Case Report

Insights on the development and clinical implications of internal jugular vein anomalies – A report on fenestrated internal jugular vein encountered during neck dissection

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ABSTRACT

In this fascinating clinical report, we explore the case of a 70-year-old male patient diagnosed with T2N1MO squamous cell carcinoma of the lip at the otolaryngology department. Diagnostic imaging before surgery unveiled an intriguing anomaly involving fenestration of the internal jugular vein (IJV), adding a layer of complexity to the surgical plan. With careful preparation, our surgical team skilfully executed a wide local excision of the primary tumor and performed a modified radical neck dissection, complemented by Abbe Estlander flap reconstruction. Identifying this rare IJV anomaly preoperatively enabled meticulous planning, allowing our team to navigate with precision, safeguarding nearby nerves and blood vessels. This exceptional case underscores the importance of recognizing anatomical variations during intricate procedures such as neck dissections. Through this report, we elucidate the pre-operative suspicion, intraoperative identification, and successful management of this rare IJV fenestration encountered during a challenging neck dissection.

Key words: Case report, Fenestration, Internal jugular vein, Otolaryngology, Spinal accessory nerve

Neck dissection stands as a cornerstone procedure in head and neck surgery, essential for oncological clearance and preserving critical neurovascular structures. The first radical neck dissection was performed by George Washington Crile at the Cleveland Clinic in the early 1900s as a curative procedure for cervical metastasis. This *en bloc* resection was later replaced by modified radical neck dissection, which was first described by Oswaldo Saurez. This procedure preserved many key neurovascular structures in the neck [1,2]. The internal jugular vein (IJV) serves as a key landmark during the neck dissection process. Recognizing anatomical variations and anomalies becomes imperative to ensure meticulous surgical planning and minimize the risk of complications, particularly concerning structures such as the spinal accessory nerve and carotid artery. Previous literature has reported duplication and bifurcations of the IJV.

The present report is a unique case of a fenestrated IJV identified through pre-operative imaging, emphasizing our surgical team's adeptness in preserving this anomaly during neck dissection. In this case report, we highlight the importance of anatomical anomalies of the IJV, which is essential to optimize patient outcomes during neck surgeries. In addition, we also explore the development of IJV anomalies and discuss the various clinical and anatomical relations of IJV with adjacent neurovascular structures that are often encountered during neck dissection procedures.

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CASE PRESENTATION

A 70-year-old male patient sought evaluation at our otolaryngology outpatient department due to a painful lesion on the right lower lip persisting for 4 months.

Upon examination, a 2 × 1.5 cm ulcer proliferative growth involving the left lower lip was noted, accompanied by a palpable lymph node in the left level 1B region. His vitals at the time of examination were found to be normal – mean blood pressure of 98 mmHg, pulse rate 87 bpm, Breathing rate 12 bpm.

A Punch biopsy was done preoperatively to diagnose any infection, cancerous, or precancerous lesion. The biopsy confirmed the presence of well-differentiated squamous cell carcinoma.

Retrospective analysis of pre-operative contrast-enhanced computed tomography imaging of the neck

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revealed an intriguing finding: Fenestration of the left IJV, whereas the right IJV appeared normal (Fig. 1a).

Intraoperatively, during neck dissection, a partial duplication of the left IJV, termed fenestration, was observed extending from just below the skull base to the level of the cricoid (Fig. 1b). Notably, the spinal accessory nerve was identified passing posteriorly to the fenestrated IJV, which was meticulously secured and preserved. Comprehensive dissection of fibro-fatty tissue was performed across all levels of the neck, followed by meticulous hemostasis and layered wound closure.

The post-operative course was uncomplicated, with preserved spinal accessory nerve function, leading to the patient's discharge on post-operative day 5.

DISCUSSION

In the 5th week of intrauterine life, three pairs of major veins can be distinguished: (i) The vitelline veins, or omphalomesenteric veins, carrying blood from yolk sac to sinus venosus; (ii) the umbilical veins, carrying oxygenated blood from placenta to embryo; and (iii) the cardinal veins, draining the blood from the embryo [3]. The main venous drainage system of the embryo comprises the cardinal veins. The cranial and the caudal parts of the embryo are drained by two sets of cardinal veins: Anterior and posterior, respectively. During the 8th week, an oblique anastomotic channel connects the two sides of the anterior cardinal veins, which becomes the left brachiocephalic vein (Fig. 2a) [4]. Most of the blood is shunted from the left side of the head and the left upper extremity to the right cardinal vein. The superior vena cava is formed by the union of the right common cardinal vein and the proximal portion of the right anterior cardinal vein. The IJV is primarily formed by the anterior cardinal veins that provide the primary venous drainage of the head and neck (Fig. 2b) [3].

The IJV is a large vein that normally drains venous blood from the brain, face, and neck. It begins as a continuation of the sigmoid sinus and leaves the skull through the jugular foramen along with the last four cranial nerves. It then descends through the neck in the carotid sheath, lateral to the vagus nerve and internal and common carotid arteries. It ends by joining the subclavian vein behind the medial end of the clavicle to form the brachiocephalic vein. The vein has a dilatation at its upper end called the superior bulb and another near its termination called the inferior bulb [5]. Anomalies such as fenestrations, where the vein splits into two branches before reuniting, are rare in the cervical region. While the literature extensively describes arterial fenestrations, venous anomalies are less commonly reported [6]. Mumtaz and Singh, in their surgical review, identified five different types of IJV anomalies: Furcation, duplication, fenestration, trifurcation, and posterior tributary. The terms duplication and bifurcation are also standardized by keeping the omohyoid muscle as a landmark. When IJV splits below the omohyoid muscle, it is termed as duplication, and when it splits at or above the omohyoid muscle, it is termed as bifurcation [7]. Wang *et al*. distinguished between fenestration and duplication of the IJV. They described duplication as the bifurcation of the vein with each branch draining separately into the subclavian vein, and fenestration as the bifurcation of the vein, which later reunites and drains into the subclavian vein [8]. In our case report, the IJV bifurcated soon after exiting the jugular foramen and reunited at the level of the cricoid cartilage. Intraoperatively, we observed the common carotid artery positioned between the two branches of the IJV, differing from previous reports. Our institution's data showed a prevalence of IJV fenestration of 0.5%, consistent with findings from other studies [9-11]. While some patients with fenestrated IJVs may present with symptoms such as neck swelling or difficulty swallowing and breathing [12], our patient remained asymptomatic.

Towbin and Kanal [13] highlighted the importance of identifying fenestrated IJVs preoperatively to prevent

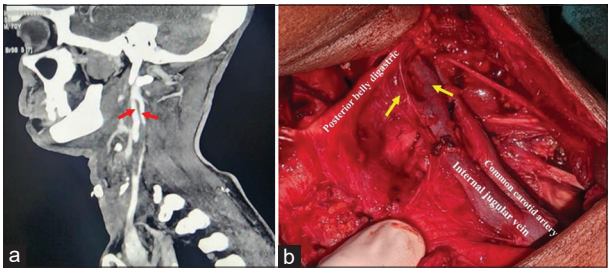

Figure 1: (a) Computed tomography angiography image showing fenestrated internal jugular vein (red arrows); (b) Fenestration of internal jugular vein (yellow arrows) found intraoperatively during neck dissection

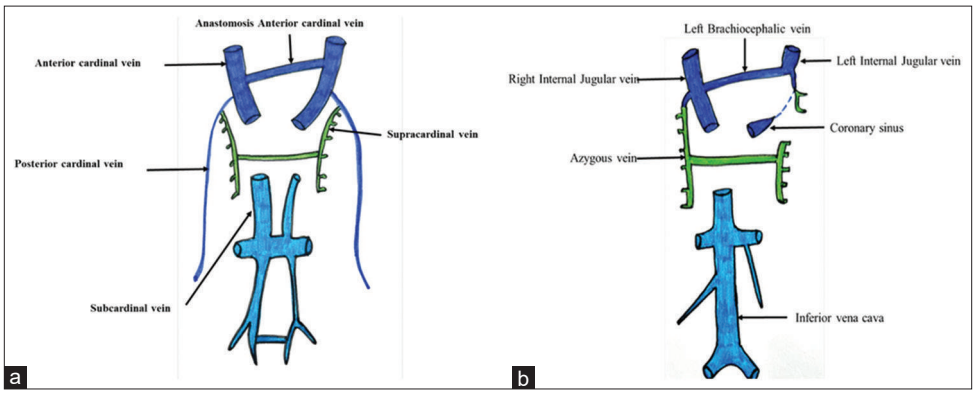

Figure 2: (a) Venous system at the 7th week of the intrauterine life; (b) Venous system of the embryo at birth

inadvertent injury during procedures. Aladham *et al*. found intraoperatively during neck dissection that the IJV was found to be splitting from near the skull base to 1 cm above the left of the carotid bifurcation. Failure to recognize unusual anatomical variations of the veins during neck dissection may lead to inadvertent injury and hard-to-control bleeding [14].

Three theories have emerged to explain the occurrence of fenestration of the IJV: The vascular, neural, and bony hypotheses. The vascular and neural theories primarily focus on the relationship between the vein and the spinal accessory nerve, primarily concerning the division of the vessel in the upper third of the neck. The bony hypothesis focuses on anomalies of the vein at the level of the jugular foramen. However, none of these theories adequately addresses the occurrence of low bifurcations and their specific association with the omohyoid muscle [11].

Recognizing the potential for spinal accessory nerve injury during neck dissection will lead to successfully navigating the anomaly intraoperatively without harming the nerve. Silva Correia *et al*. described four relationship patterns between the spinal accessory nerve and IJV: Type 1, nerve lies superficial to vein; type 2, nerve lies deep to vein; type 3, nerve crosses branches of vein; type 4, nerve splits and its branches pass around vein [15]. In the present case, the spinal accessory nerve was identified passing posteriorly to the fenestrated IJV. Aladham *et al*. found that the spinal accessory nerve crossed laterally to both divisions of the IJV [14]. They concluded that the spinal accessory nerve normally passes superficially to the IJV. Different geographical influences the anatomical variations of relations between the spinal accessory nerve and the IJV. Such variable relationship patterns are important for the safety of modified radical neck dissections. Enhanced awareness of such anomalies can prevent inadvertent damage to critical structures, ensuring optimal patient outcomes.

Pre-operative awareness of IJV anomalies is crucial for surgical planning and preventing complications, emphasizing the importance of thorough imaging and informed patient counseling.

CONCLUSION

This case underscores the significance of collaborative care among surgeons, anesthetists, and physicians in managing complex anatomical variations. Anatomical variations of the IJV are most commonly identified intraoperatively, often increasing the risk of injury to the spinal accessory nerve and surrounding vascular structures. Therefore, pre-operative identification of IJV fenestration is crucial during any neck dissection and vein cannulation to prevent inadvertent injury.

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