

Duplicated internal jugular vein: a case report

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SUMMARY

Anatomical variants of the venous central system are very infrequent; nevertheless, it is useful to be aware of them in order to avoid complications during common procedures. The purpose of the present study is to describe an anatomical variant of the Right Internal Jugular Vein (RIJV), and to investigate the frequency of this variant reported in the current literature.

Authors present an anatomical variant of RIJV, found during the dissection of an adult male cadaver, previously fixed in a formaldehyde-based solution, who was voluntarily donated to the Faculty of Medicine of Universidad de la República in Montevideo, Uruguay. The cadaveric material was used taking into account the Helsinki Declaration regarding prior live donation and informed consent. A photographic record and a bibliographic search in electronic bases were carried out in order to discover the frequency with which this variant occurs. It was described as an isolated duplicated RIJV, which had its origin at the level of the right jugular foramen, and had its division next to the thyroid cartilage after a path of 6.5 cm into two branches (anteromedial and posterolateral) that ended separately, and were 7.2 cm and 5.4 cm in length, respectively. The relations with

near structures such as the accessory nerve and the omohyoid muscle were also described and compared with the literature reviewed.

Key words: Internal jugular vein – Duplication – Fenestration – Vein catheterization – Case report

INTRODUCTION

The Internal Jugular Vein (IJV) is classically described as a vessel that originates as a continuation of the sigmoid sinus in the interior of the cranial cavity, and ends behind the sternoclavicular joint when it reaches the subclavian vein to form the brachiocephalic vein.

The anatomical variants of great veins of the body are infrequent when compared to the peripheral veins. A rare variant of the IJV is its duplication, which consists of two divergent branches of the vein that originate after its emergence as a unique vessel, and end up separately (Downie et al., 2007; Hashimoto et al., 2012; Wong et al., 2012; Nayak et al., 2015; Contrera et al., 2016).

Although it is unlikely that variants have any physiological implications, they must be taken into account in regard to avoiding injuries during

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the realization of interventional procedures (Downie et al., 2007).

In regard to the etiology of variants, some authors agreed on the existence of three embryological theories: neural, bony and vascular (Prades et al., 2002; Hashimoto et al., 2012; Nayak et al., 2017). Downie et al. (2007) added a fourth theory: the muscular one. However, there is no agreement on which theory is the most plausible.

The Right Internal Jugular Vein (RIJV) is the preferred site for placement of central venous catheters (Downie et al., 2007; Nayak et al., 2015), because it has a more direct path to the heart, in comparison to the contralateral vein. For this reason, it is necessary to know the normal anatomy and its variants.

The aim of this study is to describe the anatomy of this rare case of a variant of RIJV and to compare this finding with the ones published in the current literature in order to determine the frequency of this variant.

CASE REPORT

The present case is an anatomical variant of RIJV that was found during curricular neck dissection of an adult male cadaver, previously fixed in a formaldehyde-based solution, who voluntarily was donated to Facultad de Medicina after signing an ethical consent.

The dissection was carried out at Departamento de Anatomía de Facultad de Medicina, Universidad de la República in Montevideo, Uruguay. The cadaver did not have previous surgical approaches or pathology in thorax or neck.

The skin approach required a longitudinal incision in the middle line of the neck and two complementary ones: a superior one at the level of the lower border of the mandible, and an inferior one parallel to the clavicle. The skin flap, the platysma muscle, the superficial layer of the cervical fascia and the sternocleidomastoid muscle (SCM) were reclinated laterally to the posterior border of SCM, in order to dissect the neurovascular bundle of the neck.

To expose the entire course of the RIJV, both portions (clavicular and sternal) of the SCM were desinserted, as well as distal portions of the inf-

rahyoid muscles. The thorax was approached by median sternotomy.

The following variables were registered: vein origin, course, termination, tributaries, level of the division, level relative to the thyroid cartilage, relation with the omohyoid muscle and accessory nerve. The following measures were recorded: diameter and length of the medial and lateral branches. All the measurements were taken by a digital caliper, which was manipulated by the same researcher.

Finally, an exhaustive bibliography research was carried out in electronic bases like Medline and Pubmed, using words like "internal jugular vein", "anatomical variation", "duplication", "bifurcation" in combination with Boolean operators "AND", "OR". The collected articles were used for the discussion and analysis of the findings presented in this study, and they are properly cited at the end of this paper.

Regarding the results, it was possible to determine that RIJV corresponds to the duplicated morphology (Fig. 1A).

About the origin, it was found that the vein emerged from the jugular foramen as a unique vessel. At the level of the inferior border of the thyroid cartilage, after a path of 6.5 cm it was divided into two branches of unequal caliber (Fig. 1A).

The anteromedial branch was 1.3 cm in diameter and 7.2 cm in length. The posterolateral branch was 0.6 cm in diameter and 5.4 cm in length.

Regarding the termination, the anteromedial branch was tributary of the left brachiocephalic vein, and the posterolateral branch formed the right brachiocephalic vein with the homolateral subclavian vein (Fig. 1B).

The following were registered as tributaries of the anteromedial branch: the inferior thyroid vein and the thyrolinguofacial trunk. There were no tributaries of the posterolateral branch (Fig. 1B).

Lastly, in reference to the anatomical relations, it has been observed that the accessory nerve passes behind the RIJV in its origin, and goes straight to reach the SCM. In addition, the omohyoid muscle ran anterior to the point of division of the vein.

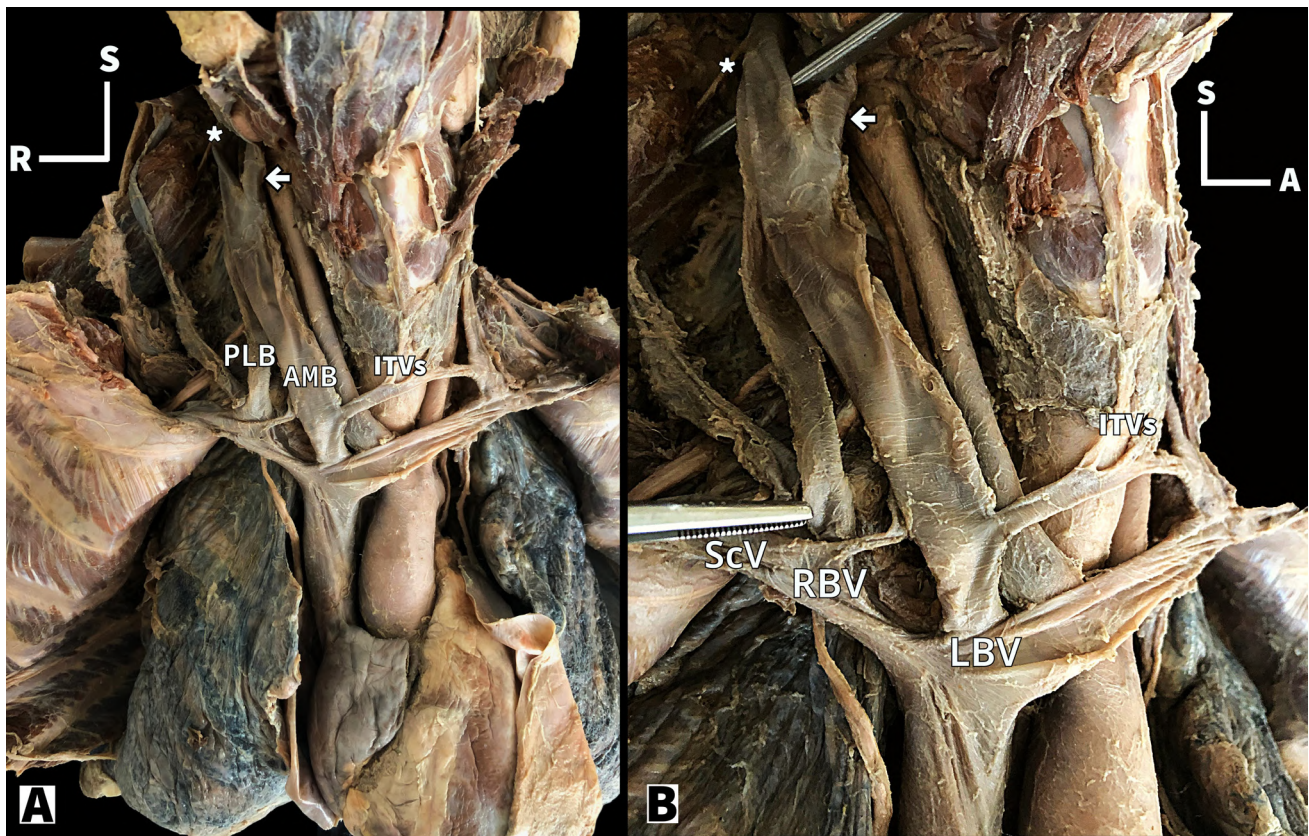


Fig. 1.- **A-** Anterior view of the neck and thorax. There is a Duplicated RIJV that originates as a unique vessel and ends as two separated branches. AMB: anteromedial branch; PLB: posterolateral branch; **B-** Right sided view of the neck. The totality of RIJV, its two branches, its tributaries and its termination is observed. The anteromedial branch is thicker and it drains in the Left Brachiocephalic vein. The posterolateral one ends up merging with the right subclavian vein to form the right brachiocephalic vein. ScV: Right Subclavian vein; RBV: Right Brachiocephalic vein; LBV: Left Brachiocephalic vein; ITVs: Inferior Thyroid veins; *: Accessory Nerve; arrow: Thyrolinguofacial trunk.

COMMENTS

A few cases of anatomical variants of Internal Jugular Vein (IJV) have been reported, using in an indistinct way the following terms: duplication, bifurcation and fenestration.

Some authors distinguish between the terms duplication and bifurcation, taking into account the level of division of the branches with respect to the omohyoid muscle. They affirm that, if IJV divides inferior to the muscle, the correct term to use is duplication. On the other hand, if it divides superior or at the level of the muscle, the proper term to use is bifurcation. (Mumtaz and Singh, 2019).

Nayak et al. (2017) propose a morphological classification into three types: A, B, C. Type A corresponds to the division of the IJV in two branches up to the level of the posterior belly of the digastric muscle, and the final reunion of the branches at the level of the omohyoid muscle with the accessory nerve passing through both branches. Type B differs from type A in the caudal extension, which

continues inferior to the tendon of the omohyoid muscle. Finally, in type C the duplication begins at the level of the hyoid bone. About the termination of types B and C, it is interpreted from the image that follows the text that the branches end independently, although this is not specified in writing.

Other authors like Downie et al. (2007), Hashimoto et al. (2012) and Contrera et al. (2016) refer to duplication when the IJV divides into two independent branches after being originated as a unique vessel, and to fenestration when previous to its end, the two branches are reunited in an only vessel. Having said that, duplication acquires an inverted “Y” shape and fenestration an eyelet one (Downie et al., 2007). In order to avoid confusion in the use of terms, the authors of this manuscript will be using the aforementioned criteria and will reclassify the previous reports to unify terms.

Due to the inconsistency about the proper terminology, the incidence of these variants is still unknown (Downie et al., 2007). Prades et al.

Table 1. Reclassification of the IJV morphology of previous reports, using Downie et al. (2007), Hashimoto et al. (2012), and Contrera et al. (2016) definition of Duplication and Fenestration. R: right; L: left; M: male; F: female.

Author	Cases and Gender (M; F)	Neck side	Proposed Classification	Reclassification
Rossi and Totori-Donati, (2001)	1 F	Bilateral	R Duplication L Partial duplication	R Duplication L Fenestration
Prades et al. (2002)	3 M	2 L 1 R	Duplications	Fenestrations
Turan-Ozdemir et al. (2004)	1 F	R	Duplication	Duplication
Downie et al. (2007)	1 F	Bilateral	Duplication R Duplication L	Duplication R Duplication L
Hashimoto et al. (2012)	4 M	3 L 1 R	Fenestrations	Fenestrations
Contrera et al. (2015)	3 (2 M, 1 F)	2 L 1 R *	Fenestration L Fenestration L Duplication R	Fenestration L Fenestration L Duplication R
Nayak et al. (2017)	1 M	L	Duplication	Fenestration
This paper	1 M	R	Duplication	Duplication

*: Corresponds to the Female case.

(2002) report a prevalence of 0.4%. Hashimoto et al. (2012) report 3.3%, and Contrera et al. (2016) report 1.0%. The authors of the present manuscript have decided to reclassify the obtained data in order to unify the terminology (Table 1).

In reference to the prevalence of this variant, taking into account the neck side and gender, 17 cases were found in the literature. A total of 6 cases of double internal jugular vein have been described in four women, due to the fact that two of them presented bilateral cases. There is a clear predominance of the left side (58.8%) over the right one (41.2%), and there is a male predominance, with 11 cases over the female cases, which are only 4 (Table 1). However, in the literature reviewed a reason for this predominance has not been specified.

The RIJV described in this paper was originated as a unique vessel at the level of the jugular foramen, and so were the veins described by other authors (Prades et al., 2002; Turan-Ozdemir et al., 2004; Downie et al., 2007; Hashimoto et al., 2012; Contrera et al., 2016; Nayak et al., 2017 and Mumtaz et al., 2019).

Prior to RIJV's division into two branches, it had a 6.5 cm distance, in comparison to Downie et al. (2007), which registered a distance of 5.0 cm at that point.

The point of division was at the level of the inferior border of the thyroid cartilage. Other authors

used different landmarks to localize this point. Prades et al. (2002) used 2 cm above the hyoid bone; Turan-Ozdemir et al. (2004) used the level of true vocal cord, and Downie et al. (2007) and Contrera et al. (2016) the level of the hyoid bone.

The branches of RIJV had unequal caliber and length. The anteromedial one had 1.3 cm of diameter and 7.2 cm in length. The posterolateral one had 0.6 cm of diameter and 5.4 cm in length. Downie et al. (2007) registered diameters of 1.5 cm for the medial branch, and 2.0 cm for the lateral branch.

In regard to the tributary veins, in the present study the anteromedial branch received the inferior thyroid vein. No tributaries of the posterolateral branch were found. The main trunk of RIJV received the thyrolinguofacial trunk before dividing. Downie et al. (2007) registered as tributaries of the medial branch: the facial, superior and inferior thyroid veins and the thyrolinguofacial trunk, while the lateral branch received the transverse cervical vein.

About the RIJV termination, in the present work the anteromedial branch drained into the left brachiocephalic vein, and the posterolateral branch formed the right brachiocephalic vein along with the homolateral subclavian vein. Some authors reported that the duplication drained into the homolateral subclavian vein (Turan-Ozdemir et al., 2004; Downie et al., 2007; Contrera et al., 2016).

None of them report a contralateral termination like this report does.

In reference to the embryological origin, vessels develop from a capillary plexus that suffers many changes, such as atrophy and development of channels in order to configure their definitive adult pattern. The IJV develops from persistence of the cranial portion of the Anterior Cardinal vein located above the transverse anastomosis at thoracic level. When more than one venous channel persists from the initial capillary plexus in the embryo, a duplicated or fenestrated pattern is seen. This corresponds to the “venous theory” (Prades et al., 2002; Nayak et al., 2017).

However, there exist other well-explained theories about the origin of duplication named “neural theory”, “muscular theory” and “bone theory” (Prades et al., 2002; Contrera et al., 2016; Nayak et al., 2017). The neural theory explains the origin of two venous branches when a nerve like the accessory is trapped between venous capillaries during development.

The bone theory proposes that the duplication is due to variations during skull ossification at birth, which may lead to the formation of two separated branches of the vein (Prades et al., 2002; Nayak et al., 2015; Contrera et al., 2016). Finally, the muscular theory argues that the duplicated IJV originates around the posterior belly of the omohyoid muscle (Contrera et al., 2016).

About the relations of duplicated RIJV, some of them may explain this vascular phenomenon as it was explained in the theories, such as those with the accessory nerve and omohyoid muscle. In this report, it was seen that the accessory nerve passes behind the main trunk of RIJV, whereas some authors reported in their fenestration cases the passage of the nerve through the branches of the vein (Prades et al., 2002; Hashimoto et al., 2012; Contrera et al., 2016; Nayak et al., 2017).

In this report, the omohyoid muscle passed in front of the point of division of the vein when compared to Downie et al. (2007), who described on the left side the passage of the muscle between the lateral branch of the duplicated vein and an aberrant one. Nayak et al. (2017) registered the finalization of fenestration at the level of the central tendon of this muscle.

Regarding the clinical importance of these findings, Prades et al. (2002) report that fenestrations are associated with venous ectasia, and Wong et al. (2012) affirm that these variants can be confused with laryngoceles or branchial cysts.

Many authors point out the importance of being aware of the existence of these variants during interventional procedures, such as the cannulation of a duplicated IJV and the neck lymph node dissection (Downie et al., 2007; Wong et al., 2012; Ferreira-Arquez et al., 2016; Nayak et al., 2017). In this context, an injury of anatomical structures adjacent to the vein may occur that may require challenging management, as well as wrong interpretations of the local imagenology. Due to this, Contrera et al. (2016) strongly recommend the documentation of the variants found, and Fernández et al. (2002) concluded that ultrasound-guided punctures can minimize the risk of associated complications when placing a central venous catheter.

CONCLUSIONS

A rare variant of RIJV was analyzed, which corresponds to the term “duplicated”, according to the bibliography. The real number of cases of this variant around the world cannot be estimated due to the inconsistency of the use of the terms “duplication” and “fenestration”.

The anatomy of the venous central system does not vary frequently. However, it is essential to take into account the existence of the aforementioned variants in order to avoid complications, due to the high frequency of procedures involving these vessels, such as central venous catheterization and those that involve the thyroid gland or its satellite lymph nodes.

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