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Venous Outflow of the Brain after Bilateral Complete Jugular Ligation

Bilateral Komple Juguler Ven Ligasyonu Sonrasında Beynin Venöz Drenajı

Serdar ENSARİ[1]
Erkan KAPTANOĞLU[2]
Kağan TUN[3]
Taylan GÜN[4]
Etem BEŞKONAKLI[5]
Serdar ÇELİKKANAT[6]
Hüseyin DERE[7]
Saruhan ÇEKİRGE[8]

[1,4,6,7] Ankara Numune Education and Research Hospital, Department of Otorhinolaryngology, Ankara, Turkey
[2,3,5] Ankara Numune Education and Research Hospital, Department of Neurosurgery, Ankara, Turkey
[8] Hacettepe University, Faculty of Medicine, Department of Radiology, Ankara, Turkey

ABSTRACT

A case of a patient with bilateral internal, external, posterior external and anterior jugular vein ligations and excisions performed in the neck due to a larynx tumor is presented. Radical neck dissection is a standard otorhinolaryngological procedure in the management of head and neck cancer patients with bilateral lymph node metastasis to the neck. Sacrifice of both internal and external jugular veins bilaterally has been recognized as a dangerous approach leading to intracranial hypertension with subsequent neurological sequela and death. In this report, we aimed to demonstrate how venous outflow from the brain diverts after jugular venous system obliteration. After bilateral jugular vein ligations, digital subtraction angiography (DSA) showed that the venous drainage route of the brain had been diverted from the jugular veins to the vertebral venous plexus.

KEY WORDS: Brain, Edema, Jugular vein, Obstruction, Radical neck dissection

ÖZ

Boyunda, bilateral internal, external, posterior external ve anterior juguler ven ligasyonu yapılarak larinks tümörü eksizyonu yapılan bir hasta sunulmuştur. Radikal boyun diseksiyonu, baş ve boyun kanserlerinde standart bir prosedürdür.Bilateral internal ve eksternal juguler ven bağlanması sonucunda intrakranial hipertansiyona bağlı nörolojik sekel ve ölüm ile sonuçlanabilir. Bu vakada, amacımız juguler venöz sistem kapatılması sonrasında beynin venöz kan boşalımının nereden olduğunu göstermektir. Bilateral juguler ven bağlanması sonrasında, digital subtraction angiography (DSA) ile beynin venöz drenajının juguler venlerden, vertebral venöz plexus'a doğru yön değiştirdiği gösterilmiştir.

ANAHTAR SÖZCÜKLER: Beyin, Ödem, Juguler ven, Obstrüksiyon, Radikal boyun diseksiyonu

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Correspondence address:
Erkan KAPTANOĞLU
Sancak Mahallesi 241. Sokak
Ozkan Apt. No: 16/4 06550, Çankaya,
Ankara, Turkey
Phone : +90 532 435 1057
Fax : +90 312 467 4550
Email : erkankaptanoglu@yahoo.com

INTRODUCTION

Radical neck dissection is a standard otorhinolaryngological procedure in the management of head and neck cancer patients with bilateral lymph node metastasis to the neck. Radical neck dissection is described as complete excision of all metastatic lesions in the neck and removal en bloc of all non-essential structures with the associated lymph nodes, the lymph-bearing fascia and adipose tissue (2). To achieve this purpose, all jugular veins, sternocleidomastoid muscle and accessory nerves should also be removed during surgery (2). Sacrifice of both internal and external jugular veins bilaterally has been recognized as a dangerous approach leading to intracranial hypertension with subsequent neurological sequela and death.

Radical neck dissection was first introduced by Crile in 1906 (4). He advocated bilateral removal of the jugular veins when necessary and claimed that deep veins were adequate by themselves to take over the venous drainage of the brain (4) but this has not been proven since than. The aim of this case report was to demonstrate the routes of venous outflow from the brain after bilateral jugular system ligations.

CASE REPORT

The patient was a 55-year-old man who had advanced laryngeal carcinoma. He was found to have bilateral neck metastasis on presentation. Preoperative digital subtraction angiography (DSA) was performed and venous phase showed patency of both jugular veins and preoperative cranial MRI (Magnetic Resonance Imaging) showed no apparent pathology (Figure 1A and Figure 1B). A total laryngectomy with right radical neck dissection was performed. DSA evaluation was performed one week after first operation, after the ligation of right internal and external jugular vein, DSA revealed patency of the left jugular vein (Figure 2). Four weeks later, following uneventful postoperative course, a left radical neck dissection was performed. After the ligation of bilateral internal and external jugular veins, DSA revealed extensive venous collaterals in the skull base and inside the neck muscles to drain sigmoid sinuses (Figure 3A). These collateral venous channels in the neck had been collected into single vessels draining into right and left subclavian veins at the cervicothoracic junction (Figure 3B and Figure 3C). Postoperative cranial

Figure 1A: *Preoperative DSA: Venous phase showing patency of both jugular veins. A- P view.*

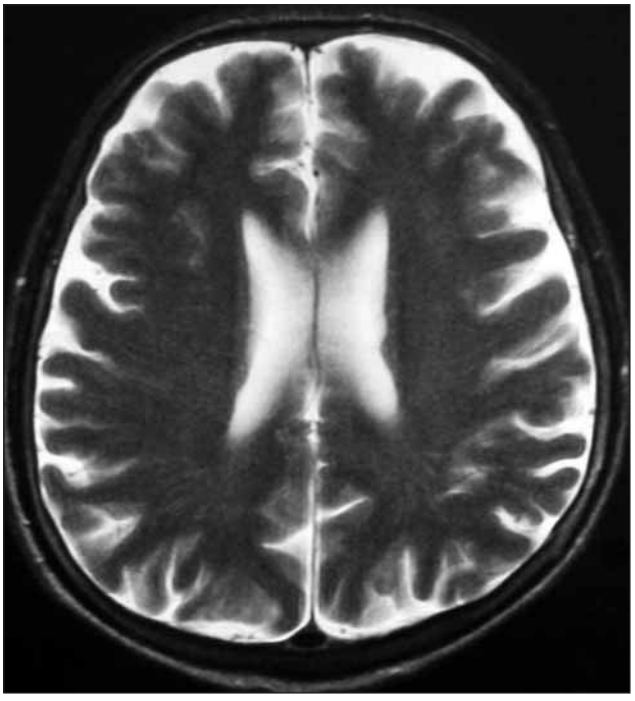

Figure 1B: *Preoperative axial MRI of brain showing no apparent pathology.*

Figure 2: *First postoperative DSA after the ligation of left internal and external jugular vein revealing patency of the right jugular vein. A-P view.*

Figure 3B: *DSA (venous phase), after the ligation of bilateral internal and external jugular vein showing the same venous collaterals of the neck inside the anterior and posterior muscle groups. Lateral view.*

Figure 3A: *DSA (venous phase) after the ligation of bilateral internal and external jugular vein revealing extensive venous collaterals developed to drain bilateral sigmoid sinuses. A-P view.*

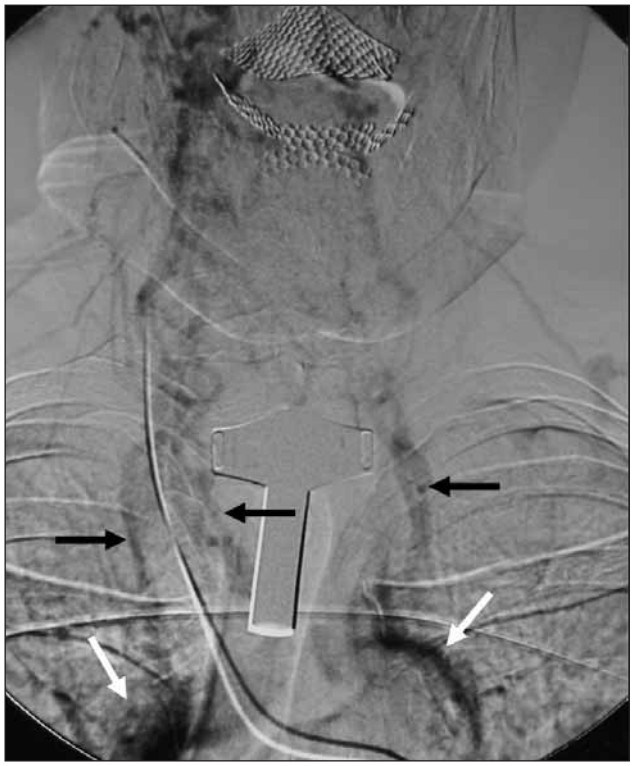

Figure 3C: *DSA (venous phase), after the ligation of bilateral internal and external jugular vein showing the collecting of venous plexus into single vessels (black arrows) draining into right and left subclavian veins (white arrows) at the cervicothoracic junction. A-P view.*

MRI showed no brain edema, venous infarct or additional pathology four weeks after bilateral jugular venous system ligation (Figure 3D). The patient did not experience any signs or symptoms of intracranial hypertension. On follow-up, the patient was neurologically intact after 4 years.

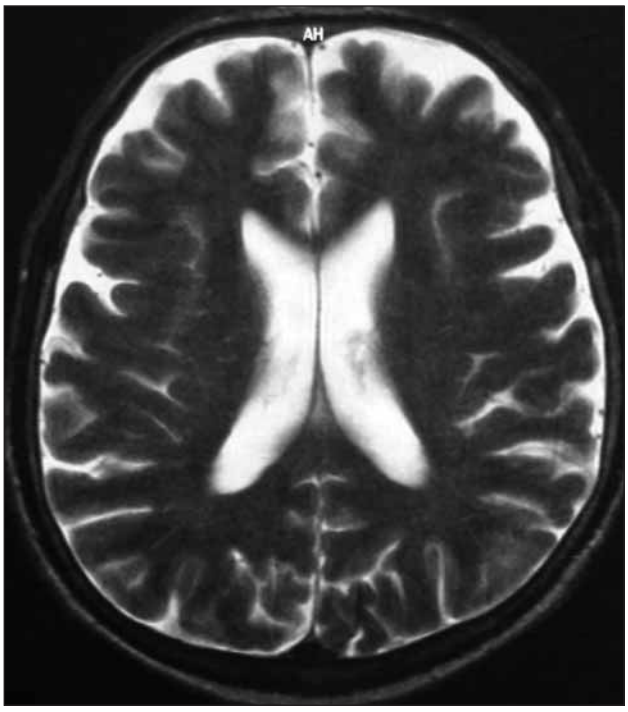

Figure 3D: *Postoperative axial MRI of brain showing no apparent brain edema or additional pathology four weeks after bilateral jugular venous system ligation.*

DISCUSSION

The management of cancer with bilateral lymph node metastasis to the neck remains controversial. It is believed that simultaneous sacrifice of both jugular veins ends up with serious complications (2). Some institutions still perform simultaneous dissections but others favor an operation in two stages with an interval of two weeks. Ahn et al. stated that there are no statistically significant differences in the complication rates between simultaneous and staged dissections (1). However, large series have found the staged operation to lead to less operative morbidity and mortality. There were no objective criteria in these reports explaining the routes of venous outflow from the brain after staged ligation of both jugular veins.

In the present study, we demonstrated that the healthy brain can tolerate bilateral jugular vein ligation during radical neck dissection by opening invisible channels. These channels are situated around the epidural space of the foramen magnum and in the neck muscles. This vertebral venous plexus drains into right and left subclavian veins at the cervicothoracic junction via single vessels (Fig. 3b and 3c). These cervical draining vessels do not resemble any of the jugular veins, but the vertebral vein with tributaries from the internal vertebral plexus, anterior vertebral vein and deep cervical veins.

Crile was one of the first surgeons to perform radical neck dissection, in 1906 (4). Crile reasoned that the closeness of the deep cervical nodes to the internal jugular vein and its branches made it imperative to sacrifice the vein by a block dissection. He also advocated bilateral removal of the jugular veins when necessary and reported one case of simultaneous bilateral neck dissection, contending that the vertebral and other deep veins were adequate by themselves to take over the venous drainage of the brain (4). Many surgeons like Crile still favor the simultaneous bilateral neck dissection (1,4). Following bilateral neck dissection, some devastating complications can occur. The staged bilateral neck dissection technique with the preservation of one jugular vein system in the first surgery is therefore more popular (5). It is believed that the sacrifice of both jugular veins leads to increased intracranial pressure with subsequent neurological sequela (6).

Earlier studies have indirectly attempted to monitor changes in intracranial pressure following ligation of the internal jugular vein (3). Studies showed that ICP levels rose dramatically but dropped to near normal levels post-operatively after one-sided ligations (6). The patient can tolerate bilateral removal of the internal jugular veins only in the presence of adequate collateral venous circulation. The patient was not investigated for this condition because bilateral jugular vein removal procedure is a standard procedure of otorhinolaryngological surgery in the management of head and neck cancer. Patients who need bilateral ligation of the internal jugular veins should be investigated preoperatively with digital subtraction angiography. Jugular vein occlusion test could give us crucial data about the patient and could support the decision of jugular vein ligation (7). It is also difficult to set an animal or cadaver modal to clarify this hypothesis.

In contrast to other mammals, humans have a restricted number of cerebral venous collaterals, making it difficult to select an appropriate laboratory model for the study (6). This is the first report that demonstrates cerebral outflow after bilateral jugular vein ligation.

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