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ORIGINAL COMMUNICATION

Location and Incidence of the Zygomaticofacial Foramen: An Anatomic Study

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The location and incidence of the zygomaticofacial foramen (ZFF) was studied in 80 dry skulls (160 sides) of unsexed adult skulls of West Anatolian people. The average distances from the ZFF to the frontozygomatic suture, to the zygomaticomaxillary suture, and to the inferior orbital rim were found to be 26.2 ± 3.2 mm, 18.6 ± 3.14 mm, and 5.94 ± 1.43 mm, respectively. The zygomas were evaluated for the number of foramina on their facial aspects. There was none in 25 (15.6%), one in 71 (44,4%), two in 45 (28.1%), three in 10 (6.3%), four in seven (4.4%), and five in two (1.3%) sides. The ZFF was also studied for its distribution around the zygoma by dividing the surface into four anatomical areas. There was no statistical difference between the morphometrical results on both sides. Data regarding the location and variation in the number of the ZFF is important in avoiding zygomatic nerve and vessel injury during surgery, but by virtue of the great variability found, ZFF is an unreliable landmark for maxillofacial surgery. Clin. Anat. 22:559–562, 2009. © 2009 Wiley-Liss, Inc.

Key words: zygomaticofacial foramen; zygomatic nerve; facial surgery

INTRODUCTION

The zygoma is one of the important structures encountered during facial surgery due to its anatomical location. The zygomaticofacial nerve and vessels arise from the zygomaticofacial foramen (ZFF) on the facial aspect of the bone. The zygomaticofacial nerve is a terminal branch of the zygomatic nerve. It perforates the orbicularis oculi muscle and supplies the skin on the prominence of the cheek. It forms a plexus conjoining the branches of facial and maxillary nerves. Occasionally, the nerve and the foramen may be absent (Standring et al., 2005).

Several authors have suggested that the ZFF may be a useful anatomical landmark for the depth of facial dissection near the bone (Aziz et al., 2002; Gonzalez et al., 2002; Martins et al., 2003). The zygomatic nerve and its branches may be injured during facial surgery in the periorbital region (Mangal et al., 2004; Lei et al., 2006). Blind surgical dissections in this area may cause postoperative hematoma by tearing the vessels arising from the ZFF (Williams, 2002).

Damage to the zygomaticofacial nerve has been reported in many cases involving osteotomies in the malar area. It may be possible to stretch the nerve and prevent numbness over the malar area (Williams, 2002; Newman, 2006; Hwang et al., 2007). The zygomaticofacial vessels may be disrupted by elevating periorbita from the lateral wall, and it is important that these vessels be identified and coagulated to prevent avulsion, bleeding and complications of postoperative hematomas. The existence and variations of the zygomaticofacial nerve, vessels, and foramina may affect the outcome of surgery (Aziz et al., 2002; Gonzalez et al., 2002; Williams, 2002; Mangal et al., 2004; Lei et al., 2006; Hwang et al., 2007).

The zygomatic bone shows variations in the number of the foramina on its facial aspect. The incidence of its presence is used as an anthropological marker

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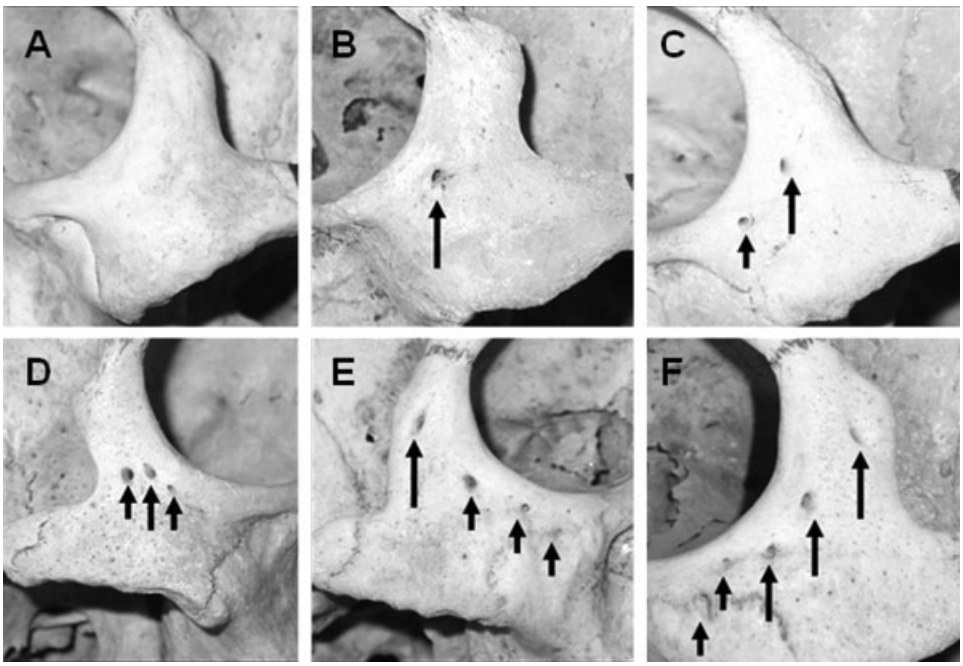


Fig. 1. The number of zygomaticofacial foramina. **A:** No foramen. **B:** One foramen. **C:** Two foramina. **D:** Three foramina. **E:** Four foramina. **F:** Five foramina.

for differentiating populations and races (Jose et al., 2001; Mangal et al., 2004). A few articles describe the location and incidence of the ZFF (Martins et al., 2003; Mangal et al., 2004; Standring et al., 2005; Hwang et al., 2007). In this study, the incidence, the location, and the number of the ZFF were evaluated in dry skulls of West Anatolian people.

MATERIALS AND METHODS

Eighty adult dry skulls (160 sides) of West Anatolian people were obtained from the Anatomy Department Laboratory of Dokuz Eylul University Medical School. The age and gender was not documented, and therefore, it could not be examined in this study. All measurements were performed by using a Vernier caliper (Mitutoyo Co., Japan), accurate to 0.1 mm.

The ZFF was counted on the right and the left sides, its incidence and distribution were evaluated (Fig. 1).

The malar surface of the zygoma was divided into four regions with two lines (one vertical and one horizontal line) named as a, b, c, and d. A vertical line was drawn from the most lateral point of the lateral orbital rim to the most inferior point of the zygomaticomaxillary suture and a horizontal line was drawn from the most inferior point of the inferior orbital rim to the zygomatic angle (the junction of the zygomatic arch and frontal process of the zygomatic bone) to cross the first line at right angles. Distributions of the foramina according to these regions were determined (Fig. 2).

The distances from the ZFF to the midpoint of the frontozygomatic suture (ZF-FZ), to the lowest point of the zygomaticomaxillar suture (ZF-ZMS), and to the closest point of the orbital rim were measured (ZF-OK) (Fig. 3). When more than one foramen was found, the largest one was accepted as the "main," and the measurements described earlier were done accordingly.

Statistical significance was determined by using "Independent-Samples *t* test" for measurable parameters, and "Chi-Square test" for the right and left side differences. Significance level was accepted as $P < 0.05$.

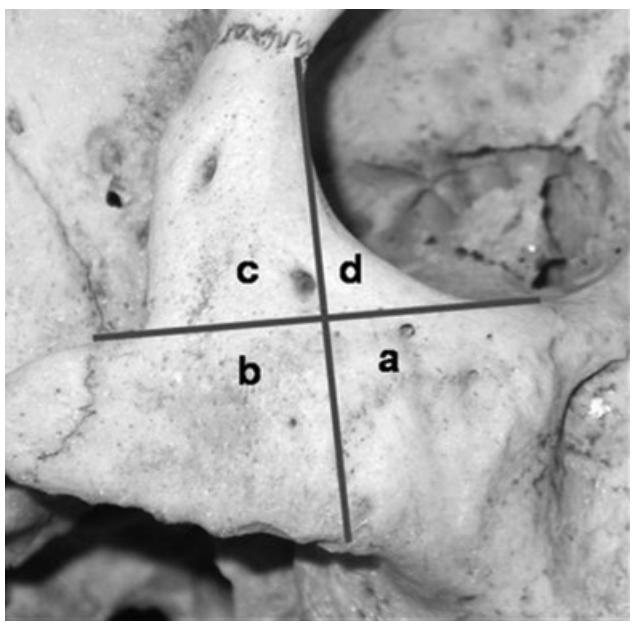


Fig. 2. Zygomatic bone was divided to four regions: a, b, c, and d with two lines.

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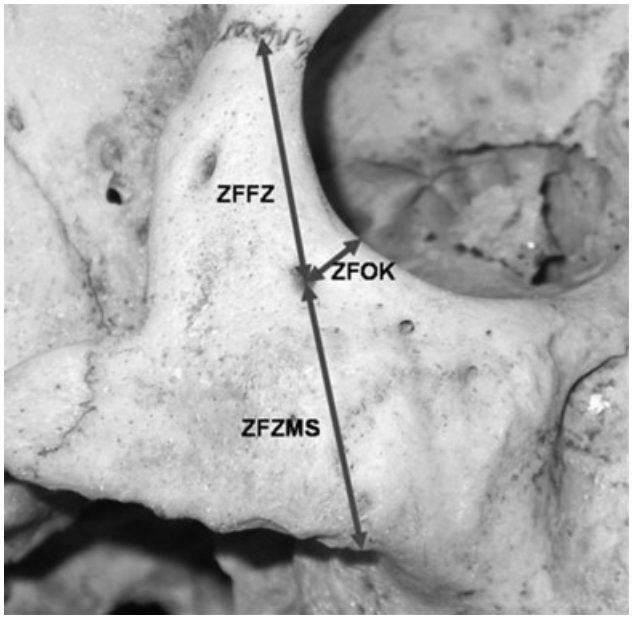


Fig. 3. The distances from the ZFF to the anatomical landmarks. ZFFZ, the distance from the ZFF to the frontozygomatic suture; ZFZMS, the distance from the ZFF to the lowest point of the zygomaticomaxillary suture; ZFOK, the distance from the ZFF to the closest orbital rim.

RESULTS

The mean ZF-FZ was 26.2 ± 3.2 mm, the mean ZF-ZMS was 18.6 ± 3.14 mm, and the mean ZF-OK was 5.94 ± 1.43 mm for both sides (Table 1). There was no statistically significant difference between the right and the left side.

When the numbers of the foramina were taken into consideration, one in 71 (44.4%), two in 45 (28.1%), three in 10 (6.3%), four in seven (4.4%), five in two (1.3%) sides were found. There were no foramina in 25 sides (15.6%) (Table 2).

TABLE 1. The Results of Independent-Samples *t* Test

		N	Mean	Std. deviation	*P**
ZF-FZ	Right	69	26.10	2.84	0.718
	Left	66	26.30	3.56	
	Total	135	26.20	3.20	
ZF-ZMS	Right	67	18,51	2.91	0.753
	Left	64	18.69	3.38	
	Total	131	18.60	3.14	
ZF-OK	Right	69	5.89	1.38	0.674
	Left	66	5.99	1.48	
	Total	135	5.94	1.43	

ZF-FZ: The distances from the ZFF to the midpoint of the frontozygomatic suture. ZF-ZMS: The distances from the ZFF to the lowest point of the zygomaticomaxillary suture. ZF-OK: The distances from the ZFF to the closest orbital rim.
[a]Independent-samples *t* test.

TABLE 2. The Number of Zygomaticofacial Foramina on the Right and the Left Sides and Their Incidence (%) in Skulls

	The number of ZF foramina					
	Frequency			%		
	Right	Left	Total	Right	Left	Total
0	11	14	25	6.9	8.7	15.6
1	33	38	71	20.6	23.8	44.4
2	21	24	45	13.1	15.0	28.1
3	9	1	10	5.7	0.6	6.3
4	6	1	7	3.8	0.6	4.4
5	0	2	2	0	1.3	1.3

When the distributions of the foramina according to four regions were evaluated, the total number of foramina were 228 in 160 bony sides and there were 67 in region a (29.4%), 51 in region b (22.4%), 107 in region c (46.9%) and 3 in region d (1.3%) (Table 3). In terms of distribution rate, no statistical difference was found between two sides of the skull.

DISCUSSION

The ZFF has often been reported as double, but occasionally absent (Standring et al., 2005). In archaeological sites in Argentina, skulls with no ZFF have been reported (Jose et al., 2001). Based on our data, the absence of the ZFF is not rare (Table 2). Martins et al. (2003) reported that frequent absence of the ZFF makes it an unreliable landmark for surgery. They evaluated the utility of the ZFF during facial surgery and found that it is a useful landmark when there is only one (50%). In this study, the zygoma with one ZFF was most frequent (44.4%). The incidence rate of the foramina was taken into consideration. It was observed that a single foramen was found in 20.6% (right side) and 23.8% (left side) respectively; so too for two foramina: 13.1% (right) and 15% (left); and for three foramina: 5.7% (right) and 0.6% (left); and for four foramina: 3.8% (right) and 0.6% (left), respectively. Finally, five foramina were observed in 1.3% on the left side only (Table 2). Foramina were absent in 6.9% (right) and 8.7% (left) sides. Mangal et al. (2004) observed one foramen 20% and 24.9%; two foramina 11.2% and 7.9%; three foramina 0.6% and 2.1%, in their samples, on the right and the left sides, respectively.

TABLE 3. Distribution of the Foramina According to Regions

Regions		Right	Left	Total
a	N	35	32	67
	%	28.0	31.1	29.4
b	N	35	16	51
	%	28.0	15.5	22.4
c	N	54	53	107
	%	43.2	51.5	46.9
d	N	1	2	3
	%	0.8	1.9	1.3
Total	N	125	103	228
	%	100	100	100

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There was no foramen 11.5% and 10.3% on the right and left sides in their study. The incidence rates of the foramina were compared with both studies; the samples with no foramen, with one foramen, and with two foramina were similar to our findings, but the samples with three foramina were markedly different from our results.

In some cases, the zygomaticofacial nerve may not exist (Standring et al., 2005). The absence of the ZFF may be an explanation for the absence of the nerve (Mangal et al., 2004). The zygomaticofacial nerve provides the malar skin with sensory innervation and anastomoses with the other branches of the trigeminal nerve in this area (Martins et al., 2003; Mangal et al., 2004). This could explain why sensory innervation still remains after the surgical dissection in case of damaged to the nerve (Mangal et al., 2004). It could also be due to the absence of the nerve, kongenitally.

To date, a maximum of four foramina in this region were reported (Martins et al., 2003; Mangal et al., 2004; Hwang et al., 2007). In this study, five foramina were found in two (1.3%) sides of the sample. This has not been described before.

The zygomatic bone may have one or three ossification centers. They appear in the 8th week and fuse in the 22nd week of fetal life (Mangal et al., 2004). The embryological origin of the variations and the high number of the ZFF may depend on the variety of ossification centers.

Mangal et al. (2004) found four zygomaticofacial foramina in one side (0.3%) in their nonmetric study on the morphological varieties and incidence of the ZFF. However, we found four foramina in seven sides (4.4%) in this study. This could be due to population-based differences between the two studies.

The relationship between the ZFF and the frontozygomatic suture is important during facial surgery. The location of the ZFF is also important during the stabilization of the zygomatic fractures involving the placement of screws above the zygomaticofrontal suture (Zide and Wu, 1990). Martins et al. (2003) described that the ZFF located 2.5 cm from the midpoint of the zygomaticofrontal suture and 0.7 cm from the inferolateral orbital rim (the closest inferolateral orbital angle from the main ZFF center). Our data is similar to that of Martins' findings.

Our measurements of ZF-FZ and ZF-OK were similar to the data of Hwang et al. (2007). The only difference was the rate of absence and four foramina. In this study, there was no foramen in 25 sides (15.6%) and there were four foramina at seven sides (4.4%). We believe that this difference is due to population differences between the two studies.

Williams, (2002) particularly emphasized the importance of the location of the ZFF, the nerve and the vessels arising from the foramen in subperiostal midface lift operation. In the study, the ZFF was found to be located at 1.5 cm inferior and lateral from orbital margin's inferolateral edge. In this study, it was found that this distance was almost 0.6 cm. The difference between two studies could be attributed to population differences of the skulls.

Hwang et al. (2007) maintain that 1 cm off the lateral portion of the lateral orbital margin's edge to be the best option in case of nerve and the vessel damage of the ZFF. However, it is the authors' view that a maximum distance of 0.5 cm from the orbital margin's edge is a better option in zygomatic bone dissection cases.

In this study, the average distance of ZF-ZMS was found to be 18.6 $\pm$ 3.14 mm. This information may be of assistance in locating the ZFF during minimally invasive surgery.

During the orbitozygomatic osteotomy, the most inferior zone point was determined as the ZFF (Aziz et al., 2002; Gonzalez et al., 2002).

In terms of regional distribution of the foramina, half of them were located at region c in this study (107 foramina, 46.9%). According to this study, when the distribution of the foramen and the number of its variations are taken into consideration, it can be said that great care should be taken in zygomatic bone osteotomy, especially in region c. It may be said that region d, where there is less ZFF distribution (1.3%), is a better choice for surgery.

CONCLUSION

In this study, we determined the incidence of the ZFF. The variability in the position of the ZFF and its frequent absence make it an unreliable landmark. We believe that this is important for maxillo-facial surgeons to be aware of in orbitozygomatic surgery.

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