

# Unusual Venous Drainage of the Common Facial Vein. A Morphological Study

ORIGINAL

Sergio Ivan Granados-Torres<sup>1</sup>, Humberto Ferreira-Arquez<sup>2</sup>

## Abstract

**Background:** Anatomical knowledge of the facial vasculature is crucial not only for anatomists but also for oral and maxillofacial surgery, plastic surgeon, otorhinolaryngologists. Access pathways, pedicled and free flap transfer, and explantation and transplantation of total faces are based on the proper assessment and use of the facial veins and arteries. The anatomical variations reported in the present study confirms the need for preoperative vascular imaging for sure good venous outflow for the free flap survival.

**Aims:** The aim of the present study was to describe a rare anatomical variation of the common facial vein which not been previously described.

**Methods and Findings:** Head and neck region were carefully dissected as per standard dissection procedure, studied serially during the years 2013-2017 in 15 males and 2 females, i.e. 34 sides, embalmed adults cadavers with different age group, in the laboratory of Morphology of the University of Pamplona. In 33 sides (97 %) of the cases the anterior facial vein (FV) terminated into the internal jugular vein via the common facial vein (CFV) as per standard anatomic description. The right common facial vein in one side (3%) was found to drain into the contralateral internal thoracic vein and contralateral pericardiophrenic vein. Remarkable communications with the external jugular vein, the internal jugular vein, the anterior jugular vein, and left brachiocephalic vein. The length of the right common facial vein from the level of its formation till its termination in the contralateral pericardiophrenic and internal thoracic vein was about 22.75 cm. The venous drainage pattern on the left side of the face was found to be normal.

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**Conclusion:** The existence of this anatomical variation among others supposes a double edge sword in the medical practice with its own opportunities and risks, especially in the surgical treatment; therefore, we need to study with more strictness these possibilities with the aim of facilitate this practices, and improve the life quality of our patients.

#### Keywords

Anatomical Variation; Common Facial Vein; External Jugular Vein; Internal Jugular Vein; Brachiocephalic Vein; Anterior Jugular Vein; Pericardiophrenic Vein; Internal Thoracic Vein.

## Introduction

If we do a quick revision about the anatomical variations that have been found in the human body, it is not weird to see that the veins of the head and the neck make various appearances in leading roles, therefore we can infer that these blood vessels are very prone to present a wide range of variations. Commonly, the anterior facial vein start from the confluence of the supratrochlear and the supra-orbital veins in the middle third of the face. The superficial temporal vein unites with the maxillary vein to form the retromandibular vein. The retromandibular vein divides into the anterior and the posterior divisions within the substance of the parotid gland. In the normal anatomy this anterior division joins to the anterior facial vein giving the common facial vein, which drains into the internal jugular vein. The posterior division, on the other side, joins with the posterior auricular vein, continuing as the external jugular vein which drains into the subclavian vein [1, 2]. The anterior jugular veins usually exist as two parallel vessels which drains into the subclavian vein or into the external jugular vein through a submandibular venous arch [3], finally we need to describe a part of the ve-

nous drainage of the thorax, specifically, we have to mention the left pericardiophrenic vein, which, as its name indicates, is formed from the venous branches draining the diaphragm's superior border or thoracic diaphragm and the pericardium; the left pericardiophrenic vein drains normally into the floor of the left brachiocephalic vein [4], for its part the internal thoracic veins (internal mammary veins) are venae comitantes to the inferior half of the internal thoracic artery. They have several valves. Near the third costal cartilages, the veins unite and ascend medially to the artery to end in their appropriate brachiocephalic vein. Tributaries correspond to artery branches [5,6].

The veins of head and neck have a very relevant importance in a whole of medical and surgical procedures, for example, these veins can be used as patches for carotid endarterectomy and for oral reconstruction surgeries being really remarkably in those cases the need of a vast vascularization [7]. Today's diagnostic, monitoring and therapeutic procedures are needed in diverse groups of patients. In the case of monitoring this is very obvious in the patients who are in the intensive care units (ICU) also known as critical care units (CCU), who are in a very precarious situation which needs a constant

observation, in order to have any information possible that could ease a convenient evolution. In the therapeutic side it is enough to see how many drugs need a parenteral administration and specifically an intravenous administration, being of vital importance to our professionals of health and specially to the radiologist, surgeons and physicians the clear knowledge of the human anatomy and a general knowledge about the possible variations that could be present, aiming to avoid any complications that could be presented [7], in this therapeutic side we can peculiarly mention that superficial veins of the head and neck are utilized for central venous cannulation, oral reconstruction and parenteral nutrition in debilitated patients [8]. And in what concerns to the diagnostic it is very interesting to see that clinical and sonological examination of these veins may provide clues toward underlying cardiac pathology [9].

As a clinical inference the external veins of the head and neck are of particular interest in the use as patches for surgery to remove plaque buildup in the carotid arteries; for oral reconstruction surgeries, where the creation of a vascular supply by anastomosis is crucial and in this case is recognized the participation of the facial vein [1], in the particular case of aesthetic procedures and plastic surgery a relevant complication to consider besides the insufficient arterial irrigation is the partial necrosis of skin flaps due to congestions who derives from a poor venous drainage making the cardiovascular anatomy of the intervention site an important factor to consider [10]. The aim of the present study was to describe an anatomical variation who hasn't been reported before according to our bibliographic revision, who involves a vast number of anastomosis (transverse venous connections) of the right common facial vein with other neighbor veins, an a very rare draining of this in the contralateral brachiocephalic vein, contralateral pericardiophrenic vein and in the contralateral internal thoracic vein, such a rare variation suppo-

ses both, an interesting opportunity concerning to some procedures, and a really dangerous risk in those procedures.

## Methods

This work was previously approved by the Ethics Committee in Research and Environmental Impact of the University of Pamplona, conformed by resolution 030 of January 16 of 2014 and Resolution No. 008430 of 1993 of October 4 of the Ministry of Health of Republic of Colombia which regulates the scientific, technical and administrative norms for health research. This descriptive cross-over study was designed to identify the morphologic features and anatomical variations in the termination of the facial vein. Head and neck region were carefully dissected as per standard dissection procedure, studied serially during the years 2013-2017 in 15 male and 2 females, i.e. 34 sides, embalmed adults cadavers with different age group, in the laboratory of Morphology of the University of Pamplona. None of the cadavers utilized for the present study had previous facial surgery or any relevant disease affecting the integrity of the facial anatomy. The cadavers had no trace of scars, adhesions or signs of trauma. This study was carried out by routine dissection classes for undergraduate medical students. Topographic details of the variations were examined, recorded and photographed. Measurements were taken with assistance of a sliding Vernier caliper with an accuracy of 0.01 mm during the course of the anatomical dissection.

## Results

In 33 sides (97%) of the cases the anterior facial vein (FV) terminated into the internal jugular vein via the common facial vein (CFV) as per standard anatomic description. In all specimens the external jugular vein is formed by union of posterior division of retromandibular vein and posterior auricular vein.

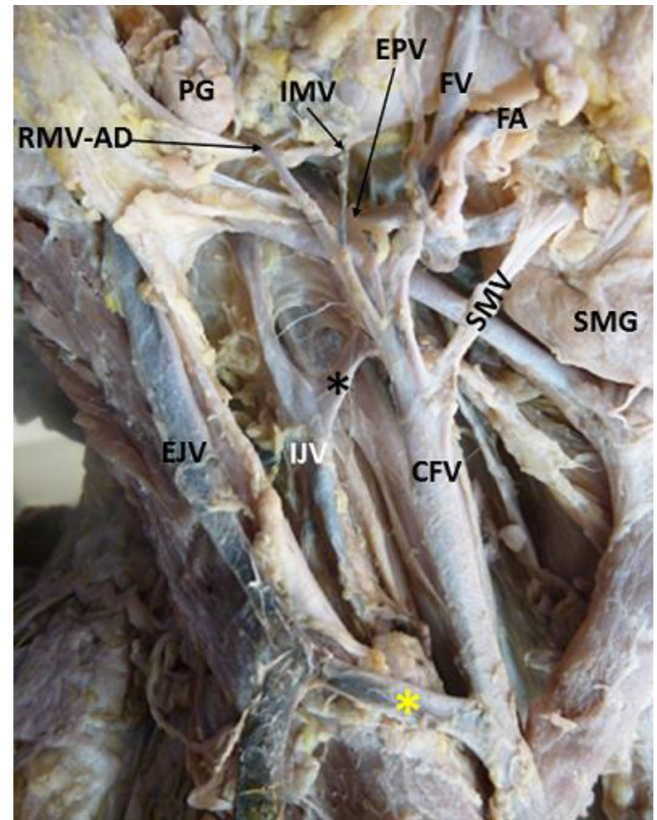
The lingual vein drain into the internal jugular vein.

In the right side (3%) the common facial vein was formed by union of the anterior division of retromandibular vein (RMV-AD); the inferior masseteric vein (IMV); the submental vein (SMV); the external palatine vein (EPV); the facial vein (FV). The common facial vein present anastomosis (transverse venous connections) with internal jugular vein (in the upper third of the neck) at 34.5 mm below the angle of the mandible and external jugular vein (in the middle third of the neck) at 69 mm below the angle of the mandible. The diameters of the transverse venous connections were of 5.53 and 5.95 mm, respectively. **Figure 1.**

At level of the inferior third of the neck, the right anterior jugular vein drain into common facial vein on its anterior aspect (33.8 mm above the right sternoclavicular joint). There was no jugular venous arch in the suprasternal space. On the posterior aspect of the common facial vein (10 mm above the right sternoclavicular joint) is observed a communicating branch (of 56.5 mm of length and 6.35 mm of diameter) united with the external jugular vein to form a common venous trunk which terminated into subclavian vein. **Figure 2.**

The right common facial vein (CFV) descended obliquely downwards and forward superficial to the sternocleidomastoid, appeared in the suprasternal space. CFV is oriented laterally obliquely, deep to the brachiocephalic artery trunk, but superficial to the left brachiocephalic vein. CFV anastomosed with left brachiocephalic vein and terminating into contralateral pericardiophrenic vein and into contralateral internal thoracic vein. **Figure 3.** The length of the right common facial vein from the level of its formation till its termination in the contralateral pericardiophrenic and internal thoracic vein was about 22.75 cms. The venous drainage pattern on the left side of the face was found to be normal.

**Figure 1:** Lateral view of neck and angle of the mandible. Right site. External jugular vein.



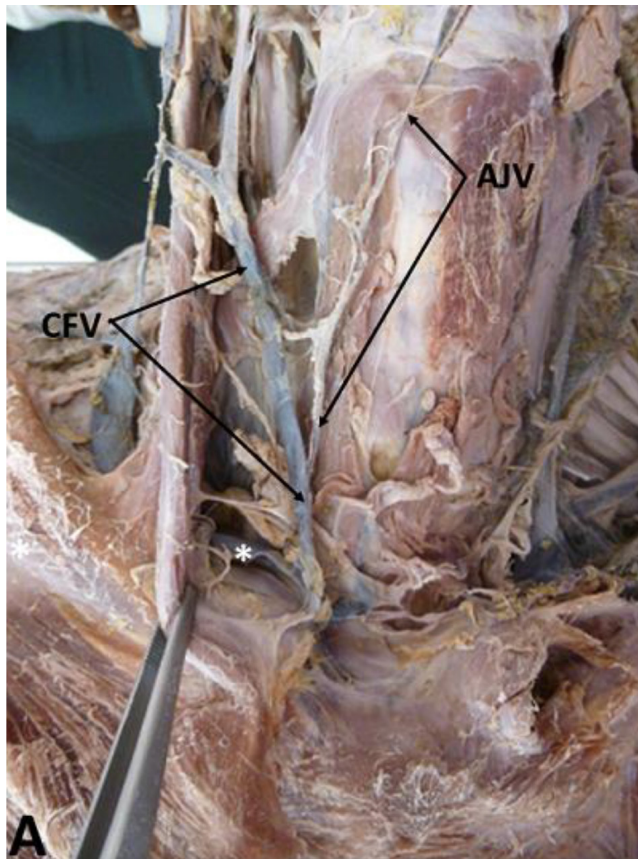
EJV; facial vein: FV; facial artery: FA; internal jugular vein: IJV; retromandibular vein- anterior division: RMV-AD; parotid gland: PG; submandibular gland: SMG; inferior masseteric vein: IMV; submental vein: SMV; external palatine vein: EPV; common facial vein: CFV; black asterisk: anastomosis between internal jugular vein and common facial vein; yellow asterisk: anastomosis between external jugular vein and common facial vein

## Discussion

During embryonic period, superficial head and neck veins develop from superficial capillary plexuses which will later form primary head veins. Larger veins are formed by the enlargement of individual capillaries, confluence of adjacent ones and regression of some from where the flow has been diverted [11]. The ventral pharyngeal vein (VPV) is the first one identified in face and neck region. VPV develops within the mesenchyme of first branchial arch and joins with the cranial part of primary head vein. Maxillary vein develops within the maxillary

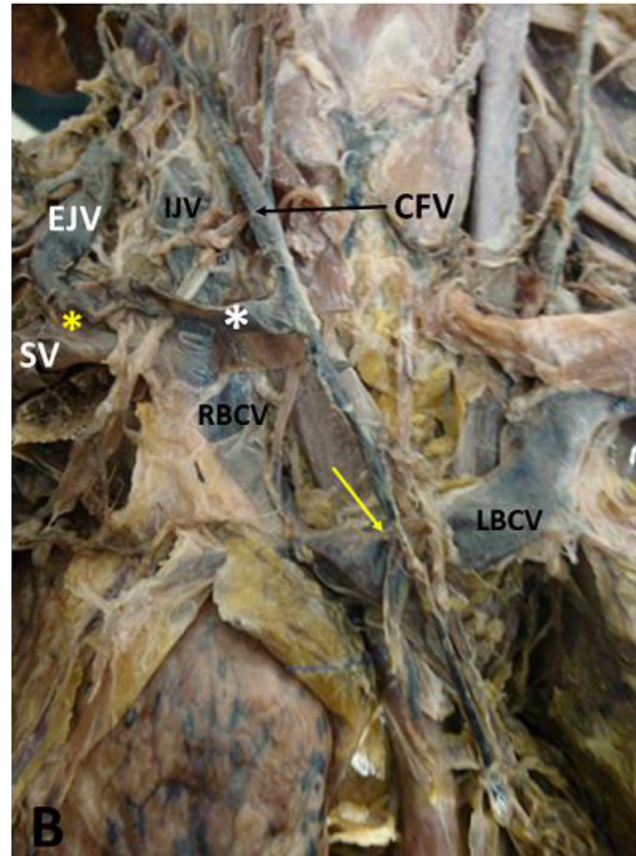


**Figure 2: A)** Anterior view of neck. Anterior jugular vein.



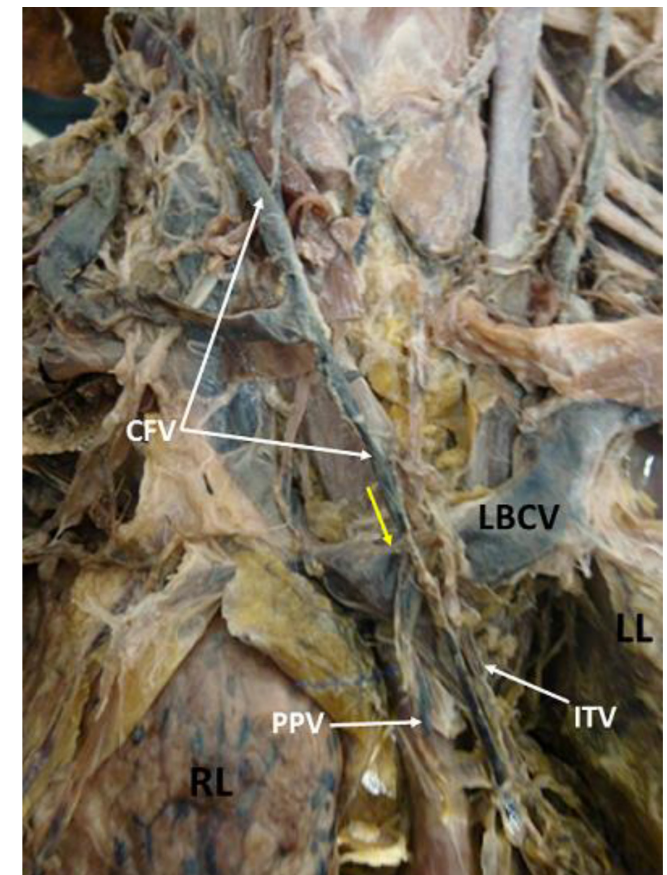
AJV; common facial vein: CFV; white asterisk: communicating branch between common facial vein and external jugular vein

**Figure 2: B)** Common facial vein.



CFV; subclavian vein: SV; left brachiocephalic vein: LBCV; internal jugular vein: IJV; external jugular vein: EJV; right brachiocephalic vein: RBCV; yellow arrow: anastomosis between left brachiocephalic vein and common facial vein; white asterisk: communicating branch between common facial vein and external jugular vein; yellow asterisk: common venous trunk between EJV and CFV.

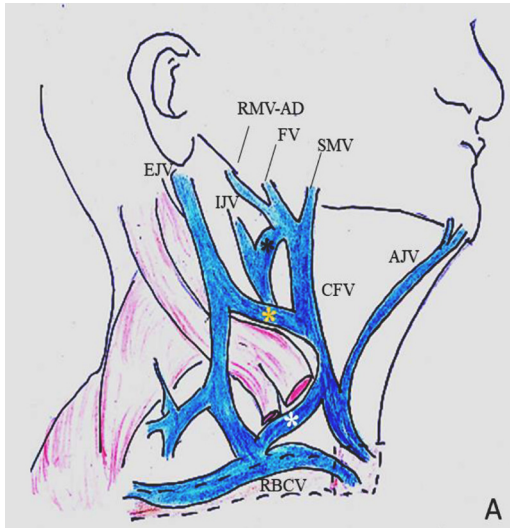
**Figure 3:** Anterior view of neck and thorax. Right lung.



RL; left lung: LL; common facial vein: CFV; pericardiophrenic vein: PPV; internal thoracic vein: ITV; yellow arrow: anastomosis between left brachiocephalic vein and common facial vein.

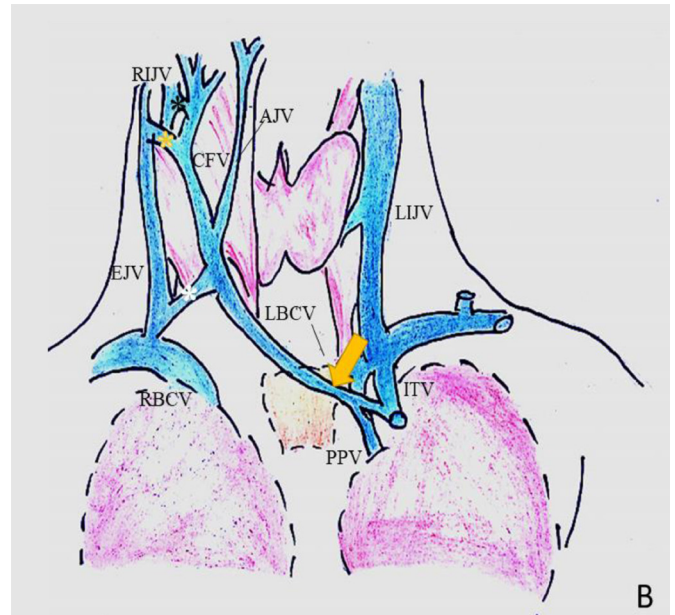
**Figure 4:** Schematic representation of the anomalous venous drainage which have been seen.

A. Lateral view of the neck and the angle of the mandible. Right site. External Jugular Vein.



EJV; retromandibular vein- anterior division: RMV-AD; Facial Vein: FV; Submental Vein: SMV; common facial vein: CFV; Anterior Jugular Vein: AJV; black asterisk: anastomosis between internal jugular vein and common facial vein; yellow asterisk: anastomosis between external jugular vein and common facial vein; white asterisk: communicating branch between common facial vein and external jugular vein; right brachiocephalic vein: RBCV.

B. Anterior view of neck and thorax. Right internal jugular vein: RIJV; left internal jugular vein.



LIJV; left brachiocephalic vein: LBCV; yellow arrow: common facial vein anastomosed with contralateral brachiocephalic vein and terminating into contralateral pericardiophrenic vein and into contralateral internal thoracic vein.

process of first branchial arch. The venous plexus around developing clavicle along with the veins of first branchial arch which elongates the terminal part of VPV is shifted toward cephalad part of precardinal vein, which later develops in internal jugular vein (IJV) [12]. Frontonasal process and maxillary process join and within its mesoderm linguofacial vein develops and join with VPV. The primitive maxillary vein anastomoses with linguofacial vein to form anterior facial vein. Retromandibular vein develops within the mesenchyme of temporal region and opens into linguofacial vein to form common facial vein (CFV). CFV ultimately drains into (IJV). IJV develops from caudal part of anterior cardinal vein. EJV develops from venous plexus in the neck region connecting caudally with cephalic vein and cranially with retromandibular vein (RMV) and anterior facial vein at 22 mm stage of embryo [13]. The cephalic vein forms a venous ring around clavicle from which it is connected to the caudal part of precardinal vein. The deep segment of this venous ring form subclavian vein. The part of cephalic vein which is ventral and superficial to the cephalic (Jugulo cephalic part) often dwindles and is lost [14]. The cephalic vein directly opens into axillary vein below the clavicle and external jugular vein (EJV) opens into subclavian vein [15].

The complex embryological development of the vascular system often results in a myriad of clinically relevant anomalies. A variation in the drainage pattern of the veins of the face has been observed in the past. The standard anatomical description of the veins of the face is of superficial temporal vein uniting with maxillary vein within the substance of the parotid gland to form retromandibular vein. The retromandibular vein divides into anterior and posterior divisions before emerging out from the apex of the parotid gland. The anterior branch joins with the facial vein slightly inferior and anterior to the

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angle of mandible to form common facial [16-17]. In the present study, the common facial vein (CFV) was formed by union of the anterior division of retromandibular vein (RMV-AD); the inferior masseteric vein (IMV); the submental vein (SMV); the external palatine vein (EPV); the facial vein (FV). The common facial vein present anastomosis (transverse venous connections) with internal jugular vein (in the upper third of the neck) at 34.5 mm below the angle of the mandible and external jugular vein (in the middle third of the neck) at 69 mm below the angle of the mandible. The diameters of the transverse venous connections were of 5.53 and 5.95 mm, respectively.

The CFV crosses the base of mandible, inferior surface of submandibular gland and drain into internal jugular vein. Different patterns of variations in the venous drainage have been observed in the past. A case of FV uniting with the RMV at a higher level in the right parotid gland was observed by Kopuz C et al, [18]. FV draining into the superficial temporal vein, with an undivided RMV was also reported [19]. CFV draining into EJV, an incidence of 5% was noted in the study done by Choudhry R et al, [20]. In another study conducted by Gupta V et al, [21], the incidence of this particular variation was 9%. Pai et al, [22] reported an incidence of 7.7%, is at par with the reported incidence which ranges between 5-9% [20, 21]. A unilateral termination of the common facial vein into the subclavian vein on the left side has been reported earlier [16]. Siddaraju SK, reported common facial vein dividing and draining in to external as well as internal jugular veins. [23]. Pikkieff *et al*, noticed facial vein ending as external jugular vein [24]. Bertha A and Suganthi Rabi [17] found in three specimens, the common facial vein opened into the external jugular vein. In one specimen, on the right side, the common facial vein ran separately for almost the whole length of the neck and opened into the external jugular vein. In other two cadavers, the left common facial vein drained into the external jugular vein, while the right vein drained into the internal jugular vein.

The anterior jugular vein is formed in the hyoid region by the confluence of the superficial submandibular veins and extends vertically downwards, left and right of the midline of the anterior cervical triangle, along the anterior border of the sternocleidomastoid muscle. Nearby the jugular notch of the sternum it passes between the sternocleidomastoid muscle and the infrahyoid muscles. In size it is usually inverse to the external jugular vein [25, 26]. Finally it drains into the subclavian (54%) or into the external jugular vein (46%) [27]. The two anterior jugular veins above the jugular notch of the sternum communicate each other by a transverse vein named jugular arch. Regarding the anterior jugular vein variations, it is possible instead of the two anterior jugular veins to be only a single one, localized in the midline of the anterior cervical region called median cervical vein [25-28]. Also it is likely that the upper main part of these veins could be replaced by a grid of venules that drain into the jugular arch [25]. Nayak reported multiple variations of the left jugular veins. The facial vein continued down as anterior jugular vein which was of the same size as the internal jugular vein and drained into the subclavian vein deep to the sternocleidomastoid muscle. In addition the anterior jugular vein had a large communicating branch with the anterior division of the internal jugular vein [29]. Fabian et al. reported an anomaly of the jugular veins system bilaterally, with the right anterior jugular vein draining into the confluence of internal jugular and subclavian vein and with the left anterior jugular vein draining into the terminal portion of the internal jugular vein. The right external and anterior jugular veins were considerably small with the external jugular vein being smaller than the anterior [30]. Maskey et al., described the formation of a common venous channel between internal jugular and anterior jugular vein where the facial, the lingual and the submental vein drained [31, 32]. In the present study at level of the inferior third of the neck, the right anterior jugular vein drain into common facial vein on its anterior aspect (33.8 mm

above the right sternoclavicular joint). There was no jugular venous arch in the suprasternal space. On the posterior aspect of the common facial vein (10 mm above the right sternoclavicular joint) is observed a communicating branch (of 56.5 mm of length and 6.35 mm of diameter) united with the external jugular vein to form a common venous trunk which terminated into subclavian vein. The right common facial vein (CFV) descended obliquely downwards and forward, superficial to the sternocleidomastoid, appeared in the suprasternal space. CFV is oriented laterally obliquely, deep to the brachiocephalic artery trunk, but superficial to the left brachiocephalic vein. CFV anastomosed with left brachiocephalic vein and terminating into contralateral pericardiophrenic vein and into contralateral internal thoracic vein.

The case presented in the present study is considered it as a rare variation has not been previously described. It is the first case reported so far in the available scientific literature.

### Clinical Importance

Standard anatomy textbooks describe the internal thoracic veins (ITVs) as the principal veins on the internal surface of the thorax, accompanying the internal thoracic arteries (ITAs). More specifically, these veins are the venae comitantes to the inferior half of ITAs, corresponding to the superior epigastric veins that mainly receive the anterior intercostal veins. At the point of the manubriosternal joint right internal thoracic vein (RITV) and left internal thoracic vein (LITV) form a common trunk that ascends and joins the right and left brachiocephalic veins respectively [33,34]. According to Romanes, the number of RITVs or LITVs could vary from one to two, but these veins will typically unite at the third costal cartilage medial to ITA [35]. The ITVs represent an important and, at times, superior, alternative to other recipient vessels of the region, especially in delayed reconstruction after mastectomy [36]. The importance of such knowledge lies

in the fact that the use of ITVs in breast reconstruction has numerous advantages. The ITVs are better than the thoracodorsal vessels with regard to flap positioning, as well as positioning for the vascular anastomoses. The field of dissection is not violated and there is no perivascular scarring in the delayed reconstruction scenario [37]. Although ITAs have been investigated anatomically [38-40] because of their frequent use in cardiac surgery [41-43] or for diagnosis in breast cancer lymphadenopathy [44-47], detailed anatomical descriptions of ITVs are still rare [34-48].

The pericardiophrenic vein is a vessel that runs along with the pericardiophrenic artery and phrenic nerve between the pericardial pleura and the pericardium bilaterally. Superiorly, the left pericardiophrenic vein, located on the lateral border of the heart, joins the left internal thoracic vein before draining into the left brachiocephalic vein. Inferiorly, its branches form veno-venous collaterals with the left gastric vein (subdiaphragmatically) and the inferior vena cava (IVC) [48]. The pericardiophrenic vein has been previously described in association with iatrogenic complications, including insertion of central venous catheters and Swan-Ganz catheters [50-52]. Furthermore, the pericardiophrenic vein has also been described in portal hypertension as a collateral pathway draining the left gastric vein [53, 54].

Deviation from the normal pattern in the vascular system is a common feature, and it is more common in the veins than in the arteries. Detailed knowledge of normal course, termination and variation of blood vessels is important to avoid complication in surgeries and to prevent undue blood loss. Common facial vein terminating into external jugular vein may give false record of central venous pressure. Complication may occur during central venous catheterization because of such variation. The knowledge of the variations of the superficial veins of the neck the effective utilization of these veins for grafting in endarterectomies [55]. The common



facial vein has been used as a patch material for carotid angioplasty, as it is almost always available at the carotid exposure site [17]. It can be harvested by the same incision by a simple technique and at no extra operating time [56, 57]. According to Siddaraju KS, external jugular vein may give diagnostic signs of heart failure. Techniques of central venous catheterization are now of great clinical importance both to measure central venous pressure (CVP), for practical purpose the pressure within the right atrium, and also to allow rapid blood replacement and long term intravenous feeding by means of glucose, amino acids and fats [23, 58-60].

The Jugular venous arch (JVA) is an infrequently found transverse connecting trunk extending across the midline between the two anterior jugular veins (AJV) of either side and lying in the suprasternal space between superficial and pretracheal layers of the cervical fascia [61]. The JVA serves as a natural crossover collateral and may become prominent in cases of deep venous outflow obstruction. It is the midline part of the anterior jugular venous system (AJVS), typically in U-shape or V-shape configuration. Apart from textbooks of surgery in the context of, for example, thyroid surgery or tracheostomy, it is mentioned in the literature mostly in relation to malposition of central vein catheters or unintended crossover placement of central lines [62, 63].

The AJVS is an important collateral venous network across the midline of the superoanterior aspect of the thorax and, if fully developed, is composed of three segments: the JVA as the transverse midline segment [64] and the two as infrequently found horizontal lateral segments connecting the JVA to the subclavian vein (SV), external jugular vein (EJV), or more rarely internal jugular vein (IJV). It is worth emphasizing that "anterior jugular venous system" is to be understood as a clinical and not as an anatomical term. In the anatomical images or the textbooks of anatomy, the horizontal lateral segment of the AJVS often is unmarked or rather regarded as the termination of the AJV. Corresponding

to its variability, the AJVS shows a wide array of formation, course, communication, and termination [65]. Schummer et al. [66] stated that correct placement of central venous catheters through the AJVS may be possible.

## Conclusion

We have found not only a rare but also a really important anatomical variation in the venous drainage pattern of the face and neck which is involving even the venous drainage of the contralateral side of the thorax, this anatomical variation supposes a therapeutic opportunity in the case of plastic surgery procedures such as the use of skin flaps which can be favored by the presence of an extensive venous drainage like the one that we have reported here. In the other hand we need to remark that this anomalous drainage also supposes a important risk to be taken into account in the performing of some diagnostic procedures in one side and face, neck, and even thorax surgeries on the other side, who could have very compromising iatrogenic complications like unnecessary hemorrhages. As we can see it is really important to keep forward with anatomical studies to discover such variations, and it would be ideal to perform an exploration of the irrigation and drainage before a surgical intervention to avoid a considerable number of complications.

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## Competing interests

None

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