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Araştırma Makalesi / Research Article

The Incidence of The Zygomatico-orbital Foramen and The Importance of Its Location in Surgical Approaches

Foramen Zygomaticoorbitale'nin Görülme Sıklığı ve Lokasyonunun Cerrahi Yaklaşımlardaki Önemi

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Abstract

Aim: The present study aimed to reveal the frequency of the zygomatico-orbital foramen (ZOF) in the zygomatic bone, its location, and its connection with the zygomatico-orbital foramen (ZFF) and zygomaticotemporal foramen (ZTF).

Material and Method: Ethics committe eapproval of our study was received by the Istanbul Medical Faculty Clinical Research Ethics Committee. Fifty (27 right; 23 left) hemicraniums of Istanbul University, Department of Anatomy of unknown gender were included in the study. Connections with ZOF were determined by passing fine wire through ZTF and ZFF. The closest point of the ZOF to the orbital rim was measured. The distance from the area used for retrobulbar injections (defined as the point where the 1/3 inferolateral edge and 2/3 inferomedial edge of the aditus orbitalis intersect.) to the ZOF was measured. All measurements were measured with a digital caliper and the data were evaluated with SPPS v.21.

Results: The number of ZOF was found 46 (51.68%) on the right and 43 (48.32%) on the left side. ZOF, was found to be single in 18 (36%) orbits, double in 16 (32%) orbits, 3 (18%) in 9 orbits, and 4 (6%) in 3 orbits. ZOF was absent in 4 (8%) orbits. Of 89 ZOFs, 37 (20 right; 17 left) were found to be associated with (via a channel) ZFF and 16 (8 right; 8 left) with ZTF. It was noted that 36 (18 right; 18 left) ZOF had no connection with any foramina. The closest distance of ZOF to the orbital rim was 4.54±2.33 mm and the distance to the retrorobulbar injection area was 7.89±2.98 mm.

Conclusion: The location and variations of FZO may be helpful in preventing complications during retrobulbar injection, lateral orbitotomy approach for intraorbital tumors, and during surgical interventions such as repair of zygomatic fractures.

Keywords: Zygomatico-orbital foramen, zygomaticofacial foramen, zygomaticotemporal foramen, zygomatic bone, retrobulbar injection

Öz

Amaç: Os zygomaticum'un facies orbitalis'inde bulunan foramen zygomaticoorbitale (FZO)'nin görülme sıklığının ortaya konulması, konumunun belirlenmesi, foramen zygomaticofaciale (FZF) ve foramen zygomaticotemporale (FZT) ile bağlantılarının tespit edilmesi amaçlanmıştır.

Materyal ve Metot: Çalışmamızın Etik kurul onayı İstanbul Tıp Fakültesi Klinik Araştırmalar Etik Kurulu tarafından alındı. İstanbul Üniversitesi, İstanbul Tıp Fakültesi Anatomi Anabilim Dalı laboratuvarında bulunan, cinsiyeti bilinmeyen 50 adet (27 sağ; 23 sol) hemicranium çalışmaya dahil edildi. FZT ve FZF'den ince tel geçirilerek FZO ile olan bağlantılar tespit edildi. FZO'nin aditus orbitalis'in inferior kenarına olan en yakın mesafe ölçüldü. Son olarak, retrobulbar enjeksiyon için kullanılan noktadan (aditus orbitalis'in 1/3 inferolateral kenarı ile 2/3 inferomedial kenarının kesiştiği nokta) FZO'ye olan mesafe ölçüldü. Tüm ölçümler için dijital kaliper kullanıldı ve verilerin değerlendirilmesi SPPS v.21 ile gerçekleştirildi.

Bulgular: FZO'nin sayısı sağ tarafta 46 (%51,68) sol tarafta ise 43 (%48,32) olarak bulundu. FZO; 18 (%36) orbitada tek, 16 (%32) orbitada çift, 9 (%18) orbitada 3 ve 3 (%6) orbitada 4 foramenli olarak bulundu. 4 (%8) orbitada ise FZO hiç görülmedi. 89 FZO'den 37'si (20 sağ; 17 sol) FZF ile 16'sı (8 sağ; 8sol) FZT ile bağlantılı (bir kanal aracılığı ile) olduğu bulundu. 36 (18 sağ; 18 sol) FZO'nin ise herhangi bir foramen ile bağlantısı olmadığı kaydedildi. FZO'nin aditus orbitalis'in inferior kenarına olan en yakın mesafe 4,54±2,33 mm ve retrorobulbar enjeksiyon noktasına olan mesafe 7,89±2,98 mm olarak ölçüldü.

Sonuç: FZO'nin lokasyonu ve varyasyonları retrobulbar enjeksiyon sırasında, intraorbital tümörler için uygulanan lateral orbitotomi yaklaşımında ve zigomatik fraktürlerin onarımı gibi cerrahi girişimler esnasında komplikasyonlarının önlenmesinde yardımcı olabilecektir.

Anahtar Kelimeler: Foramen zygomaticoorbitale, foramen zygomaticofaciale, foramen zygomaticotemporale, os zygomaticum, retrobulbar enjeksiyon

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INTRODUCTION

The zygomatic bone (ZB) is one of the important viscerocranium bones in the facial region due to its anatomical location. Three important surfaces, namely lateral surface, temporal surface, orbital surface, and zygomaticofacial foramen (ZFF), zygomaticotemporal foramen (ZTF), and zymatico-orbital foramen (ZOF) are located on these surfaces, respectively (1). The number, location, and interconnection (via canal) of these foramina may differ between individuals.

The zygomatic nerve, which emerges as a branch of the maxillary nerve in the pterygopalatine fossa, reaches the orbit by passing through the inferior orbital fissure. After advancing on the outer wall of the orbit, it passes through the ZOF and reaches the ZB, where it divides into two branches called the zygomaticotemporal and the zygomaticofacial branch (1). The zygomaticotemporal branch reaches the temporal fossa after passing through the ZTF. Here, it penetrates the temporal fascia 2.5 cm above the zygomatic arch, reaches the skin, and performs the sensory innervation of the region. After the zygomaticofacial branch passes through the ZFF, it pierces the orbicularis oculi muscle and distributes in the skin of the region, and provides sensory innervation (2-5).

The zygomatico-orbital artery, which is usually a branch of the superficial temporal artery, courses near the zygomatic arch and between the two layers of the temporal fascia. This artery supplies the orbicularis oculi muscle by anastomoses with the lacrimal and palpebral branches of the ophthalmic artery (1). Moreover, the lacrimal artery, which is a branch of the ophthalmic artery gives two branches, the zygomaticofacial and the zygomaticotemporal branch. These arteries are very important for surgeons, especially during facial surgery. However, the intraorbital course of this artery has rarely been described in the literature, but it is an important structure that ophthalmologists should consider when approaching the orbit. Therefore, the zygomaticoorbital foramen is the junction of neurovascular structures on the orbital surface of the ZB, where occurs between the ZOF, ZFF, and the ZTF. The ZOF is the common opening on the orbital surface of the ZB that transmits neurovascular structures through other foramina. Although the opening of ZFF on the lateral surface of the ZB has been found in many studies in the literature, there are not enough studies on ZOF and its connections, although it has clinical importance (6-8).

The ZB is an important guide point for surgical dissections of the facial, maxillofacial, and periorbital interventions, due to it contains (nerves and vessels) and its anatomical position. The variability of the number and location of the foramina makes the area far from being completely safe (6,8). Neurovascular structures in the region should be protected, especially in transmaxillary surgical interventions to the orbit. In case of damage to these structures, paresthesia, dysesthesia, or neuralgia-type pain may occur in half of the face of the patient. In addition, damage to vascular structures can cause intraoperative hemorrhage or postoperative hematomas. Therefore, a good knowledge of the anatomy and variations of the region is important in surgical planning or the prevention of iatrogenic injuries and subsequent morbidity (8-10). In the literature review, cadaver studies show that the foramina on the zygomatic bones perform multiple variations (11). This study aimed to describe the morphological and morphometric features of the ZOF on its orbital surface. Additionally, it is also aimed to determine a safe intervention area during the surgical approach to the lateral orbital wall and during retrobulbar injections.

MATERIAL AND METHOD

Fifty (27 right; 23 left) hemicrania of unknown gender and age in the laboratory of Istanbul University, Istanbul Faculty of Medicine, Department of Anatomy were included in the study. Ethics committee approval of our study was received by the Istanbul Medical Faculty Clinical Research Ethics Committee (date: 30.07.2021, number: 358356). The non-metric and metric measurements described in Figure 1, Figure 2, Figure 3 and Figure 4 were made:

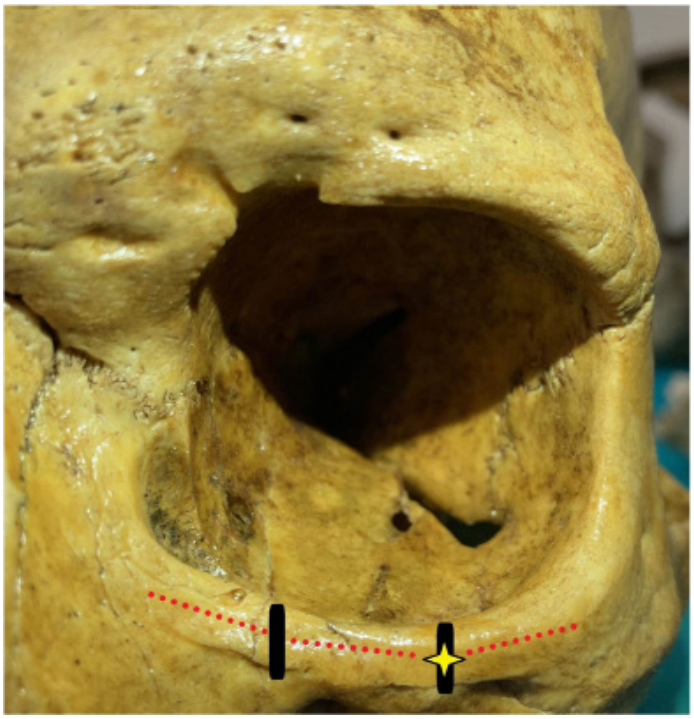

Figure 1. The point of the retrobulbar injection (yellow asterisk): The transverse distance to the ZOF from the point used for retrobulbar injection. First, the inferior part of the orbital rim (red points) is divided into three parts then the lateral 1/3 edge (yellow asterisk) is marked

Non-metric analysis

1. The numbers of ZOF

2. The connections of ZOF with ZFF and ZOF: These connections were determined by passing a thin wire

through the ZTF on the temporal surface of the ZB and the ZFF on the lateral surface of the zygomatic bone.

Metric analysis

3. The position of ZOF: The closest distance to the orbital rim of the ZOF was measured to determine the position. When more than one foramen was detected, the closest to the orbital rim was included in the measurement.

4. The point of the retrobulbar injection: The transverse distance to the ZOF from the point used for retrobulbar injection (the point where the 1/3 inferolateral edge of the orbital rim and the 2/3 inferomedial edge) (Figure 1).

By 0.01 mm precision digital caliper (Mitutoyo Company, Kawasaki-shi, Kanagawa, Japan) was used for all measurements.

Statistical analysis

All data were expressed as mean, standard deviation, minimum and maximum. IBM SPSS V21(IBM corporation, Armonk, NY) was used for all data analyses. Since the hemicrania are not bilateral, no correlation was made between left and right.

Figure 2. Different types and frequency of zygomtico-orbital foramen (black arrows)

Figure 3. The closest distance to the orbital rim (red points) of the zygomtico-orbital foramen

Figure 4. The position of needle during the retrobulbar injection (left orbit).

RESULTS

The incidence of ZOF in a total of 50 hemicrania (54% right; 46% left) included in our study was recorded as 92%. The number of ZOF was 46 (51.68%) on the right and 43 (48.32%) on the left side. ZOF was single in eighteen (36%) orbits, double in 16 (32%) orbits, three in 9 (18%) orbits, and four in 3 (6%) orbits. In addition, ZOF was not found at all in four (8%) orbits (Table 1). Of 89 ZOF, 37 (20 right; 17 left) were found to be associated (via a channel) with ZFF and 16 (8 right; 8 left) with ZTF. It was noted that 34 (16 right; 18 left) ZOF had no connection with any foramina (Figure 2 and Figure 5).

The metric analyzes of the two parameters determined for ZOF are as follows:

The closest distance of the ZOF to the inferior border of the orbital rim was 4.54 ± 2.33 mm, and the values of this distance varied between 1.50 mm and 8.90 mm on the left side and between 2.68 mm and 10.50 mm on the right side. The distance to the retrobulbar injection point was measured as 7.89 ± 2.98 mm and ranged from 5.70 mm to 13.60 mm on the left side, and between 4.60 mm and 12.80 mm on the right side. Since the hemicrania included in the study did not belong to the same side, correlations

Table 1. Incidence of ZOF

Number of Foramen (%)		0 (%)	1 (%)	2 (%)	3 (%)	4 (%)
ZOF	LEFT	1(4.35%)	8 (34.78%)	8 (34.78%)	5 (21.73%)	1 (4.35%)
	RIGHT	3 (11.11%)	10 (37.03%)	8 (29.63%)	4 (14.81%)	2 (7.40%)
	TOTAL	4 (8%)	18 (36%)	16 (32%)	9 (18%)	3 (6%)

ZOF: zygomatico-orbital foramen

Table 2. Location of ZOF

mm	ZOF-OR		ZOF-RIP	
	LEFT	RIGHT	LEFT	RIGHT
Mean	4.45	4.62	8.08	7.73
Minimum	1.50	2.68	5.70	4.60
Maximum	8.90	10.50	13.6	12.8
SD	2.01	2.61	2.62	3.30

ZOF-OR: The closest distance to the orbital rim of the ZOF. ZOF-RIP: The point of the retrobulbar injection. SD: Standard Deviation

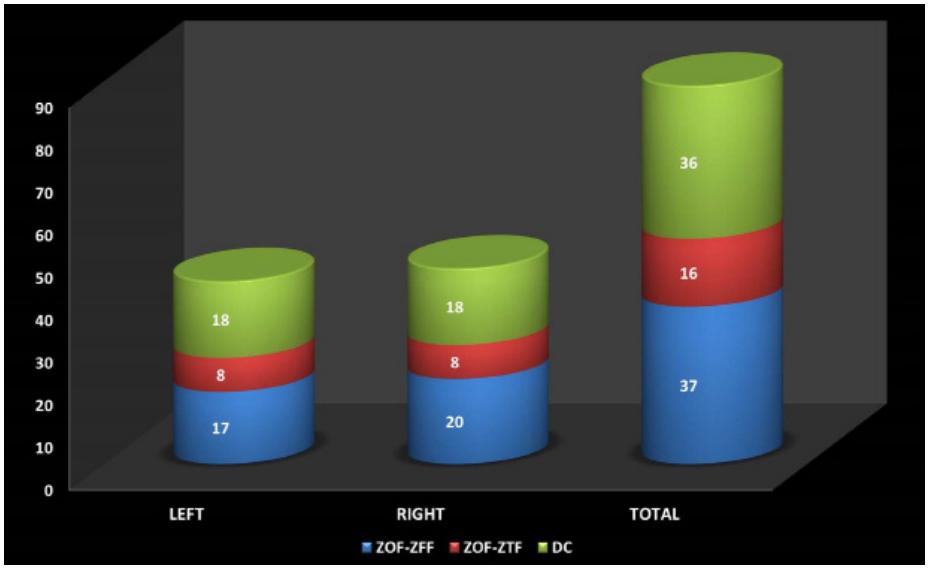

Figure 5. Number of connections of zygomatico-orbital foramen with zygomaticotemporal and zygomaticofacial foramen. ZOF-ZFF: The connection between the zygomatico-orbital foramen and zygomaticofacial foramen. ZOF-ZTF: The connection between the zygomatico-orbital foramen and zygomaticotemporal foramen. DC: Disconnected

between the right and the left sides were not evaluated (Table 2).

DISCUSSION

The ZB is a hard bone that plays an important role in shaping the face in terms of aesthetics. In therapeutic or cosmetic surgical procedures, ZB osteotomies are frequently used to access the skull base and orbit. Foramina such as ZFF, ZTF, and ZOF, which provide the passage of the terminal ends of the maxillary nerve on the ZB and allow the branches of the ophthalmic artery and superficial temporal artery to pass, constitute important landmarks for neurosurgery, plastic surgery, maxillofacial surgery and oculoplastic surgery (6,12). Embryological studies have shown that the branching of the maxillary nerve begins before it enters the zygomatic bone, and these branches contribute to the emergence of foramina such as ZFF, ZTF, and ZOF (6, 13). The variation in the number of ZFF, ZTF, and ZOF in the embryological development process is also stated that the ZB is associated with the number of ossification centers that begin to emerge at the 8th week and begin to fuse at approximately 22nd week (7). Knowing the location of these foramina, which varies in terms of location and number, is very important for surgeons and anesthesiologists (10). ZOF contains vascular structures that carry a risk of bleeding in interventions associated with the lateral orbital wall and may complicate operations such as oculoplastic surgery, which requires deep dissection to reach the orbital apex (14). In terms of peribulbar and retrobulbar blocking and orbital surgery, it is important to know the location of the ZOF on the inferolateral wall of the orbit and its connections with the ZFF and ZTF (15). Loukas et al. (6) examined 400 orbits in 200 skulls, and the rates of cases where ZOF was not seen at all, single foramen, two foramina, three foramina, and four foramina were found to be 17%, 50%, 20%, 10%, and 3%, respectively. Kim et al. (12) have detected on 14 zygomatic bone, 1 orbit with single foramen, 2 with double foramina, 5 with triple foramina, 5 with 4 foramina, and 1 orbit with five foramina, but it was not found the ZB in which the ZOF is absent. Likewise, Babcan et al. (16) have not reported absent ZOF in 28 orbits while the most common was seen as a single foramen. Similar to the results of Lukas et al. (6), our study have supported that in 4 (8%) of 50 orbits the ZOF was absent agrees with the well-documented finding that foramen number can also vary, with larger case studies showing a range from none to many (Table 1 and Figure 2). Examining the connection of ZFF with the ZOF, Jibu et al. (17) observed that ZFF was associated with ZOF by a canal at a rate of 62%. On the other hand, Kim et al. (12), using micro-computed tomography, three-dimensionally demonstrated the foramina and canals in the zygomatic bone. According to their results, ZTF and ZFF can be opened to ZOF independently, through a single canal, as well as ZTF can also be opened into the intraosseous canal formed between ZFF and ZOF (12). This may mean that there are structures that pass through these foramina and may be interconnected, or these foramina are interconnected (18). Since the exits ossified over time, a few of the skulls used did not have an exit (19). However, it should be taken into account that the skulls and their morphology may differ slightly with the change in the population, the place, or the area of their occurrence (20). However, the main foramen of exit from the Anatolian population considered in our study is the zygomatico-orbital foramina. The results of studies with different populations and people with different demographic characteristics may differ. On the other hand, the location of the ZOF within the orbital surface of the ZB is highly variable. Patel et al. (15) have examined 28 orbits in which the closest distance between the ZOF and the orbital rim was calculated as 4.70 mm. Also, Coutinho et al. (21) have measured this distance as 5.00 mm on the right side and 4.50 mm on the left side in 69 orbits. We observed that our results are consistent with previous studies measuring the position of the ZOF relative to the orbital rim. However, only one study was found in the literature measuring the proximity of the ZOF to the retrobulbar injection point, and this distance was recorded as 6.00 mm by Patel et al. (15). ZOF includes vascular structures that carry a risk of bleeding in interventions related to the lateral orbital wall and may complicate operations that require deep dissection to reach the orbital apex (14). It is important to know the location of the ZOF on the inferolateral wall of the orbit in terms of peribulbar blocking and orbital surgery (15). The generally accepted approach to administering retrobulbar anesthesia is to direct the needle under the lateral third of the lower lid just above the orbital rim. Here, the ZOF and its critical neurovascular structures are found, the zygomaticofacial and zygomaticotemporal arteries and nerves. Therefore, it is an important structure that ophthalmologists should consider when applying retrobulbar block or oculoplastic surgery. So that; in the study reported by Mootha et al. (22), has been presented a case of subperiosteal orbital hemorrhage resulting in blindness during the retrobulbar injection. The authors speculate that this complication is likely a rupture of the zygomaticofacial artery. Other clinical situations where recognition of these structures is important to include elevation of the periorbita from the lateral wall, lateral orbitotomy approach to intraorbital tumors, and zygomatic fracture repairs. As a result, our study is presented with the conclusion that in addition to the surgical procedures to be performed on the facial region, knowing the variations of the foramina in access to the cranium and providing the passage of neurovascular structures in this region will contribute to the anatomy literature and will also be beneficial for anesthesiologists and surgeons.

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