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Araştırma / *Research Article*

A Modified Postauricular Approach to Foramen Jugulare

Uzay Erdoğan
Ahmet Akbaş

Jügüler Foramene Modifiye Postauriküler Yaklaşım

ABSTRACT

Objective: *Tumors as neurinomas and meningiomas are the most common lesions observed in the jugular foramen. Their deep location and the complexity of the surrounding structures represent a difficulty in removing tumors of the jugular foramen. The size, the location and the clinical presentation of the tumor should be carefully evaluated before planning surgery. The aim of the study is to provide a detailed understanding of the anatomical features of jugular foramen in order to recognize the characteristics of the tumoral lesions related to the area and to plan the most suitable surgical approach.*
Method: *After obtaining a permission from The Institute of Forensic Medicine of Istanbul, the modified postauricular approach was performed on 30 fresh cadavers.*
Results: *Modified postauricular approach can be preferred for selected small glomus jugulare tumors and extraaxial lesions. The advantage of the approach is the superficial exposure of the jugular vein and related pathologies, thus providing a safer access for the surgeon.*
Conclusion: *Surgical interventions for the pathologies of the jugular foramen have a high morbidity and mortality rate. Having a comprehensive knowledge about the region's anatomical features plays a key role for proper management of the patients without decreasing their quality of life.*

Keywords: *Jugulare foramen, modified postauricular aproach, cranial nerves, extracranial pathologies*

ÖZ

Amaç: *Nörinom ve meningioma gibi tümörler jugular foramenlerde en sık görülen lezyonlardır. Derin yerleşimi ve anatomik yapıların karmaşıklığı, juguler foramen yerleşimli tümörlerin çıkarılmasında bir zorluktur. Ameliyat planlanmadan önce tümörün büyüklüğü, yeri ve klinik görünümü dikkatle değerlendirilmelidir. Bu çalışmanın amacı, bölgeyle ilgili tümör lezyonlarının özelliklerini tanımak ve en uygun cerrahi yaklaşımı planlamak için jugular foramenlerin anatomik özelliklerinin ayrıntılı bir şekilde anlaşılmasını sağlamaktır.*
Yöntem: *İstanbul Adli Tıp Enstitüsü'nden izin alındıktan sonra otuz kadavrada modifiye postauriküler yaklaşım gerçekleştirildi.*
Bulgular: *Seçilmiş küçük glomus jugulare tümörleri ve ekstraaksiyel lezyonlar için modifiye postauriküler yaklaşım tercih edilebilir. Yaklaşımın avantajı, juguler veni koruyarak ilgili patolojilere daha yüzeysel ulaşılabilmesine olanak sağlamaktadır. Böylece cerrah için daha güvenli bir koridor sağlar.*
Sonuç: *Jugular foramen patolojileri için cerrahi müdahaleler yüksek morbidite ve mortalite oranına sahiptir. Bölgenin anatomik özellikleri hakkında kapsamlı bilgi sahibi olmak, hastaların yaşam kalitelerini düşürmeden cerrahinin uygun şekilde yönetilmesinde anahtar rol oynar.*

Anahtar kelimeler: *Juguler foramen, modifiye postauriküler yaklaşım, kraniyal sinirler, ekstrakraniyal patolojiler*

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Uzay Erdoğan
S.B.Ü. Bakırköy Prof. Dr. Mazhar Osman Ruh Sağlığı ve Sinir Hastalıkları Eğitim ve Araştırma Hastanesi Beyin ve Sinir Cerrahisi Kliniği
İstanbul - Türkiye
uzayerdogan@gmail.com
ORCİD: 0000-0001-8268-6306

A. Akbaş 0000-0002-6375-4761
Taksim Eğitim ve Araştırma Hastanesi
Beyin ve Sinir Cerrahisi Kliniği
İstanbul - Türkiye

INTRODUCTION

Foramen jugulare is a region difficult to identify anatomically, and to approach surgically. Among reasons complicating discernment of the region, even in the same cranium, differences in dimensions, and shape of bilateral, intra-, and extracranial aperturas with complicated, and irregular configurations, their progression in an oblique course, and formation of the jugular foramen with two different bony structures with multiple nervous, and venous structures inside can be enumerated [1,2].

Factors restricting surgical approach to this foramen consist of its deeper location, and surrounding critical anatomic structures. These surrounding structures are carotid artery in the anterior, facial nerve in the lateral, hypoglossal nerve in the medial, and vertebral artery in the inferior aspect. Jugular foramen is separated into 3 parts as 2 venous and 1 neural (or intrajugular) compartments. Venous compartments constitute the larger posterolateral venous canal (sigmoid portion) which receives the drainage of the sigmoid sinus, and a smaller compartment ie. anterolateral venous canal (petrosal portion) where inferior petrous sinus drains into [1].

The aim of this study is to define detailed anatomic structure of jugular foramen which has a critical importance and a gradually increasing must in the surgical treatment of pathologies such as tumours of glomus jugulare, jugular neurinomas, and glossopharyngeal neuralgia. Detailed examination and recognition of the region carry a great importance in the selection of optimal surgical approach to localized tumoral structures, and their safer management.

MATERIAL and METHODS

In compliance with the permission given from Directorate of Istanbul Institute of Forensic Medicine, modified postauricular approach was performed on 30 new cadavers based on our application dated 08.03.2010 (protocol no 25094), and in accordance with the approval # 10.4.İSM.04.34.26.03-41 of the Ethics Committee of Bakirkoy Prof. Dr. Mazhar Osman Training and Research Hospital of Neuropsychiatric Diseases we performed our study.

The cadavers were laid on their back, and their heads turned 45 degrees to the contralateral side. An incision starting from 4 cm above the earflap, curving backward and inferiorly and passing behind the mastoid process was performed. This incision was extended to the anterior aspect of the ipsilateral side of the neck, and to the level of thyroid cartilage 1-2 cm medial to the midline. Cervical incision line was performed parallel to the contours of the sternocleidomastoid muscle (Figure 1). Skin, and subcutaneous layers were passed through, and the created flap was retroflexed to the midline. Cartilaginous external ear canal was excised, and separated from the skin flap. Parotid gland which is situated in the inferomedial aspect of the external ear canal, on the lateral edge of the mandibula, and above the mandibular angle was seen. Medial to the parotid gland a superficially coursing retromandibular vein, and major auricular nerve lateral to the gland were observed (Figure 2). Sternocleidomastoid muscle was dissected from its insertion to the mastoid process, and retracted laterally (Figure 3, 4, 5, 6). The incision was started from the lower margin of the mastoid process, and parotid gland, and deepened between these two structures to find stylomastoid foramen, and facial nerve originating from this foramen. We observed that as the facial nerve emerged from this foramen, it passed through parotid gland,

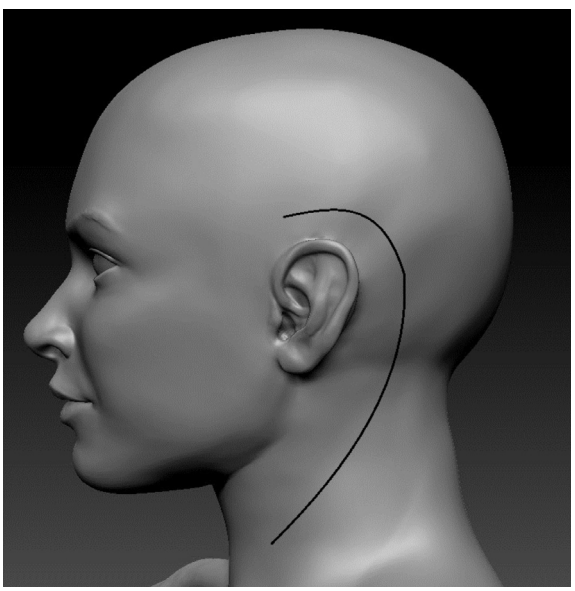

Figure 1. An incision starting from 4 cm above the earflap, curving backward and inferiorly and passing behind the mastoid process.

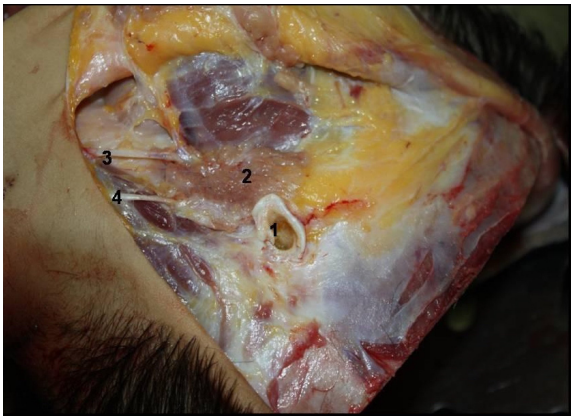

Figure 2. Cadaver at supine positions and left side of the cadaver, vertex right side of the figure.
1. External acustic canal, 2. Parotid gland, 3. Retromandibular vein, 4. Greater auricular nerve

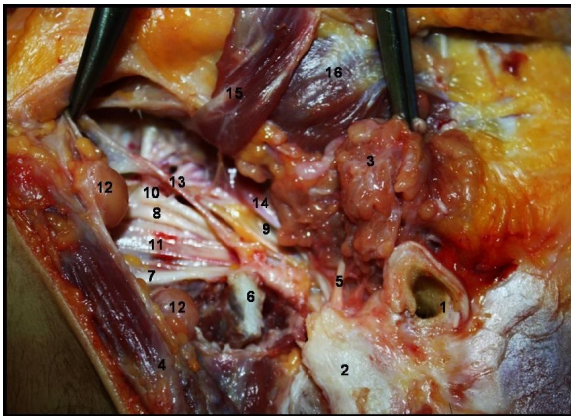

Figure 4. Cadaver at supine positions and left side of the cadaver, vertex right side of the figure .
1. External acustic canal, 2. Mastoid process, 3. Parotid gland, 4. Sternocleidomastoid muscle, 5. Fasial nerve, 6. C1 transvers process, 7. Accessory Nerve CN-XI, 8. Vagal nerve, 9. Glossopharingeal nerve, 10. Internal Carotis Artery, 11. Juguler vein, 12. Jugulodigastrik lymph nodes, 13. Occipital artery, 14. Stylofaringeus muscle, 15. Digastric muscle, 16. Masseter muscle

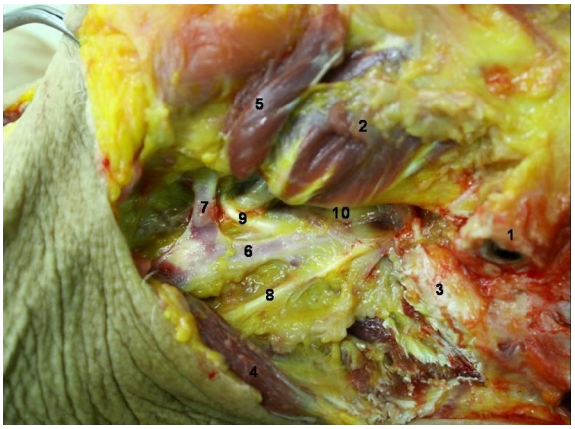

Figure 3. Cadaver at supine positions and left side of the cadaver, vertex right side of the figure.
1. External acustic canal, 2. Masseter muscle, 3. Mastoid process, 4. Sternocleidomastoid muscle, 5. Digastric muscle, 6. Juguler vein, 7. Fasial vein, 8. Aksesuar sinir CNXI, 9. Hypoglossal nerve, 10. Glossofaringeal nerve

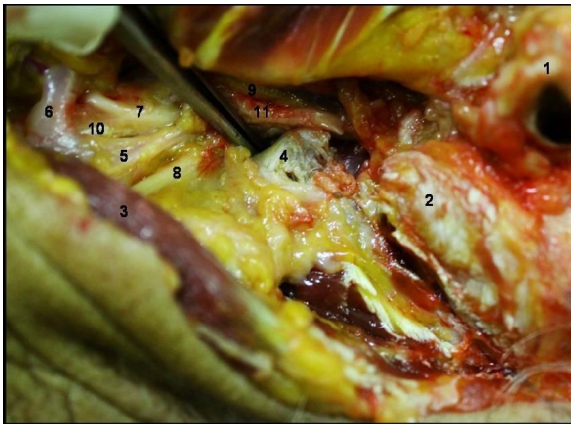

Figure 5. Cadaver at supine positions and left side of the cadaver, vertex right side of the figure.
1. External acustic canal, 2. Mastoid process, 3. Sternocleidomastoid muscle, 4. C1 transvers process, 5. Juguler vein, 6. Fasial vein, 7. Hypoglossal nerve, 8. Accessory nerve CN-XI, 9. Glossopharyngeal nerve, 10. Vagal nerve, 11. Occipital artery

and gave many branches while it was coursing to the surface. Facial nerve was dissected away from inside the parotid gland, and followed up from the mandibular margin up to its insertion to the facial structures (Figure 4). During this approach facial nerve tract should be recognized, and preserved, and partial or total parotidectomy should be performed in strict observance of this tract. After partial or total removal of the parotid gland, posterior belly of the digastric muscle situated below, and in deeper structures which adhered to the medial aspect of the mastoid process, and extended to the hyoid bone in the midline was observed. Just below this muscle, and at the same or at a little lower level two lymph nodes (jugulodigastric lymph nodes) were seen (Figure 4). Digastric muscle was separated from its insertion to the mastoid process, and retroverted to the midline (Figure 3, 4, 6). Lymph nodes were removed. Inferiorly, on the outermost aspect, jugular vein, and accessory nerve crossing over jugular vein were observed. This crossing over is at the level of inferior border of C1 transverse process (Figure 4, 5). At the level approached, the uppermost structures ie. jugular vein, cranial nerve XI, and transverse

process of atlas are important reference landmarks during surgical interventions. A facial structure over C1 transverse process, and superior, and inferior oblique muscles adhered to this process were observed.

After resection of C1 transverse process, V2 distal, and V3 proximal segments of the vertebral artery passing through foramen transversarium was seen. (Figure 6). The course of the vertebral artery was tracked upward, and its progression over arch of atlas was noted. Medial to the C1 transverse process, jugular vein, and inferior cranial nerves were started to be identified one by one. Cranial nerve XI was seen to cross over jugular vein laterally at the level of C1 transverse process, and to enter between fibres of sternocleidomastoid muscle (Figure 3, 4, 5, 6). Just medial to the jugular vein, cranial nerve X courses inferiorly within the carotid sheath (Figure 4, 5). Cranial nerve X was seen to be localized deeper between jugular vein, and internal carotid artery (Figure 4, 5). Cranial nerve IX, starting from its emergence from jugular foramen, courses inferomedially, and more superficially to the cranial nerve X and, then medially, and gives end branches towards pharynx, and tongue at the level of the styloid process (Figure 3, 4, 5). It was seen that cranial nerve XII had a more superficial course relative to IX, and X. After its departure from hypoglossal canal, it passes downward, and slightly medially, and before approaching hiyoid bone level, it bends towards the tongue, where it gives branches into lingual muscle (Figure 3, 5).

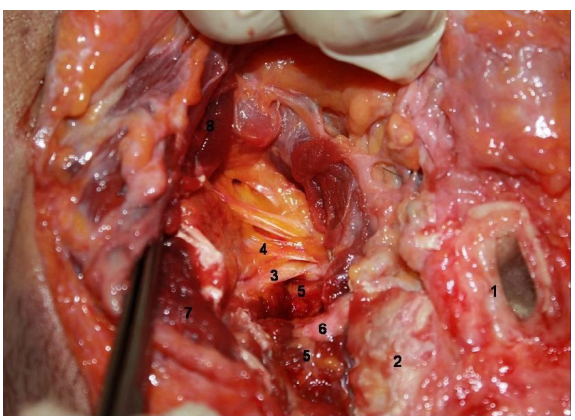

Figure 6. Cadaver at supine positions and left side of the cadaver, vertex right side of the figure.
1. External acustic canal, 2. Mastoid process, 3. Accessory nerve CN-XI 4. Juguler vein, 5. C1 tranvers procces residue after resection, 6. Vertebral artery V2 to V3 segment, 7. Sternocleidomastoid muscle, 8. Digastric muscle.

Styloid process was identified medial, and deeper to the mastoid process. At the tip of this process, stylohyoid muscle is seen extending to the hyoid bone. This muscle, and process were removed to provide a wider superior exposure.

RESULTS

We have arrived at the following conclusions during our surgical dissection trial:

- As an acceptable corollary, section (retromandibular vein, major auricular nerve, sternocleidomastoid and digastric muscles) or dissection (parotid gland, jugulogastric lymph nodes) of superficial structures does not lead to a significant morbidity.
- Within mastoid notch, occipital artery, and below the mastoid process facial nerve are identified. Facial nerve is dissected within the parotid gland so as to be able to perform total or partial parotid resection.
- Nearly 6 cm distal to the superior nuchal line where fibers of the sternocleidomastoid muscle penetrate, the cranial nerve XI can be identified.
- At the anteromedial aspect of the C1 transverse process, jugular vein is characterized. Being very fragile, this vein is an important reference point in our understanding of the relevant anatomy in general.
- Surgery aims to expose inferior cranial nerves, and jugular vein situated to anteroposterior aspect of C1 transverse process.
- The advantage of this approach is to provide the surgeon a safer opportunity to approach jugular vein, and related pathologies which are localized more superficial to the inferior cranial nerves.
- With modified postauricular approach, cranial nerves VII., IX., X., XI., and XII. are exposed which might reduce the risk of damage incurred.
- In this approach, after excision of C1 transverse process, V2 distal, and V3 proximal segments of the vertebral artery are exposed.
- With postauricular approach, exposure of the opening of the jugular foramen does not require any resection of the temporal bone.

- Our modified postauricular approach is suitable for selected small glomus jugulare tumours, and extraaxial lesions.
- When we review current literature, it can be said that transposition of the facial nerve is not required for the resection of the glomus jugulare tumours. With this approach the risk of occurrence of operational facial nerve paralysis is avoided. With modified postauricular approach, jugular foramen can be exposed only by dissecting the nerve towards the parotid gland without transposition of the facial nerve.

DISCUSSION

"Modified Postauricular Approach", which we performed to reach jugular foramen, targets extracranial pathologies, and it is the combination of infratemporal, and juxtacondillary approaches. In our study, we could achieve a larger angle of view to the extracranial segment of the jugular foramen without the need for transposition of the nerve.

Major tumours of the jugular foramen consist of tumours of glomus, meningiomas, schwannomas, chordomas, chondrosarcomas, and myxomas with distinct individual diagnostic pecularities. For each one of these tumours, different imaging modalities are used. Successful removal of the tumour requires good anatomic knowledge of the region. The aim of the surgery in benign tumours is total resection. Surgery of glomus jugulare tumours is considered to be extremely risky because of their hypervascularity, and higher risk of vulnerability of the facial nerve during the operation. Surgical planning should be made according to the location of the tumour, and its relation with the jugular foramen.

Samii et al. (3) managed type A schwannomas of jugular foramen with retromastoid suboccipital craniectomy, and for types B, C, and D they used combined cervical- mastoidectomy. Our study on cadavers has revealed that masteidectomy is not a must for these operations.

In 1978, Ugo Fisch [4], using an infratemporal approach, after anterior transposition of the facial nerve, intervened jugular foramen tumours. With our approach, without transposition of the facial nerve, the nerve was dissected towards the parotid gland, and a good command of the jugular foramen exposure was achieved. George et al. [5,6] used juxtacondillary approach for total or subtotal resection for these tumours without the need for transposition of the facial nerve because of its higher mortality, and morbidity. Despite interventional radiologic techniques, tumoral invasion of the internal carotid artery wall can cause destructive changes in this structure during operation. In juxtacondillary approach vertebral artery might be exposed to surgical trauma. While trying to stop emergent intraoperative bleeding, cranial nerve can be injured resulting in the development of postoperative neurological deficit. Since we don't use drilling, related potential complications such as bony defects can be avoided. Removal of C1 transverse process can expose all of vascular anatomy. Since in these tumours bone infiltration, and invasion of the lower cranial nerves, and major vessels can be seen, partial resection of the tumor can decrease surgical complications. Dysphagia, facial nerve palsy, and aspiration are frequently encountered complications. Meningitis, and temporary CSF leakage are seen in more than 15 % of the cases despite imporved surgical repair (7). Since we don't intervene dura, any risk of meningitis; and CSF fistula are not encountered.

Arenberg and McCreary et al. [8], and Neely et al. [9] had used suboccipital approach in all of their patients. However most of the authors reported that removal of the petrous bone was required for total resection. Gacek [10] advocates a transmastoidal approach for subtotal resections. Crumley [11] and Wilson [12], advocated a two -step intervention which combines autologic, and neurosurgical approaches. These authors performed suboccipittal craniectomy following an infratemporal approach for tumours extending intracranially. Horn et al. [13] performed a one-stage operation combining transmastoidal, translabirenthine, and infratemporal approaches. However Kamitani et al. [14] preferred combined extradural-posterior petrous, and suboccipital approaches. Recently, Mazzoni et al. [15] have used petrooccipital transsigmoidal approach. Samii et al. [3] indicated that any approach which might lead to hearing loss had not been recommended. For tumours with an intracranial extension, craniectomy can be added to modified postauricular approach Jugular foramen is

situated below the middle ear, labyrinthine, and internal acoustic canal, and behind the vertical portion of the petrosal segment of the internal carotid artery. With infratemporal approach, a part of the petrous bone is drilled to see superior, and anterior part of the jugular foramen. This approach requires accumulation of sound knowledge about the anatomy of petrous bone. Otherwise the patient is exposed to risk of postoperative complications such as hearing loss, facial nerve palsy, and CSF leakage [16,17]. George et al. [5] used juxtacondillary approach to expose posterior, and inferior parts of the jugular foramen. To be able to observe inferior wall of the jugular foramen, condyle, and supracondillary bone should be drilled. This approach lessens the risk of any complication considerably. With modified postauricular approach, the risk of drilling-related operative complications, and development of potential postoperative craniocervical instability are not observed.

The choice of surgical approach is determined by the histologic characteristics, and spread of the tumour. Samii et al. [3], preferred suboccipital approach for type A, and cervical-transmastoidal approach for type B, C, and D tumours. With this approach; 1) facial nerve remains within the bony canal and 2) drilling of petrous bone below labyrinth, and cochlea ensures preservation of auditory and vestibular functions. In type A tumours, standard lateral , suboccipital craniectomy guarantees a good angle of vision. However in type B and D tumours Pellet et al. [18] suggested extended transcochlear approach as the best surgical option. In this method, sternocledomastoid, digastric, and hyoid muscles are dissected away from their insertion points, petrous bone is removed for the transposition of the facial nerve, auditory canal is resected, temporomandibular joint, and zygomatic process are displaced to achieve a larger exposure of the surgical field. In modified postauricular approach, the surgical field is reached without the need for transposition of the facial nerve.

In our modified postauricular approach any morbidity can not be encountered provided that extreme care is instituted. For selected cases of small glomus jugulare tumors, and extraaxial lesions this method is appropriate. Therefore the usage of this corridor is extremely safe.

CONCLUSION

Modified postauricular approach is a combination of infratemporal approach used by Fisch et al. [4], and juxtacondillary approach performed by George et al. [5,6]. In our study we have demonstrated that a larger field of view to the extracranial compartment of jugular foramen can be achieved without creating a bone defect, and resorting to transposition of the nerve.

Provided that extreme care is exerted with the dissection, and surgical intervention targeting relevant pathology, development of any operational morbidity is not possible Therefore usage of this corridor during the intervention is considerable safer.

With the advancements in microanatomy, neuroradiology, surgical techniques targeted at basis cranii, surgical outcomes of the patients have changed favourably. Surgical interventions directed at jugular foramen abnormalities have a higher incidence of morbidity, and mortality. A perfect knowledge of this region ensures optimal treatment for the patient without impairing his/her quality of life.

Ethics Committee Approval: S.B. Bakirkoy Prof. Dr. Mazhar Osman Expert Mental Health and Neurological Diseases Education and Research Office Ethics Committee approved (03.08.2010 / 25094).
Conflict of Interest: The authors declare no competing interest.
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