Comparative Analysis of a Foramen Ovale Bifurcation. Anatomical Variation

Análise Comparativa de uma Bifurcação do Forame Oval. Variação Anatômica

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ABSTRACT

Introduction: The foramen ovale is an opening located in the greater wings of the sphenoid bone which allows the passage of the mandibular nerve, the accessory meningeal artery, the lesser petrosal nerve, and the emissary vein. It is important to comprise the variations of its morphology to distinguish potentially abnormal foramina. Objective: The present study aims to report a unilateral variation in the morphology of the foramen ovale, with two internal openings and two external openings, and relation to possible consequences. Methods: A study was carried out with a bone piece of human skull, part of the collection of the institution. Data was collected and the measures of internal and external diameter of right and left foramina ovalia of the skull were analyzed. Results: A comparison was made between the left and right side and demonstrated that the right foramen, with the variation, had a significant smaller diameter than the left one, and this can bring some consequences to the patient. Conclusion: It is essential to know the precise anatomy of skull base to avoid problems in some procedures. From this perspective, it is possible to conclude that the significant difference in size can trigger clinical and surgical complications.

Keywords: Foramen ovale; Trigeminal neuralgia; Sphenoid bone; Anatomic variation

RESUMO

Introdução: O forame oval é uma abertura localizada na asa maior do osso esfenóide que permite a passagem do nervo mandibular, a artéria meningea acessória, o nervo petroso menor e a veia emissária. É importante compreender as variações na morfologia para distinguir potenciais forames anormais. Objetivo: O estudo tem o objetivo de reportar uma variação unilateral da morfologia do forame oval, que contém duas aberturas internas e duas aberturas externas, e relacioná-la com possíveis consequências. Métodos: Estudo realizado em uma peça de crânio humano do acervo da instituição. Os dados foram coletados e as medidas do diâmetro interno e externo dos forames ovais esquerdo e direito foram analisadas. Resultados: A partir de uma comparação feita entre os forames ovais esquerdo e direito foi demonstrado que o forame esquerdo, com a variação, tem um diâmetro significativamente menor, podendo trazer algumas consequências para o paciente. Conclusão: É essencial saber precisamente a base anatômica do crânio para evitar problemas em alguns procedimentos. Por essa perspectiva, é possível concluir que a diferença significativa pode provocar complicações no campo médico.

Palavras-chave: Forame oval; Neuralgia do trigêmeo; Osso esfenóide; Variação Anatômica

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INTRODUCTION

A foramen is a type of bone accident in which there is a passage through a bone. At the skull base there are numerous foramina that allow the passage of cranial nerves, blood vessels and other structures\(^1,2\). Among them is the foramen ovale (FO), an opening located in the greater wing of the sphenoid bone, posterior and lateral to the rotundum foramen and antero-medially to the spinous foramen\(^1,2\). The embryological origin of the sphenoid bone occurs by ossification and fusion of the cartilaginous base which was developed from the twelfth week around the veins and cranial nerves already existing\(^3\).

The foramen ovale gives passage to the mandibular nerve, a branch of the trigeminal nerve, accessory meningeal artery, lesser petrosal nerve, and emissary vein. Occasionally, the foramen ovale may be covered by a bone blade or bridges, resulting from the ossification of the pterygoospinous and pterygoalar ligaments (Civinini and Hyrtl ligament, respectively), promoting the formation of bifurcations in the structure\(^4-6\).

The morphology has been described in several ways. Prakash et al.\(^4\) used terms such as oval, almond, round and irregular. Naqshi et al.\(^7\) used oval, almond, round and slit. Daimi et al.\(^8\) described as ‘D’ (D-shaped), oval, rounded, elongated, and slit. Although different classifications in the literature, the “oval” shape is the most common of the described shapes.

The knowledge of the morphology and their variations can make it possible to distinguish potentially abnormal foramina in computed tomography and magnetic resonance imaging\(^4\). In view of that, the FO has neurosurgical practical significance in the access to the trigeminal nerve (for performing surgeries) and in the anesthetic procedures of mandibular division\(^9\).

Information on the morphological variations of the foramen ovale is sparse in the literature and the purpose of this study is to present a unilateral variation of the morphology of the foramen ovale, with two initial exits and two final exits, and that does not match it to any of the classifications currently described.

METHODOLOGY

The present study is classified as a study with the use of anatomic specimen. Approval was given by the Research Ethics Committee (REC) under protocol 12923919.8.0000.5430.

The study was conducted in one human skull specimen from the Anatomical Department of the institution. A transverse section in the skull was performed for visualization of the foramen ovale and the greater wings of the sphenoid bone and the middle cranial fossa were observed internally. The inferior view of the base of the skull was also evaluated.

The measure of the diameter (mean ± standard deviation) of the foramen was analyzed using the computer program “Image-J”, intended for image processing, in which photographs of the foramen and the openings were submitted.

From the measures, it was possible to compare the left and right foramina ovalia and establish, using the literature, possible consequences and clinical applications resulting from the variation.

RESULTS

During routine dissection for the improvement of anatomical parts, it was detected in a bone piece of human skull, an atypical morphology of the foramen ovale. The specimen was obtained by anonymous donation and characteristics such as age, gender, ethnicity, and clinical history could not be determined, since there are no identification records in the institution.

In the course of dissection of the lower region of the base of the skull, the right and left foramina ovalia were identified in the inner part of the greater wings of the sphenoid bone and a variation in the foramen was identified.

While the left foramen was clearly visible and normally developed (Figure 1), a bifurcation was observed on the right (Figure 1). Two holes with different diameters were detected internally on
the right side: one with a larger diameter and the other with a smaller diameter (major right foramen and smaller right foramen, respectively) (Figure 1).

Two more foramina were verified externally, one is anterior to the spinous foramen and the other, posterior (external right anterior foramen and external right posterior foramen, respectively – Figure 2).

No anatomical changes were detected in the other cranial foramina that could be related to the reported variation.

Data was collected and analyzed by the computer program “Image-J”, calculating the measure of the diameter of the foramina ovalia of the skull. In the present study, the mean and standard deviation values of the diameter (mm) of the FO calculated were 5.655 ± 0.196 (mm) in the left foramen in the inner part of the skull. The mean and standard deviation in the major right foramen, also in the internal region, was 4.700 ± 0.064 (mm). The values found for the mean and standard deviation in the smaller right foramen were 1.510 ± 0.082 (mm). A comparison was made between the left and right side foramen ovale in a

Figure 1. A. internal view. B. external view of the skull base evidencing the foramina ovalia – bifurcation right and left.

Figure 2. Right lateral view of the skull evidencing the posterior external foramina.

Graphic 1. Diameter (in millimeters) of the left and right side foramen. * Statistically significant difference (p<0.001).
DISCUSSION

The presence of the foramen ovale with two external openings and two internal openings in the skull has major clinical and surgical implications. It is necessary to obtain the precise anatomical base that includes the size of the skull, shape, distance, to avoid a blind puncture during the therapy of blockage of the nerves passing through the foramen. Among the surgical implications, it can be mentioned that additional foramina in the region may be a barrier to the surgeon's needle as it approaches the lower surface of the foramen ovale during trigeminal nerve ablation procedures. The presence of a smaller diameter, area and/or perimeter may justify possible nerve compression between osseous structures and muscles, causing neuralgia.

The trigeminal neuralgia is a painful syndrome related to the area of innervation of one or more trigeminal branches, characterized by paroxysmal, high-intensity, short-period pain that can be caused by the compression of the nerve. It can be treated by drugs and surgical approach.

According to studies by Liu et al., a narrow foramen ovale may result in a restriction of blood flow and possible ganglion ischemia. Furthermore, FO variations may interfere with transcutaneous needle placement or distort anatomical relations during approaches at the base of the skull. The knowledge about the difference between a normal and an abnormal foramen is fundamental during computed tomography and magnetic resonance imaging and has great surgical and diagnostic importance in procedures such as microvascular decompression, percutaneous trigeminal rhizotomy for trigeminal neuralgia – a technique of deep transfacial needle aspiration in perineural dissemination of the tumor, electroencephalographic analysis for seizure and percutaneous biopsy of cavernous sinus tumors. Endoscopic, endofacial, transzygomatic, and transpterygoid approaches can also be used for the infratemporal fossa, radiologically or surgically guided, and to access the pathologies in and around the FO, contributing to reduce patient morbidity and the costs involved.

CONCLUSIONS

Although the information about variation of foramen ovale is sparse in literature and there is no correct classification of the morphology, comprehension of the structure is extremely important to avoid several complications. In this case, because of the downsizing of the right foramen ovale aperture and its abnormal division compared to the left, some procedures, and structures that the foramen gives passage, it can bring risks to the patient.

REFERENCES


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