Royal College of Surgeons
ADVANCING SURGICAL CARE

REVIEW

Ann R Coll Surg Engl 2019; **101:** 2–6
doi 10.1308/rcsann.2018.0185

Surgical review of the anatomical variations of the internal jugular vein: an update for head and neck surgeons

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ABSTRACT

BACKGROUND The internal jugular vein is one of the major vessels of the neck. The anatomy of this vessel is considered to be relatively stable. It is an important landmark for head and neck surgeons as well as the anaesthetists for both diagnostic and therapeutic purposes.

METHODS We present two case reports of the posterior tributary of the internal jugular vein and review the surgical literature regarding anatomical variations of the vein.

FINDINGS A total of 1197 patients from 27 published papers were included in this review. Of these patients, 99.6% had neck surgery and the rest were cadaveric dissections. Anatomical variations of the internal jugular vein were found in 2% of the patient cohort (n = 40). The majority of these patients had either bifurcation or fenestration of the vein. The posterior tributary of the internal jugular vein is unusual and is scarcely reported in the literature (three cases).

Knowledge of variations in the anatomy of the internal jugular vein assists surgeons in avoiding complications during neck surgery and preventing morbidity. Two rare cases of posterior branching of the internal jugular vein and experience of other surgeons are demonstrated in this extensive review.

KEYWORDS

surgical variations – Internal Jugular Vein – Anatomical variations

Accepted 10 September 2018

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Introduction

The vasculature of the head and neck is complex. A number of blood vessels traverse this region, which supply important and vital structures. Knowledge of the anatomy of the neck is particularly relevant to head and neck oncology and reconstructive surgeons and trainees, together with anaesthetists and intensivists.

Anatomical variations of the internal jugular vein (IJV) are uncommonly reported. Most of these reports are from anaesthetists and are based on evaluation of imaging for central venous access. The 'surgical literature' is solely based on the anatomical variations noted by the surgeons or anatomists during neck surgeries and teaching dissections. The anatomical features of the IJV are shown in Table 1.

Literature review

An extensive literature search to study the various anatomical variations of IJV as noted by surgeons and anatomists was conducted using electronic databases such as Medline, EMBASE and Google Scholar. A total of 124 papers were found, of which 27 were relevant (Table 2). A total of 40 anatomical variations were noted from a cohort of 1197 patients included in these 27 papers (Table 3).

Methods

Case history: patient A

A 72-year-old man presented with a T1N0M0 squamous cell carcinoma of the right posterior buccal mucosa/retromolar region. He underwent prophylactic selective neck dissection (level 1–4) of the right neck as part of ablative and reconstructive surgery for this cancer. During the level 2–4 neck dissection, a posterior tributary was seen draining into the IJV from the medial aspect of sternocleidomastoid muscle (SCM) going antero-inferiorly joining the lower third of the IJV (Fig 1).

Case history: patient B

A 74-year-old woman presented with a lump in the right neck of four weeks' duration. She had previously had squamous cell carcinoma of the left floor of the mouth

Table 1 Anatomical features of internal jugular vein.

Feature	Description
Embryology	Derivatives of the right and left anterior cardinal veins (week 8 of intrauterine life)[1]
Formation	Direct continuation of sigmoid sinus
Course	After exiting the jugular foramen, the IJV descends downwards in close proximity to the internal/common carotid arteries and the vagus nerve in the carotid sheath
Structure	Two dilated bulbs containing valves – superior (after exiting jugular foramen) and inferior (just before joining the subclavian vein is seen with its tributaries
Termination	Behind the sternal end of clavicle, the IJV joins the subclavian vein to form the brachiocephalic vein
Tributaries (all anterior)	1. Inferior petrosal sinus 2. Pharyngeal vein 3. Common facial vein 4. Lingual vein 5. Superior thyroid vein 6. Middle thyroid vein
Surface landmarks	Band joining ear lobe to sternoclavicular joint

Table 2 Review of the surgical literature.

No.	Paper	Year	Modality	Cohort	Feature	
					Variation	Cases
1	Deepak *et al*[4]	2015	Surgical	3	Bifurcation	1
					Trifurcation	1
					Posterior tributary	1
2	Sankar *et al*[5]	2011	Cadaveric	1	Fenestration	1
3	Contrera *et al*[6]	2016	Surgical	295	Bifurcation	1
					Fenestration	1
					Duplication	1
4	Hashimoto *et al*[7]	2012	Surgical	123	Fenestration	4
5	Prades *et al*[8]	2002	Surgical	750	Duplication	3
6	Micozkadioglu *et al*[9]	2011	Surgical	1	Posterior tributary	1
7	Moreno-Sánchez *et al*[10]	2015	Surgical	1	Fenestration	1
8	Pegot *et al*[11]	2015	Surgical	1	Fenestration	1
9	Downie *et al*[12]	2007	Surgical	1	Duplication	2
10	Gardiner *et al*[13]	2002	Surgical	1	Bifurcation	1
11	Nayak *et al*[14]	2006	Surgical	1	Duplication	1
12	Turan-Ozdemir *et al*[15]	2004	Surgical	1	Duplication	1
13	Ozturk *et al*[16]	2010	Surgical	1	Fenestration	1
14	Ibrahim *et al*[17]	2016	Surgical	2	Fenestration	2
15	Bacchoo *et al*[18]	2014	Surgical	1	Duplication	1
16	Sidana *et al*[19]	2014	Surgical	1	Duplication	1
17	Dogan *et al*[20]	2010	Cadaveric	1	Duplication	1
18	Kapre *et al*[21]	2012	Surgical	1	Duplication	1

Table 2 (Continued)

No.	Paper	Year	Modality	Cohort	Feature	
					Variation	Cases
19	Thakur *et al*[22]	2011	Surgical	1	Fenestration	1
20	Wong *et al*[23]	2010	Surgical	1	Duplication	1
21	Paolo *et al*[24]	2008	Surgical	1	Fenestration	1
22	Nayak *et al*[25]	2017	Cadaveric	1	Bifurcation	1
23	Bathala *et al*[26]	2015	Surgical	1	Duplication	1
24	Cvetko[27]	2015	Cadaveric	1	Fenestration	1
25	Cvetko *et al*[28]	2017	Cadaveric	1	Fenestration	1
26	Anehosur *et al*[29]	2016	Surgical	1	Posterior tributary	1
27	This paper	2018	Surgical	2	Posterior tributary	2

Table 3 Anatomical variations (from $n = 1197$ cases).

Variation	Incidence (*n*)
Bifurcation	4
Duplication	14
Fenestration	16
Trifurcation	1
Posterior tributary	5
Total	40

and underwent ablative and reconstructive surgery, including neck dissection of the left side, 10 years ago. Ultrasound and fine-needle aspiration of this lump revealed a diagnosis of metastatic squamous cell carcinoma. As a consequence, the patient had selective neck dissection (level 1–4) of the right hand side on this occasion. A posterior tributary was seen draining the IJV arising from under the SCM joining the antero-inferior aspect of the lower-third of the IJV (Fig 2).

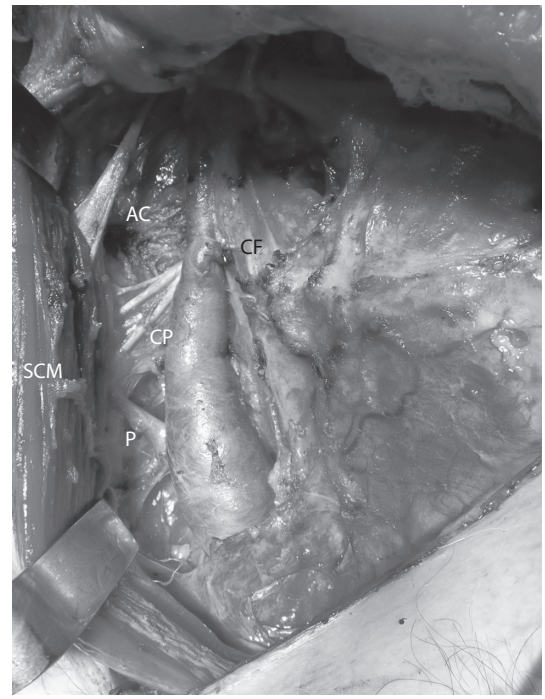

Figure 1 Posterior tributary of right internal jugular vein; AC – accessory nerve, CF – common facial vein (ligated), CP – cervical plexus, SCM – sternocleidomastoid, P – posterior tributary.

Findings

The paired jugular veins and the carotid arteries form the major vasculature of the head and neck region. Head and neck surgeons frequently perform neck dissections or cervical lymphadenectomy in a prophylactic and therapeutic role for patients with oral cancer. Anaesthetists and intensivists perform central venous access in patients who need central venous pressure monitoring, drug administration and volume resuscitation.[1]

Different variations reported in the surgical literature are presented (Fig 3). A predominance of duplication and fenestration was noted (31 of 40 cases). There is some ambiguity in terms of what surgeons considered as bifurcation as opposed to duplication. To ensure that a standardised approach is followed, the authors recommend using the level where the omohyoid muscle crosses the IJV as standard to discriminate between the two terms. If the IJV splits at or above the level of the omohyoid muscle, the terminology 'bifurcation' should be used. If the split occurs inferior to the level of omohyoid muscle the term 'duplication' should be used (Fig 4).

In more than two-third of the patients, these variations were noted to occur on the left side (Table 4). There is

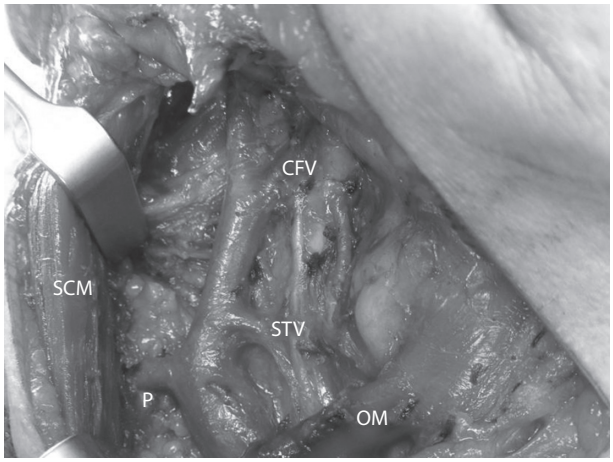

Figure 2 Posterior tributary of right internal jugular vein; CF – common facial vein, SCM – sternocleidomastoid, OM – omohyoid muscle, P – posterior tributary.

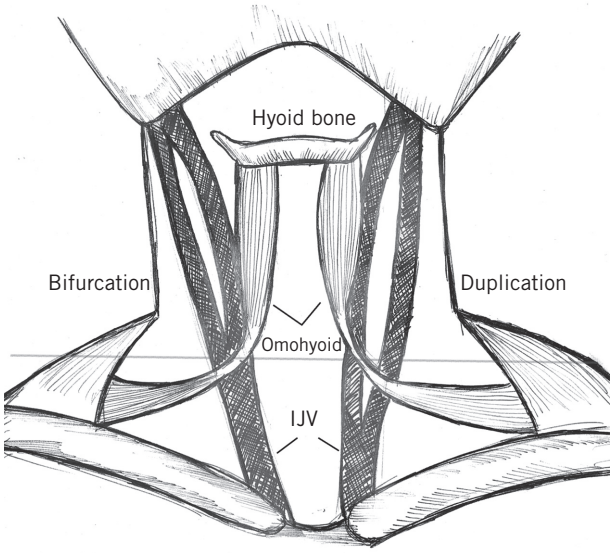

Figure 4 Diagrammatic representation of the relationship between the internal jugular vein (IJV) variations and the omohyoid muscle. The recommended definition of bifurcation (superior to the level of omohyoid) and duplication (inferior to the omohyoid) are shown (red line indicates the level where the omohyoid muscle crosses the IJV).

evidence to suggest that the right IJV is slightly larger and thicker in dimension compared with the left.[2] Additionally, it is common knowledge that the ease of access and relatively less intimate carotid artery makes the right IJV a popular venous access site.

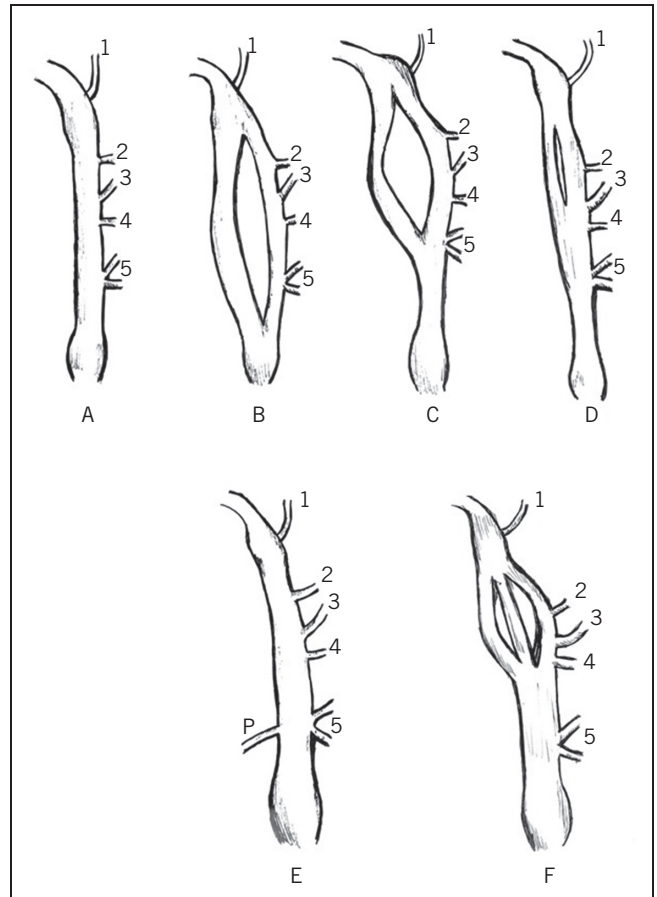

Figure 3 Anatomical variations of the internal jugular vein. A) Normal. B) Duplication. C) Bifurcation. D) Fenestration. E) Posterior tributary. F) Trifurcation. (1. inferior petrosal sinus; 2. pharyngeal vein; 3. common facial vein; 4. lingual vein; 5. thyroid veins; 6. posterior tributary).

The posterior tributary has been reported in only five patients (including our cases) so far. Anehosur *et al* noted that the posterior tributary was actually a communication from the external jugular vein, which normally drains directly into the subclavian vein.[3] Further dissection to assess this posterior tributary was not carried out in our case, as it was deemed unnecessary for satisfactory completion of the planned procedure.

Conclusions

Anatomical knowledge is one of the basic tenets of surgery. Variations in anatomy are well known amongst both anatomists and surgeons. Surgeons from different fields such as oral and maxillofacial surgery, otolaryngology, vascular, plastic and general surgery frequently operate in the head and neck region. We have endeavoured to improve knowledge, prevent

Table 4 Laterality of anatomical variations.

Laterality	Bifurcation	Duplication	Fenestration	Trifurcation	Posterior Tributary	Total (%)
Right	1	3	5	0	3	12 (30)
Left	3	11	10	1	2	28 (70)

morbidity and promote further understanding regarding these variations.

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