



# Duplication of the external jugular vein: a language barrier of database search in classic anatomical studies

Kisho Ono<sup>1</sup> · Norie Yoshioka<sup>1</sup> · Dany Hage<sup>2</sup> · Soichiro Ibaragi<sup>1</sup> · R. Shane Tubbs<sup>2,3,4,5,6</sup> · Joe Iwanaga<sup>2,3,7,8</sup> 

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## Abstract

**Objective** Many anatomical variations of the superficial veins of the head and neck have been reported throughout the literature. Accordingly, anatomists and surgeons must have a comprehensive understanding of these variations to avoid confusion. Duplication of the external jugular vein (EJV) is occasionally observed during routine cadaveric dissections; however, this variation seems to be reported less often than actual experience suggests. Therefore, to gain a better understanding of its anatomical and clinical implications, an analysis of the available data should be available. Thus, in this article, we reviewed the current available literature for studies reporting duplication of the EJV.

**Methods** We conducted a search using PubMed and Google Scholar with the following keywords: “duplication of the external jugular vein,” “division of the external jugular vein,” and “fenestration of the external jugular vein,” “double external jugular vein,” and “doubled external jugular vein.” As a case illustration, we also describe a case of a duplicated EJV found during a right neck dissection of a female cadaver.

**Results** Twenty sides across sixteen different studies were analyzed including the present case. All studies were published between 2009 and 2020. EJV division patterns were classified as either duplication, fenestration, fenestration followed by duplication, or double fenestrations.

**Conclusions** We have reviewed the literature regarding cases documenting duplication/fenestration of the EJV. As it is often difficult to find recent studies that report on classic anatomical variations, therefore, revisiting older articles and textbooks is necessary for achieving a “comprehensive” review, especially across different languages.

**Keywords** Anatomic variation · Head and neck surgery · Cadaver · Jugular veins

## Introduction

The external jugular vein (EJV) is a vein in the lateral neck that collects superficial venous blood from the head and neck. The EJV is usually formed behind the mandibular angle by the union of the posterior auricular vein (PAV) and

the posterior branch of the retromandibular vein (RMV). It runs deep to the platysma muscle, descending diagonally on the surface of the sternocleidomastoid muscle and draining into the subclavian vein (SV) at the supraclavicular fossa [40]. Although both the EJV and internal jugular vein (IJV) can be observed by inspection and palpation of the

✉ Joe Iwanaga  
iwanagajoeca@gmail.com

<sup>1</sup> Department of Oral and Maxillofacial Surgery, Dentistry and Pharmaceutical Sciences, Okayama University Graduate School of Medicine, Okayama, Japan

<sup>2</sup> Department of Neurosurgery, Tulane Center for Clinical Neurosciences, Tulane University School of Medicine, 131 S. Robertson St. Suite 1300, New Orleans, LA, USA

<sup>3</sup> Department of Neurology, Tulane Center for Clinical Neurosciences, Tulane University School of Medicine, New Orleans, LA 70112, USA

<sup>4</sup> Department of Anatomical Sciences, St. George's University, St. George's, Grenada

<sup>5</sup> Department of Structural and Cellular Biology, Tulane University School of Medicine, New Orleans, LA, USA

<sup>6</sup> Department of Neurosurgery and Ochsner Neuroscience Institute, Ochsner Health System, New Orleans, LA, USA

<sup>7</sup> Dental and Oral Medical Center, Kurume University School of Medicine, Kurume, Fukuoka, Japan

<sup>8</sup> Division of Gross and Clinical Anatomy, Department of Anatomy, Kurume University School of Medicine, Kurume, Fukuoka, Japan

neck, it is generally easier to discern the EJV, which may provide a reliable estimate of central venous pressure [19]. The EJV has gained popularity for its many clinical applications including being used as a recipient vein for free tissue transplantation of the head and neck, diagnostic methods by insertion of a cannula, and intravenous treatment [7]. Therefore, a comprehensive knowledge of normal anatomy and potential variations is important for physicians seeing patients with pathology of the head and neck.

Anatomical variations of the venous system are more common than those in the arterial system. The size of the EJV may vary depending on many factors such as body type and neck size [4]. Additionally, duplication of the EJV is a well-known variation. However, it seems to be less reported than numbers suggest due to its perceived high incidence. To understand and discuss the anatomical and clinical implications of a duplicated EJV, it is vital to analyze the information currently available throughout the literature. Herein, we reviewed previously reported studies on duplication of the EJV and presented an additional case report.

## Materials and methods

A database search using PubMed and Google Scholar was conducted on November 25, 2020 without any language limitations. The following keywords were used in the search: “duplication of the external jugular vein,” “division of the external jugular vein,” and “fenestration of the external jugular vein,” “double external jugular vein,” and “doubled external jugular vein.” Two authors (K.O. and J.I.) independently reviewed the titles and abstracts of all the results and excluded studies that were duplicated or not in English. A total of fifteen studies underwent full-text assessment and were noted for publication year, age, sex, side, method of identification, division pattern, and positional relationship with other blood vessels and nearby structures. A division of the EJV was defined as “fenestration” when the EJV reunited after the division and “duplication” when the duplicated EJVs terminated separately [12]. Additionally, we present a case illustration of a duplicated EJV with the presence of an unusual submental vein.

## Results

### Data analysis

Twenty sides across sixteen studies were analyzed including the present case. All the included studies were published between 2009 and 2020. Ages ranged between 47 and 82 years, with six of unknown age. Six females, eight males, and five of unknown sex were included. Eight were on the

right side, seven were on the left side, one was on both sides, and three were unknown. Two were found during surgery and seventeen were found during cadaveric dissection. Duplication, triplication, fenestration, fenestration followed by duplication, and double fenestrations were reported. All other results are presented in Table 1 [9–11, 13, 21, 23, 25, 26, 29–31, 33–35, 38].

## Case presentation

A duplicated external jugular vein (EJV)—anterior and posterior—was found during a right-sided head dissection of an 82-year-old at death female of European descent cadaver. Anterior and posterior EJVs ran lateral to the sternocleidomastoid muscle (Figs. 1, 2). The posterior EJV was classified as normal, whereas the anterior was the duplicate. The superficial temporal vein had a small loop lateral to the temporomandibular joint. The superficial temporal vein and maxillary vein coursed posterior to the neck of the condyle and merged to become the retromandibular vein. The retromandibular vein descended posterior to the ramus and divided into superficial and deep parts at the angle of the mandible. The superficial part became the anterior EJV and communicated with the posterior EJV. The deep part was an extension of the normal retromandibular vein and joined the confluence of the facial vein to form the common facial vein (Fig. 3). The common facial vein then drained into the internal jugular vein. The anterior and posterior EJVs joined to form the common EJV, while an anastomosis was formed between the submental and facial veins, and the submental and anterior jugular veins (Figs. 1, 4). The submental vein ran lateral to the submandibular gland. The EJV on the left side was normal. There were no surgical scars or pathological features found within the dissected area.

## Discussion

### EJV variations

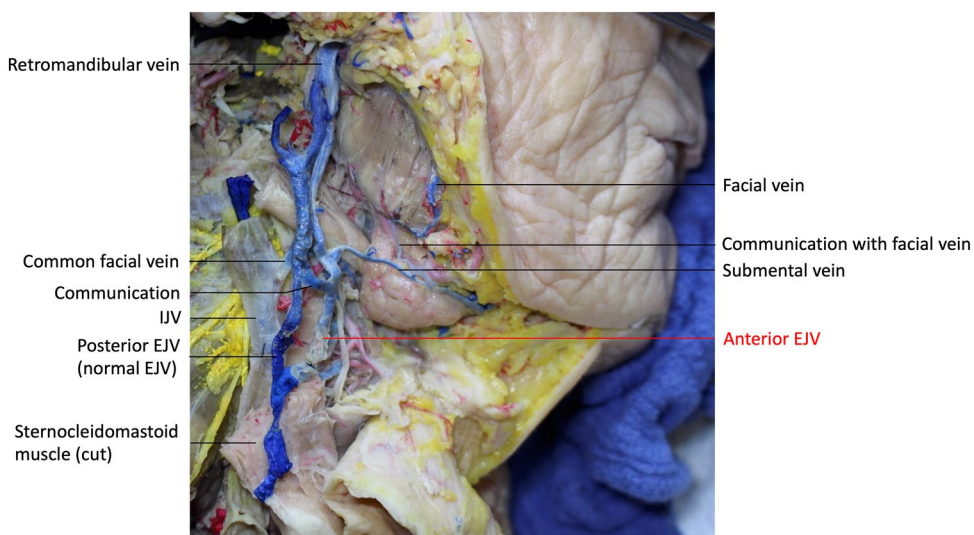
Numerous variations affecting the size, morphology, course, branching, drainage, and confluence, of the EJV have been previously reported in the literature [32]. Tubbs et al. (2016) have observed several EJV variations including being formed by the posterior auricular vein, receiving tributaries from the facial and lingual veins, draining into the cephalic, subclavian, or internal jugular veins [36]. Vollala et al. (2008) performed dissections on 75 cadavers and reported variations in the formation of the EJV including one cadaver with a very low formation of the EJV and another with an EJV that was formed by the union of the facial vein and the retromandibular vein [39].

**Table 1** Previously reported English literature on duplication/triplication/fenestration of the external jugular vein

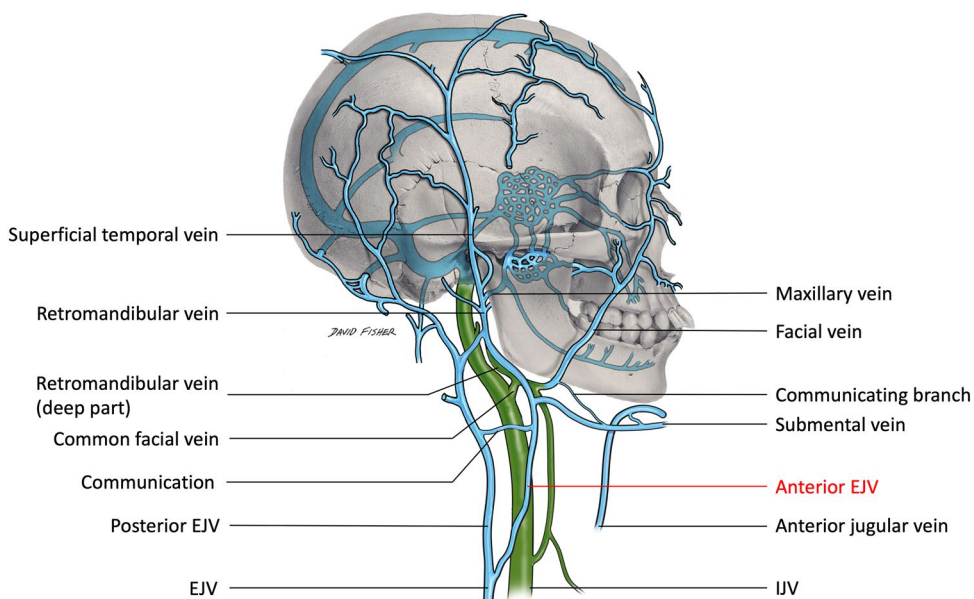
Study No.	Author (year)	Year	Age (years)	Sex <sup>a</sup>	Side <sup>b</sup>	Method identification	Division pattern	Notes
1	Comert and Comert [9]	2009	47	F	R	Surgery	Fenestration	None
2	Singla et al. [31]	2011	50	M	R	Cadaveric dissection	Duplication	Supraclavicular nerve passing through a venous ring
3	Shenoy et al. [30]	2012	60	M	L	Cadaveric dissection	Duplication	None
4	Cvetko [10]	2013	75	F	L	Cadaveric dissection	Fenestration	Facial nerve passing through fenestration
5	Snoj and Cvetko [33]	2013	77	F	L	Cadaveric dissection	Fenestration and duplication	EJV fenestration followed by duplication
6	Sangeeta et al. [29]	2013	Unknown	M	B	Cadaveric dissection	Fenestration	Bilaterally EJV fenestration, terminating subclavian vein
7	Paraskevas [23]	2014	63	M	R	Cadaveric dissection	Triplication	Triple EJV
8	Olabu et al. [21]	2015	Unknown	Unknown	R	Cadaveric dissection	Duplication	Terminating subclavian vein and internal jugular vein
			Unknown	Unknown	L	Cadaveric dissection	Double fenestration	None
9	Cvetko [11]	2015	75	F	R	Cadaveric dissection	Fenestration	EJV absent on left
10	Sugiyama et al. [34]	2017	77	F	L	Surgery	Fenestration	Contralateral side not investigated
11	Pillay et al. [25]	2018	Unknown	Unknown	Unknown	Cadaveric dissection	Duplication	Fetal specimen, “H” shaped communication joining the two
						Cadaveric dissection	Duplication	
						Cadaveric dissection	Duplication	
12	Eskell et al. [13]	2019	80	M	L	Cadaveric dissection	Fenestration	None
13	Vani et al. [38]	2019	50	M	R	Cadaveric dissection	Fenestration	Supraclavicular nerve trunk passing through fenestration
14	Ponnambalam and Karupiah [26]	2020	52	M	L	Cadaveric dissection	Fenestration	Transverse cervical nerves passing through fenestration
15	Téllez-Hernández et al. [35]	2019	55	M	R	Cadaveric dissection	Duplication	Termed the second external jugular vein draining into the subclavian vein
16	Ono et al. (present case)	2021	82	F	R	Cadaveric dissection	Fenestration	Submental vein drainages into the anterior EJV

<sup>a</sup>F Female, <sup>M</sup> Male <sup>b</sup>R Right, <sup>L</sup> Left, <sup>B</sup> Bilateral

**Fig. 1** A duplication of the external jugular vein (EJV) on the right side. Anterior and posterior EJV travel lateral to the sternocleidomastoid muscle



**Fig. 2** Schematic drawing of the duplication of the external jugular vein

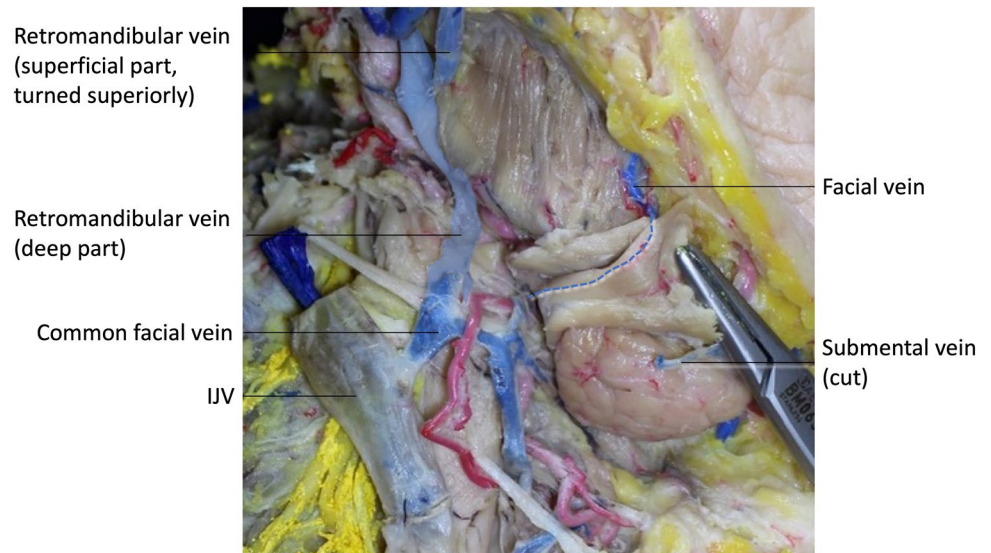


Vascular variations in the arteries of the head and neck region are typically highly reported and relevant, however, divisions of the veins are rarely discussed due to being perceived as less clinically significant. Furthermore, while division (fenestration or duplication) of the IJV is estimated to occur in about 0.4% of the population, there are very few reports of fenestration or duplication of the EJV [27]. A review of the existing English literature found nineteen cases reporting EJV division including the present case (Table 1). Comert et al. reported EJV fenestration during neck surgery [9]. Shenoy et al. found that the left EJV of a 60-year-old at death male cadaver was duplicated and ran anterior to the original EJV [30]. In 2013, Cvetko et al. reported a case in which the cervical branch of the facial nerve passed through a fenestrated EJV and a case in which the left EJV duplicated

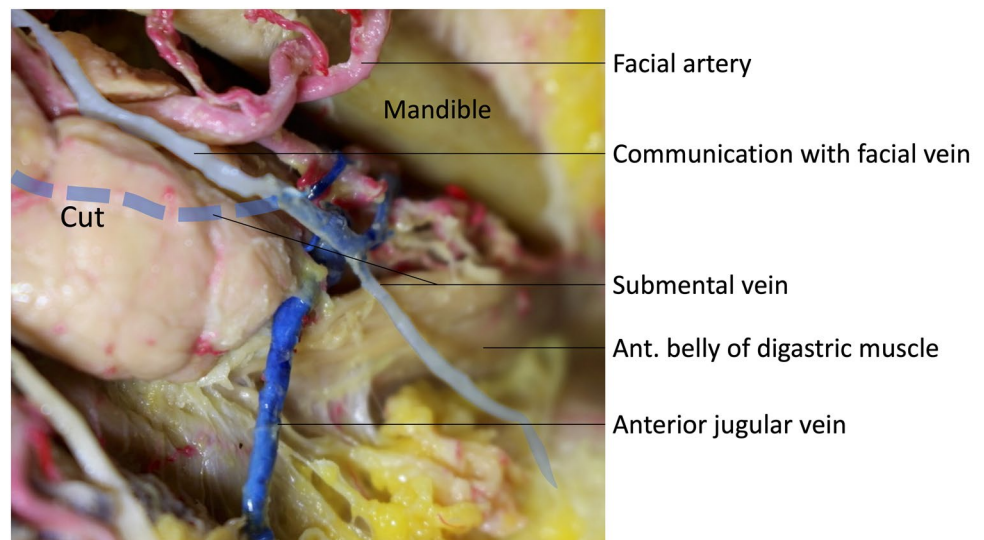
after its fenestration [10, 33]. Additionally, in 2015, these authors reported a deficiency of the left EJV and a fenestration of the right EJV in the same cadaver [11]. Sugiyama et al. surveyed 250 neck dissections performed on patients with oral cancer between January 2004 and September 2016 [34]. Fenestration of the EJV was present in only one of these cases, giving an incidence of 0.4% [34]. Recently, four additional cases of EJV duplication or fenestration were reported [13, 26, 35, 38]. The EJV in the case illustration reported herein divided into anterior and posterior branches, which reunited before invading the deep fascia. Of note, the present case is the only case reported to our knowledge where the submental vein drains into the anterior EJV.

While the reported cases of duplication or fenestration of the EJV we identified were all published between 2009

**Fig. 3** Unification of the deep part of the retromandibular vein (normal retromandibular vein) and facial vein forming the common facial vein



**Fig. 4** The submental and facial veins, and submental and anterior jugular veins show anastomoses



and 2020, it was hard to believe that this variation had not been reported prior to 2009. This should reduce the rarity of this variation as anatomists occasionally see the variations during cadaveric dissections and empirically know this is not extremely rare. To further explore this, we searched for additional relevant literature from the reference list of the cited articles and found Pikkeiff (1937), Brown (1941), and Jansky et al. (1959) who all classified different patterns of origin of the EJV [6, 17, 24]. Searching Japanese literature using 医中誌Web (Ichushi web by the Japanese Medical Abstract Society, <https://login.jamas.or.jp>), we found additional anatomical studies of the EJV by Ao (1960), and Mochizuki (1925), Yamada (1935), Adachi (1931), and Ogawa (1934) by the reference search [1, 2, 18, 20, 42]. They reported the origin of the EJV

from the retromandibular vein (94.2–96.7%), posterior auricular vein (43.3–62.8%), and (common) facial vein (34.9–44.4%). Other veins (submental, anterior jugular, parotid, and occipital veins) had a lower probability of giving rise to the EJV with an incidence of less than 5%.

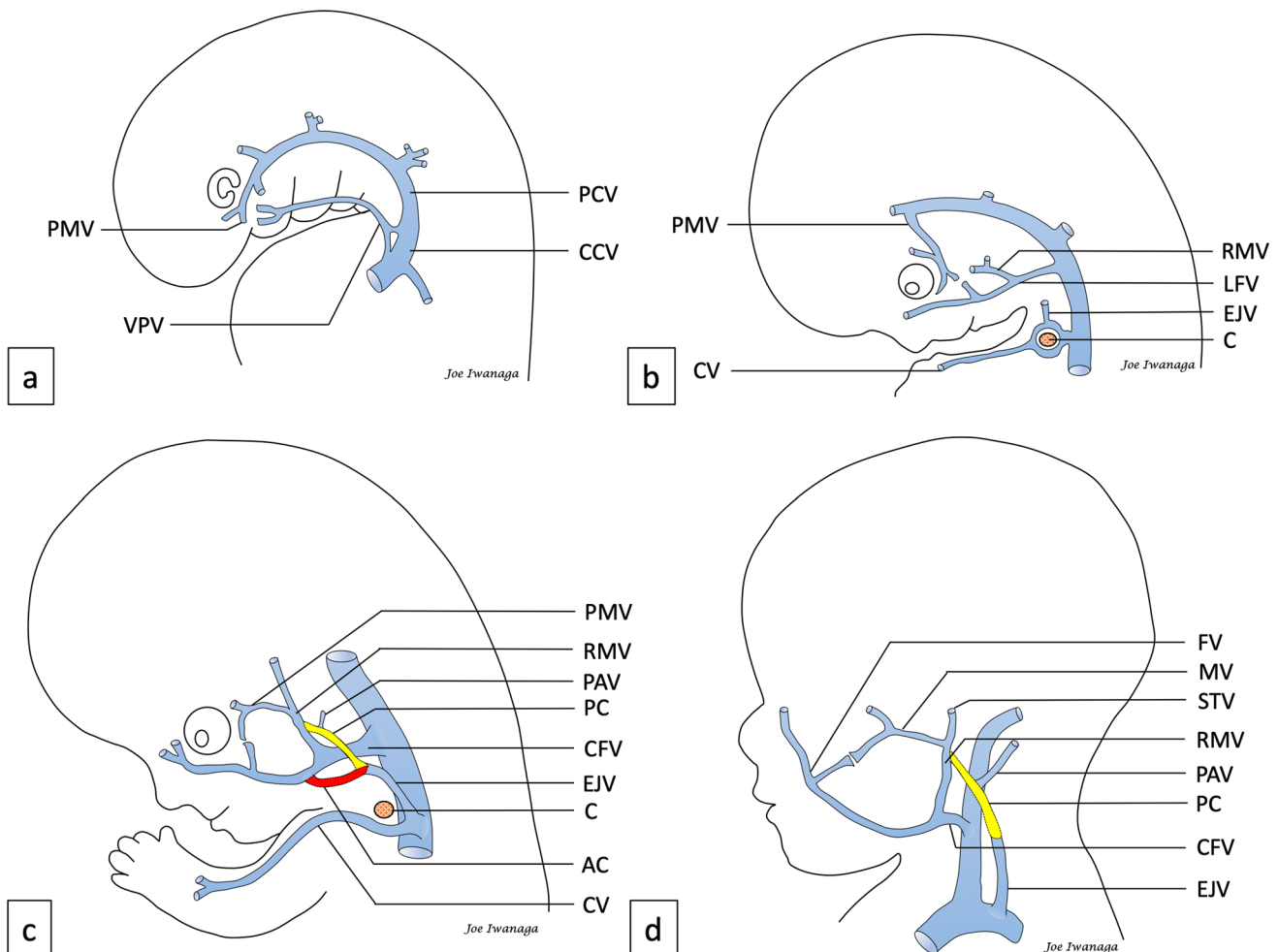
The majority of duplicated EJV's described by Ao (1960) originated from the retromandibular and (common) facial veins, whereas Mochizuki (1925) and Ogawa (1934) found the retromandibular and anterior jugular veins to be more common [2, 18, 20]. Finally, Ao found that only 4.2% of all the duplicated EJVs originated from the submental vein [2]. As shown above, the duplication/fenestration of the EJV has been reported, not only as a case report but also as part of an anatomical study of the EJV.

## Embryology

The development of the veins in the head and neck does not begin until after the skull has been formed. The ventral pharyngeal vein is the first venous structure formed; it opens into the precardinal vein (early IJV) and receives a tributary from the linguofacial vein. The retromandibular vein develops at the 18 mm stage of development and drains into the linguofacial vein to form the common facial vein, which then drains into the precardinal vein [14]. The preaxial vein (early cephalic) drains the neck via tributaries from the developing EJV [14]. The EJV is formed by the common facial vein and the anterior branch of the retromandibular vein [14]. The

early posterior auricular vein utilizes the posterior communication between the retromandibular vein and the EJV for drainage [14]. Later in development, the EJV is formed from the union of the posterior branch of the retromandibular vein and the posterior auricular vein, with eventual drainage into the subclavian vein [14] (Fig. 5).

It has been hypothesized that vein duplication may be due to derangement from the early development of the fetal period between weeks three to six [28]. There are reports documenting a disappearance of the cephalic connection to the EJV, leading to the development of additional communication between the CFV and EJV [5, 14]. Additionally, cases of IJV duplication are commonly reported in association



**Fig. 5** Embryogenesis of the vein in the head and neck (after Paget [22] and Choudhry et al. [8]). **a** Ventral pharyngeal vein and precardinal vein draining into the common cardinal vein (10 mm embryo, Carnegie stage 16 [15]). **b** Ventral pharyngeal vein replaced with the linguofacial vein into which the retromandibular vein drains. Note that the primitive maxillary vein draining into the precardinal vein anastomoses with the linguofacial vein (18 mm embryo, Carnegie stage 20 [15]). **c** The EJV anterior communication (red area) with the linguofacial vein and posterior communication (yellow area)

with the retromandibular vein are shown (40 mm embryo). **d** Anterior communication degenerates and posterior communication forms upper part of the external jugular vein (new born). AC anterior communication (red area); C clavicle; CCV common cardinal vein; CFV common facial vein; CV cephalic vein; EJV external jugular vein; FV facial vein; LFV linguofacial vein; MV maxillary vein; PAV posterior auricular vein; PC posterior communication (yellow area); PCV precardinal vein; PMV primitive maxillary vein; RMV retromandibular vein; STV superficial temporal vein; VPV ventral pharyngeal vein

with phlebectasia and are thought to be due to abnormal development of the venous wall, with incomplete formation of the muscular layer [33]. The superficial veins of the head and neck develop from the superficial plexus of capillaries and are finally formed through dilation of individual capillaries, the confluence of adjacent ones, and some regression from where the flow has been diverted. Anatomical venous variations can be caused by specific errors in these processes; however, these obvious factors are not yet completely understood [41].

## Clinical considerations

Venous variations and malformations in the head and neck regions are important to consider when performing reconstructive microsurgery and diagnostic procedures [37]. Preservation of the EJV in neck dissections not only reduces postoperative edema of the face and neck but can also be utilized for anastomosis in reconstructive microsurgery in cases requiring resection of the IJV [34]. Moreover, by familiarizing ourselves with their diverse patterns, we can prevent accidents such as massive bleeding during neck surgery [7]. It is important to understand EJV variations not only for performing neck surgery, but also for various other applications including, but not limited to, percutaneous central vein cannulation, shunt surgery for hydrocephalus, biocompatibility studies for synthetic materials for prostheses, total parenteral nutrition in critically ill patients, and invasive monitoring, which all make use of the EJV [39]. Additionally, knowledge of unusual drainage between the EJV and IJV are especially important for radiologists performing angiographic and sonographic studies [3].

## Conclusions

We reviewed the reported cases of duplication/fenestration of the EJV and reported a case of the venous fenestration of the EJV with a tributary of the mental vein. It is important for physicians to be aware of these variations in order to improve diagnoses (e.g., radiologists) and avoid intraoperative complications (e.g., surgeons).

It is often difficult to find recently published studies reporting on classic anatomy and its variations. In that case, it is necessary to revisit older articles and textbooks. Additionally, the languages derived from Latin such as French and German may be utilized when performing a database search, however, languages phenotypically different from Latin such as Japanese and Korean, are more likely to be missed despite having many previously published detailed anatomical studies, due to the difficulty of translation. Broadening a literature search to include these studies will provide a more comprehensive review of the anatomy.

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**Author contribution** KO: data collection, data analysis, and manuscript writing; NY: data analysis, and manuscript writing; DH: data analysis and manuscript editing; SI: data analysis and manuscript editing; RST: protocol/project development and manuscript editing; JI: protocol/project development, data collection, and manuscript editing.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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