Anatomic Characteristics of the Infraorbital Foramen: A Cadaver Study

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Purpose: The aim of this study was to document the variability in the position of the infraorbital foramen with relation to the facial midline, infraorbital rim, supraorbital notch, and maxillary teeth.

Materials and Methods: Forty-seven cadavers (94 sides) were dissected, exposing the infraorbital foramen, supraorbital foramen, and orbital floor bilaterally. Measurements made included (A) distance between the infraorbital foramen and inferior orbital rim; (B) distance of the infraorbital foramen from the facial midline; (C) distance of the supraorbital foramen from the facial midline; (D) distance between the infraorbital foramen and supraorbital foramen. Means, standard deviations, and ranges were determined, and statistical differences were calculated between the left and right orbits and sexes by use of an unpaired sample t-test (P < .05).

Results: In men, the mean distance between the infraorbital foramen and the inferior orbital rim was 8.5 ± 2.2 mm. In women, this was 7.8 ± 1.6 mm. The distance between the infraorbital foramen from the facial midline was 27.7 ± 4.3 mm in males and 26.2 ± 3.2 mm in females. The mean distance between the infraorbital foramen and supraorbital notch in males was 43.3 ± 3.1 mm and in females was 42.2 ± 2.4 mm. The average distance of the supraorbital notch from the midline was 26.5 ± 3.5 mm in males and 26.3 ± 3.3 mm in females. There were no statistically significant differences between the left and right sides or between sexes. The maxillary tooth most commonly found in the same vertical plane as the infraorbital foramen was the first premolar. Multiple ipsilateral foramina were found in 15% of cadavers.

Conclusion: These anatomic characteristics may have important implications for surgical and local anesthetic planning.

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The infraorbital foramen is an important anatomic landmark for the oral and maxillofacial surgeon from both a surgical and local anesthetic perspective. Its location and the possibility of multiplicity are important during periorbital surgery. Despite such significance, little attention has been given to documentation of the most common location for this foramen and its other associated anatomic characteristics.

There is a large variation in the measurements reported in the literature with regard to the distance between the infraorbital foramen and the inferior orbital rim. A number of review articles on the surgical anatomy of the orbit describe the foramen as lying 4 to 5 mm below the inferior margin of the orbit,1-4 whereas others describe this distance as being greater than 10 mm.5,6 Such disparity may be partially explained by the use of information obtained from old anatomy texts4-6 or studies of dried human skulls,7 which often did not provide a description of which reference point on the inferior orbital rim was used to determine the distance between it and the infraorbital foramen. In these studies, it is unclear whether the most inferior point of the orbital rim was used (the point yielding the shortest distance from the foramen) or whether another landmark was chosen. Furthermore, the objectives of the prior studies were not focused on the infraorbital anatomy, but rather on the anatomy of the orbit. Therefore, the aim of the current study was to document the location of the infraorbital foramen in relation to the infraorbital rim, facial midline, supraorbital notch, and maxillary teeth. Such information may allow clinicians to better ap-
proximate the location of the infraorbital foramen for nerve blockade and periorbital surgery.

**Materials and Methods**

Forty-seven intact cadavers (24 male, 23 female; 33 white, 11 black, 3 Hispanic) were obtained in conjunction with the Head and Neck Anatomy course given to first-year Columbia University Medical and Dental students. All dissections (94 sides) and measurements were completed by the authors before student dissection of the head. Bilateral Weber-Ferguson incisions, coupled with intraoral maxillary vestibular incisions, were made on each cadaver to expose the maxilla from the alveolar ridge to the inferior orbital rim and the zygoma. The infraorbital nerve and foramen were then identified.

A vertical midline incision was then made from the frontal bone to the glabella and directed bilaterally along the superior orbital rim to the lateral canthi. The soft tissue was then reflected superiorly, exposing the superior orbital notch/foramen bilaterally. The facial midline on each cadaver was determined by passing a silk suture from the glabella through the anterior nasal spine to the intermaxillary suture line. Measurements were performed to the nearest 0.5 mm by use of graded calipers and millimeter rulers. The following measurements were made (Fig 1):

A—Distance between the superior wall of the infraorbital foramen and the inferior orbital rim in a line parallel to the facial midline
B—Distance between the medial wall of the infraorbital foramen and the midline in a line perpendicular to the facial midline
C—Distance between the medial wall of the supraorbital notch/foramen and the midline in a line perpendicular to the facial midline
D—Distance between the superior wall of the infraorbital foramen and superior wall of the supraorbital notch/foramen
E—Mediolateral width of infraorbital foramen

The maxillary tooth most frequently found in the same vertical plane (parallel to the facial midline) as the infraorbital foramen was determined bilaterally in both sexes. Also, in addition to the distance between the infraorbital foramen and the supraorbital foramen/notch, their relationship in a vertical plane parallel to the midline was determined, grouped by whether the supraorbital notch/foramen lay medial, lateral, or in the same vertical line as the infraorbital foramen. In those cadavers with multiple ipsilateral infraorbital foramina, the foramen with the largest dimensions was considered to be the primary foramen and included in the data. The remaining accessory foramina were excluded. All measurements were tabulated and separated by gender and side. The mean, standard deviation, and range for each of the measurements were determined. An unpaired sample t-test (using Statistical Analysis Software—SAS) was performed for each measurement to test for statistically significant differences ($P < .05$).

**Results**

Measurements obtained from the 47 cadavers were separated by gender and then further divided into left and right sides (Table 1). In males, the average distance between the infraorbital foramen and the inferior orbital rim in a vertical line parallel to the facial midline was 8.5 mm on the right (range, 3.0 to 15.0 mm; standard deviation [SD], ±2.1 mm) and 8.5 mm on the left (range, 3.5 to 13.5 mm; SD, ±2.3 mm). In females, this distance was 8.1 mm on the right (range, 3.0 to 12.0 mm; SD, ±1.6 mm) and 7.5 mm on the left (range, 2.5 to 12.0 mm; SD, ±1.6 mm). The overall average distance combining both sexes was 8.3 mm on the right and 8.1 mm on the left, with a range of
2.5 to 15 mm (SD, ±1.9 mm). The distance between the infraorbital foramen and the midline in males was 27.9 mm on the right (range, 24.0 to 32.5 mm; SD, ±4.9 mm) and 27.5 mm on the left (range, 24.5 to 33.0 mm; SD, ±3.7 mm). In females, right and left measurements were 25.5 (range, 23.0 to 30.0 mm; SD, ±3.6 mm) and 26.9 mm (range, 23.0 to 31.0 mm; SD, ±2.7 mm), respectively.

A supraorbital notch was found on the right in 74% and on the left in 78% of males, and 71% bilaterally in females. A supraorbital foramen was seen on the right in 26% on the left in 22% of males and 29% bilaterally in females. The average distance between the infraorbital foramen and supraorbital notch/foramen in males was 43.3 mm on the right (range, 40.0 to 47.0 mm; SD, ±3.1 mm) and 43.2 mm on the left (range, 39.0 to 47.5 mm; SD, ±3.1 mm). In females, this distance was 42.2 mm on the right (38.0 to 44.0 mm; SD, ±2.3) and 42.3 mm on the left (range, 37.5 to 44.5 mm; SD, ±2.4 mm). The distance of the supraorbital notch/foramen from the midline in males was 25.9 mm on the right (range, 22.0 to 30.0 mm; SD, ±5.7 mm) and 27.1 mm on the left (range, 23.5 to 32.5 mm; SD, ±5.3 mm). In females, this distance was 26.8 mm on the right (range, 22.5 to 29.0 mm; SD, ±4.1 mm) and 25.8 mm on the left (range, 22.0 to 28.5 mm; SD, ±2.6 mm). The infraorbital foramen averaged 4.5 mm in width in both sexes, with a range of 1 to 7 mm (SD, ±1.1 mm). No statistically significant differences were found in any of these measurements when comparing left and right sides or sexes.

In approximately 50% of the cadavers, the supraorbital notch/foramen was on the same vertical plane as the infraorbital foramen. In males, it was the same 38% of the time on the right and 54% on the left. In female cadavers, it was the same in 52% bilaterally. In most of the remaining cadavers, the infraorbital foramen was located lateral to the supraorbital foramen/notch, 40% in males and 33% in females. In 15% of males and in 13% of females, the infraorbital foramen was located medial to the supraorbital foramen/notch (Table 2).

Seven cadavers (15%) had multiple infraorbital foramina (3 female/4 male), of which 4 were bilateral. Of the 11 sides with this anatomic variation, 8 had double foramina (Fig 2), 2 had triple foramina, and one cadaver had 4 ipsilateral foramina (Fig 3). Of the total cadavers, 49.5% were edentulous in the left maxilla and 49% in the right maxilla. In those cadavers with maxillary teeth, the tooth most commonly found in the same vertical plane as the right infraorbital foramen was the first premolar (64%), followed by the right canine and second premolar (17% each) and the first molar (2%). On the left, there was a similar pattern, with the first premolar being the most common (72%), followed by the second premolar (17%), the canine (8%), and the first molar (3%).

### Table 1. PERIORBITAL MEASUREMENTS

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<td>8.5 ± 2.3 (3.5-13.5)</td>
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<td>27.5 ± 3.7 (24.5-33.0)</td>
<td>27.9 ± 4.9 (24.0-32.5)</td>
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<td>C</td>
<td>27.1 ± 3.3 (23.5-32.5)</td>
<td>25.9 ± 3.7 (22.0-30.0)</td>
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<td>D</td>
<td>43.2 ± 3.1 (39.0-47.5)</td>
<td>43.3 ± 3.1 (40.0-47.0)</td>
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<td>E</td>
<td>4.6 ± 1.2 (1.0-7.0)</td>
<td>4.8 ± 1.0 (2.0-7.0)</td>
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NOTES. All measurements in millimeters (mm): mean ± standard deviation (range).
A: Distance between the superior wall of the infraorbital foramen and the inferior orbital rim in a line parallel to the facial midline.
B: Distance between the medial wall of the infraorbital foramen and the midline in a line perpendicular to the facial midline.
C: Distance between the mediolateral width of the infraorbital foramen.
D: Distance between the medio lateral width of the infraorbital foramen and the midline.
E: Mediolateral width of the infraorbital foramen.

### Table 2. COMPARISON OF VERTICAL PLANES BETWEEN INFRAORBITAL AND SUPRAORBITAL FORamina

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NOTES. A: infraorbital foramen is <4 mm medial to vertical plane of supraorbital foramen/notch.
B: infraorbital foramen is <4 mm lateral to vertical plane of supraorbital foramen/notch.
C: infraorbital foramen is >4 mm medial to vertical plane of supraorbital foramen/notch.
D: infraorbital foramen is >4 mm lateral to vertical plane of supraorbital foramen/notch.
E: infraorbital foramen is >4 mm lateral to vertical plane of supraorbital foramen/notch.
Discussion

There is a wide range of values in the surgical literature for the location of the infraorbital foramen in relation to the inferior orbital rim, ranging from 4 mm to over 10 mm below the inferior margin of the orbit. These values were either taken from anatomy texts\textsuperscript{4-6} or based on a small number of studies using dried skull,\textsuperscript{7} unilateral dissections,\textsuperscript{8} or case reports.\textsuperscript{9} Even a recent study on the distance between the various orbital landmarks did not address the distance between the infraorbital foramen and inferior orbital rim, and made the assumption that the foramen was located in line with the supraorbital notch/foramen and halfway along the rim.\textsuperscript{10} Perhaps the most important factor making the previous data somewhat difficult to interpret is the unknown and likely inconsistent landmark chosen on the infraorbital rim.

This study focused primarily on the positional variability of the infraorbital foramen and was performed on a large group of previously undissected cadavers resembling a racial cross section of the United States. To the best of our knowledge, it is the first cadaver study to look specifically at these relationships. The reference point on the inferior orbital rim was chosen as the point on which a line through the inferior orbital foramen and parallel to the facial midline intersects the rim. On average, the foramen was 8.2 mm from the rim (2.5 to 15 mm) with no significant difference between the sexes. Contrary to the popular belief that the foramen is situated in the same vertical plane as the supraorbital notch/foramen, the...
basis on which several infraorbital nerve block techniques are performed, this situation was found in only 50% of cadavers in this study.

The closest estimation of the location of the infraorbital foramen should be used when designing access incisions to the orbital floor and rim and planning regional nerve blockade. Two recent studies suggested a technique that involves infiltrating an anesthetic solution in an area defined by dropping a vertical line from the palpable supraorbital notch to about 10 to 15 mm below the inferior orbital rim.\textsuperscript{11,12} In another transcucaneous approach, a point of injection medial to the upper nasolabial groove, a few millimeters lateral to the alar groove and 4 to 7 mm below the inferior orbital rim, was described.\textsuperscript{3} According to our results, it may be more effective to infiltrate an anesthetic solution in the area that is 1) 24 to 29 mm lateral to the facial midline and in a line perpendicular to the facial midline, 2) about 8 mm below the infraorbital rim, and 3) in the same vertical plane as the first premolar tooth. This technique may be more reliable in the 50% of cases in which the supraorbital notch and the infraorbital nerve are not in the same vertical plane.

Although the finding of multiple ipsilateral infraorbital foramina in 15% of cadavers in this study is consistent with prior reports by Le Double\textsuperscript{9} and Poirier,\textsuperscript{5} quadruple ipsilateral foramina were not previously described. In another study by Berry\textsuperscript{13} that used skulls obtained from several geographic locations, a higher frequency of multiple foramina was noted in Mexicans. However, the number of accessory foramina was not documented in that study.

It may be astute for surgeons to recall that multiple supernumerary foramina may exist in a minority of

patients, and injury to any branch can result in a sensory deficit. The presence of such supernumerary foramina could also result in partial nerve blockade. The area of anesthetic infiltration suggested in this study may lead to more effective infraorbital block anesthesia in a high percentage of patients.

Acknowledgment

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References


CHARACTERISTICS OF THE INFRAORBITAL FORAMEN