cases, with the remaining 35% exhibiting a posterolateral trajectory. They observed that the course of this IJV remained identical among individuals presenting with presyloid tumors, but for retrostyloid tumors, the IJV was compressed and displaced directly posterolateral to the tumor (Li et al., 2023) (Table 3).



Table 3. Studies examining valve variations.

Authors	Cadaver count	Age	Valve variations	Rate of variation % (n)	Side	Country
Dresser, McKinney, 1987	7	-	-Bicuspid in 5 cadavers -Tricuspid in 2 cadavers -Diameter right IJV > left IJV in 6 cadavers	-	Bilateral	USA
Imai et al., 1994	20 (19 valve)	-	-Monocuspid -Bicuspid -Tricuspid -Semilunar	-16 bicuspid and semilunar -2 monocuspid -1 tricuspid	Bilateral	Japan
Sanchez-Hanke et al., 2000	100 (55 M, 45 F)	0-60	-Bicuspid -Tricuspid	92% bicuspid on the right, 64% tricuspid on the left	Bilateral	Germany
Furukawa et al., 2012	60 (35 M, 25 F)	17-85 mean age: 59.5	-Unicuspid -Bicuspid -Tricuspid	-Unicuspid 26.3% -Bicuspid 72.0% -Tricuspid 1.7% -Bilateral 96.7% -Unilateral 3.3%	Bilateral	Japan
Khan et al., 2015	62 (40 M, 22 F)	46-74	- Unicuspid (7.25%) - Bicuspid (68.54%) -Tricuspid (0.80%)	%76.62	Bilateral	Saudi Arabia
Khan et al., 2016	1 M	65	Cascade valve in the right IJV	-	Dexter	Saudi Arabia

Central venous catheterization performed on the IJV is a very commonly used procedure, but it carries a high risk of vein damage (Sanchez-Hanke et al., 2000). The larger diameter of the right IJV renders it a clinically superior site for central venous catheterization, as widely documented. Right IJV cannulation is clinically favored Because of its more direct pathway to the right atrium, lower risk of thoracic duct injury, lower cupular height, and greater anatomical consistency compared to the left (Yoon et al., 2013; Saiki et al., 2013). Many cadaver studies in the literature have suggested that IJV access should be preferably performed from the right side and under ultrasound guidance. This significantly reduces the risk of potential complications with this method (Patra et al., 2025; Topal et al., 2013; Chandra et al., 2015; Yoon et al., 2013; Asouhidou et al., 2008; Kosnik et al., 2023). To minimize the risk of inadvertent arterial puncture from retrovaginal or posterior vessel anatomy at the mastoid and supraclavicular levels, the cricoid level is recommended as the optimal entry site for right IJV catheterization (Chandra et al., 2015). Evaluating 80 cadavers and 35 patients to assess Seldinger needle length for central venous access, a 2022 study recommended a needle length of 2 cm or less (Wenzel et al., 2022).

In conclusion, the IJV is of great clinical importance and is one of the most frequently preferred veins, especially in central venous catheterization. For anesthesiologists performing this procedure, variations of the IJV such as duplication, fenestration, and anastomosis, as well as its small diameter, can increase the concern of vascular injury during the procedure. It can also make the procedure more difficult or impossible. Furthermore, the presence of valves in this area must be considered, and care must be taken to avoid damaging these valves.

In cervical lymph node surgeries performed in this region, and in surgical interventions by neurosurgeons, it is essential to highlight that the spinal accessory nerve shows variations, and if these variations are not identified, the vessel can be damaged and cause severe bleeding. To minimize complications and identify underlying anatomical variations, pre-procedural imaging is strongly advocated as a first-line precaution, as omitting this step significantly increases adverse event rates.



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