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Original Research Article

Anatomical evaluation of supraorbital notch and supraorbital foramen morphology and supraorbital nerve distribution: a cadaveric study

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ABSTRACT

Background: Peripheral nerve compression at trigger points is considered a cause of migraine and primary headaches. These trigger points are most commonly found in the sensory regions. In particular, compression of the supraorbital nerve by fascial bands or at the supraorbital foramen has been reported as a source of headache in the literature. This study aimed to evaluate the structures through which the supraorbital nerve passes to reach the innervation area.
Methods: Eleven female and 11 male cadaver heads fixed with formalin were dissected and the formation of the supraorbital nerve emerging the cranium was evaluated.
Results: Cadaveric sides were divided into four types based on the presence of a notch or foramen. Sides with only one notch constituted the majority at 45.4% (Type A).
Conclusions: In this study, in cases with only supraorbital notch, the distance of the notch to the midsagittal line was found to be 23.51±3.74 mm on the right side and 22.77±3.75 mm on the left side on average. In cases with only supraorbital foramen, the right side average was calculated as 20.50±4.30 mm and the left side average was calculated as 25.60±3.83 mm. These measurements are of considerable importance in procedures such as migraine botox or migraine surgery.

Keywords: Migraine, Supraorbital nerve, Migraine surgery, Nerve entrapment, Trigger points, Supraorbital foramen

INTRODUCTION

Compression of peripheral nerves at trigger points is among the causes of migraine and primary headache pathogenesis.[1] The most common trigger points are the sensory innervation areas of the supraorbital and supratrochlear nerves, the auriculotemporal and zygomaticotemporal nerves, and the greater occipital, lesser occipital, and third occipital nerves.[2] The morphological features of the points where the neurovascular structures pass are effective in the etiology of nerve compression. Information on headaches caused by compression of the supraorbital nerve by fascial bands or while passing through the supraorbital foramen is available in the literature.[3] The supraorbital nerve and supraorbital artery leave the orbit through the supraorbital notch or foramen and enter the frontal region.

The supraorbital nerve divides into medial (superficial) and lateral (profundus) branches in the frontal region. The medial branch pierces the corrugator supercilii muscle and passes to its anterior surface, while the lateral branch and supraorbital artery course behind the muscle and superficial to the frontal bone. These two branches of the supraorbital nerve can reach to the region through the same foramen (notch) or through separate structures. When the morphology of this notch/foramen and the branching variations of the nerve are revealed in detail, compression syndromes can be better elucidated.

The aim of this study is to classify the notch/foramen morphology of the orbital margin of the frontal bone, which is one of the peripheral entrapment points that can lead to headache syndromes, and the supraorbital structures passing through there.

METHODS

The present study is a cadaveric study was carried out on 22 formalin-fixed adult cadavers (11 female and 11 male) in the Department of Anatomy, Faculty of Medicine, Istanbul University, during the period July 2024-March 2025. The specimens consisted of donated cadaveric head materials. Information regarding race, age, or other physical characteristics was not available. Cadavers with preserved frontal and orbital region integrity were included in the study. Cadavers who had previously undergone surgery in the orbital region, had a history of trauma or mass in the facial region, and whose orbital integrity was impaired were excluded from the study.

After the cadavers were placed in the supine position, a vertical incision was made, starting from the nasion and continuing to the hairline, followed by a horizontal incision following the upper eyelash line. Following fine dissection of the frontal and orbicularis oculi muscles, the corrugator supercilii muscle and the neurovascular structures on its surface were accessed. The corrugator supercilii muscle was then freed from the frontal bone. Subsequently the supraorbital notch/foramen and the supraorbital artery and supraorbital nerve branches passing through the frontal bone were observed. The number of branches and the distance from this structure where these branches left the orbit to the midline were photographed using a millimetric ruler and these photographs were transferred to digital media. Measurements were made with the obtained images using the ImageJ 1.54g Java 13.0.6 (National ınstitutes of health, USA) program. Measurement results were recorded using the Microsoft excel program. Ethics committee approval was received for the study from the Istanbul medical faculty clinical research ethics committee (dated 22 July 2024 and numbered 2736236), and the study process was carried out in accordance with the 1964 world medical association Helsinki declaration.

RESULTS

The presence of supraorbital notch and/or supraorbital foramen located in the orbital margin of the frontal bone was evaluated. Considering the presence of these structures, the cases were divided into 4 groups (Figure 1).

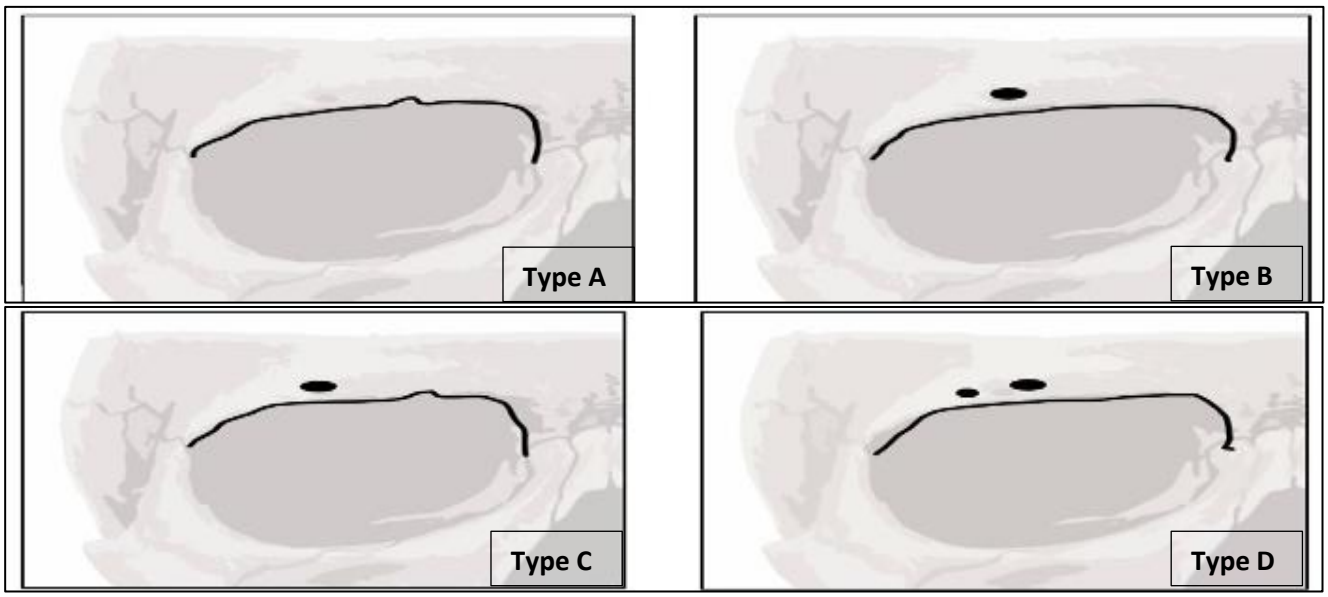

Figure 1: Typing (Type A to Type D) of supraorbital foramen-notch morphology.

Type A

Cases with only 1 supraorbital notch were included in this group, 45.4% (20/44) of sides were classified as type A.

Type B

Cases with only one supraorbital foramen were included in this group. 32% (14/44) of the sides were named as type B.

Type C

Cases with one supraorbital notch and one supraorbital foramen were included in this group. 13.6% (6/44) of the sides were in this group.

Type D

It was observed that there were two supraorbital foramen on 4/44 sides. 9% of the cases were classified in this group.

Among these types, the female-male distribution of cadavers in type A and B groups was equal. In the cases in type C group, the female:male ratio was recorded as 1:5. In the type D group, it was observed that all the cases were female (Table 1).

Supraorbital nerve

In 50% of the cases in the type A group, it was seen that it emerged as 2 branches, and in 50% it emerged as 3 branches from the orbit. In 7% of the cases in the type B group, it was seen that it emerged as 1 branch, in 28% as 2 branches, and in 65% as 3 branches. In 33% of the cases in the type C group, it was recorded that it emerged as 2 branches each from the notch and foramen, in 17% as 1 branch each from the notch and foramen, in 33% as 1 branch from the notch and 3 branches from the foramen, and in 17% as 1 branch from the notch and 2 branches from the foramen (Table 2).

Type D group, it was observed that 25% of the branches emerged from the notch as 2 branches and 1 branch from the foramen, 50% of the branches emerged from the notch as 1 branch and 2 branches from the foramen, and 25% of the branches emerged from the notch as 1 branch and 3 branches from the foramen (Table 3).

Table 1: Gender distribution by types.

Gender	Type A	Type B	Type C	Type D	Total
Female	10	7	1	4	22
Male	10	7	5	0	22
Total	20	14	6	4	44

Table 2: Number of supraorbital nerve branches of type C.

Total number of sides in type C group	Number of branches emerging from the supraorbital notch	Number of branches emerging from the supraorbital foramen
2	2	2
1	1	1
1	1	2
2	1	3
Total=6 sides		

Table 3: Number of supraorbital nerve branches of type D.

Total number of sides in type D group	Number of branches emerging from the supraorbital foramen 1 (medial)	Number of branches emerging from the supraorbital foramen 2 (lateral)
2	1	2
1	2	1
1	1	3
Total=4 sides		

DISCUSSION

Migraine is one of the primary headache syndromes according to international headache society classification. It is characterized by periodic, often unilateral and throbbing type pain. It can start at any age and is known to have familial transmission. It is diagnosed clinically and there is no definitive diagnostic imaging/lab test.[4] Although pathogenesis of migraine has not been clearly elucidated, data from recent studies suggest that primary neuronal mechanisms play an important role in migraine pathophysiology.[5] The presence of trigger points and response to relaxant treatments have led to the idea that entrapment neuropathies play a role in pathophysiology.[3]

Although the place of medical treatment in migraine treatment remains unquestionable, surgical treatment methods and their diversity have also increased their importance day by day.

If these surgical treatments are examined, it is possible to encounter the methods mentioned below. If the corrugator supercilii muscle is suspected of causing nerve compression, it is resected to decompress the supraorbital and supratrochlear nerves. If the supraorbital nerve passes through the supraorbital foramen, a foraminotomy can be performed. Fascial bands and bone bridges, if present, can be cut to free the nerves.[6] When the literature is reviewed, there are studies comparing the frequency of presence of a supraorbital notch and a supraorbital foramen in cases of nerve compression. One of these studies with computed tomography specifies the presence of a supraorbital foramen instead of a supraorbital notch in 27% of the population.[3] In order to guide the surgeries performed in the frontal region and to understand the etiology of pain, different studies have attempted to show the presence and types of notch/foramen. In her study conducted with computed tomography on two groups of 70 patients with migraine and healthy control group of 70 people, Bucioğlu reported that the rate of patients with migraine with only supraorbital notch on the right side of the group of patients

with migraine was 54.3%, the rate of those with only supraorbital foramen was 22.9%, and the rate of those with both notch and foramen was 8.6%[7]. In the same group, the rate of only supraorbital notch was reported as 50%, only supraorbital foramen as 17.1%, and both notch and foramen as 22.9% on the left side. In the control group, the rate of only supraorbital notch was reported as 54.3%, only supraorbital foramen as 20%, and both foramen and notch as 12.9% on the right side. In the same group on the left side, the rate of those with only supraorbital notch was 57.1%, the rate of those with only supraorbital foramen was 8.6%, and the rate of those with both notch and supraorbital foramen was 8.6%.[7] Fallucco et al examined 60 supraorbital regions belonging to 30 cadavers in their study to compare notch-foramen incidences in the community and reported that 16.6% of the cases had only supraorbital foramen, 73.3% had only supraorbital notch, and 10% had both foramen and notch.[3] Agthong et al found in their study with 110 dry bones that the percentage of cases with only supraorbital notch was 50% on the right and 42.7% on the left, the percentage of cases with only supraorbital foramen was 39.1% on the right and 42.7% on the left, and the cases with both notch and foramen were 1.8% on the right and 1% on the left. They also reported that cases with two supraorbital foramen were seen at a rate of 3.6% on the right and 3.6% on the left.[8] In our study, it was observed that 45.4% of the cases had only supraorbital notch (Type A), 32% had only supraorbital foramen (Type B), 13.6% had both supraorbital foramen and supraorbital notch (Type C), and in addition, 9% had two supraorbital foramen (Type D). In these studies in the literature, the transverse distances between the supraorbital notch/foramen and the midsagittal line were also evaluated and comparisons were made between the groups.[7,8] In their study with 83 dry bones, Ashwini et al reported the supraorbital foramen-midsagittal line distance as 22.24±0.40 mm on the right side and 22.20±0.39 mm on the left side.[9] Barker et al in their study on 64 orbits belonging to 23 skull bones and 9 fixed cadavers, reported that 63.6% of the cases had only a supraorbital notch and 36.4% had only a supraorbital foramen. As a result of the distance measurements between the supraorbital notch and the midsagittal line, the average value was found to be 22.69±3.78 mm, and the average value between the supraorbital foramen and the midsagittal line was found to be 25.86±3.67 mm.[10] In our study, in cases with only supraorbital notch, the distance of the notch to the midsagittal line was found to be 23.51±3.74 mm on the right side and 22.77±3.75 mm on the left side on average. In cases with only supraorbital foramen, the right side average was calculated as 20.50±4.30 mm and the left side average was calculated as 25.60±3.83 mm.

Limitations

This study, being a cadaver-based investigation, presents a limitation in sample size. Furthermore, performing such detailed dissections under a dissection microscope or magnifying glass could enhance the quality and efficiency of the study by minimizing human error.

CONCLUSION

Considering that the mechanisms involved in migraine etiology are not yet fully clarified, migraine surgery is an effective option for relieving nerve entrapment and compression caused by mechanical effects. Knowing the nerve distributions of the region will be important and valuable in increasing the success of the procedures to be performed. In conducting our study, we aimed to obtain anatomical data that could guide these treatment options. This study, particularly as a cadaveric study, supports and expands upon existing radiologic and dry bone studies in the literature.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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