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Effects of infraorbital nerve's anatomical course on the fracture pattern of the orbital floor

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Summary In this study, details of the infraorbital nerve's (ION's) anatomical course variants were compared using computed tomography (CT), and relationships between the variants and fracture patterns in the orbital floor were investigated. Fifty-two normal individuals and 50 patients with unilateral isolated orbital floor fractures were enrolled in this study. Four measurements in normal individuals and five measurements in fracture patients were obtained in parasagittal sections. The anatomical variations of the ION were categorized into three types according to the classification by Ferences et al. Among the normal individuals, 42 orbits were classified as type 1 ION, 48 orbits as type 2, and 14 orbits as type 3. The distance from the inferior orbital rim to the upper border of the inferior orbital foramen and the length of descension portion of the ION in type 1 ION were significantly shorter than in type 2 and type 3 IONs. In patients with orbital floor fractures, the distance from the inferior orbital rim to the upper border of the inferior orbital foramen was positively correlated with herniation level of bone and soft tissue. The ION had three anatomical variants according to the degree of descension in the anterior portion of the orbit. When fracture of the orbital floor occurs in patients with type 1 ION, inferior displacement of the fractured orbital bone and orbital soft tissue may be less severe than in patients with other ION types.

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Introduction

The infraorbital nerve (ION), a terminal branch of the maxillary nerve, travels obliquely from medial to lateral across the orbital floor. In the anterior portion of the orbit, the ION is in a canal, and in the middle and posterior portions of the orbit, it lies in a groove.[1] This is commonly known as the ION anatomical course. Recently, several studies have reported anatomical variants of the ION's course using computed tomography (CT).[2,3] The researchers reported that the ION descends toward the inferior orbital foramen in several different forms.

In the middle portion of the orbit, a communication is present from the infraorbital neurovascular bundle to the inferior rectus muscle.[4] In orbital floor fractures, the inferior orbital groove and canal are often damaged. Thus, differences in fracture patterns can occur such as defect area or herniation type and level of orbital tissue between the anatomical variants of the ION's course. Therefore, in this study, the details of ION anatomical course variants were compared in a normal population using CT, and relationships between the anatomical variants and orbital floor fractures were investigated.

Materials and methods

A retrospective review of adult patients who underwent a facial CT to diagnose facial bone fractures was performed at Keimyung University Dongsan Hospital between 2010 and 2014. To evaluate the variations in the ION anatomical course, patients diagnosed with no facial bone fracture were included in this study. To evaluate the relationship between the variations and orbital floor fracture patterns, patients diagnosed with unilateral isolated orbital floor fracture were included in this study. Patients who had accompanying nasal bone fracture, mandibular fracture, or zygomatic arch fracture, except multiple wall orbital fractures and those associated with orbital-zygomatic fractures, were included. This study was approved by the Institutional Review Board of Keimyung University.

CT imaging (LightSpeed VCT; GE Medical Systems, Milwaukee, WI, USA) was performed using 2-mm-thick slices. A picture archiving and communication system (PACS; Impax; Agfa, Ridgefield Park, NJ, USA) was used to measure and analyze the anatomical course of the ION and fracture pattern of the orbital floor fracture. CT numbers were set in the −200 to −30 Hounsfield units (HU) range for orbital fat volume and −300 to +1200 HU for periorbital bone. To reduce errors, measurements were performed three times by the same investigator (R.K.).

Evaluation items

In normal patients, the distance from the inferior orbital rim to the upper border of the inferior orbital foramen, the distance from the inferior orbital rim to the point where the ION descends toward the inferior orbital foramen, the length of the descension portion of the ION, and the distance from the inferior orbital rim to the inferior orbital fissure were measured. The measurements were made in one section among the parasagittal sections in which the infraorbital foramen and descension of the ION were well visualized (Table 1 and Figure 1). In patients with orbital floor fractures, the distance from the inferior orbital rim to the upper border of the inferior orbital foramen, the distance from the inferior orbital rim to the anterior fracture margin, the distance of herniated orbital tissue and bone segment from a plane connecting the anterior and posterior fracture margin, and the distance from the inferior orbital rim to the inferior orbital fissure were measured. The distance from the inferior orbital rim to the upper border of the inferior orbital foramen and distance from the inferior orbital rim to the inferior orbital fissure were measured in the same section (Table 1 and Figure 2). The anatomical variations of the ION were categorized into three types according to the classification by Ferences et al. (Figure 3).[3]

Statistical analyses

Results are presented as means. Mann-Whitney *U* tests were used to analyze differences in the measurements based on gender or side. Pearson's correlations were used to analyze relationships among the measurements. *P*-values < 0.05 were considered statistically significant. The Kruskal–Wallis test was used to compare the measurements between the three ION types. If the Kruskal–Wallis test was significant ($p < 0.05$), we examined pairwise comparisons using the Dunn test with a Bonferroni correction at 0.05/3. *P*-values < 0.017 were considered statistically significant. The professional statistics programs SPSS version 21.0 (IBM, Inc., Chicago, IL, USA) and

Table 1 The seven measurements taken.

Subjects	Evaluation items
Normal	distance from inferior orbital rim to upper border of inferior orbital foramen
	distance from inferior orbital rim to the point where ION descended down toward inferior orbital foramen
	length of descension portion of ION
	distance from inferior orbital rim to inferior orbital fissure
Orbital floor fracture	distance from inferior orbital rim to upper border of inferior orbital foramen
	distance from inferior orbital rim to anterior fracture margin
	distance of herniated orbital tissue from a plane connecting anterior and posterior fracture margin
	distance of bone segment from a plane connecting anterior and posterior fracture margin
	distance from inferior orbital rim to inferior orbital fissure