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Original research

Computed tomographic measurements of orbital entrance dimensions in relation to age and gender in a sample of healthy Iranian population

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Abstract

Purpose: To determine the dimensions of orbital entrance in unaffected bony orbit by computed tomography (CT) in a sample of Iranian population.

Methods: Radiologic features of 120 patients were gathered using standardized skull protocol by CT scan. We measured the distance between anterior lacrimal crest and orbital border of zygomatic bone, termed *width*, and the distance between the plane passing through the anterior orbital entrance to optic canal, termed *depth*, using horizontal sections of skull base CT scan. Sagittal sections were used to demonstrate the *height*, the distance between frontal and maxillary bone. Orbital index (height/width *100) was then calculated.

Results: The mean values of orbital width, height, and depth were 28.49 ± 2.35 mm, 32.14 ± 1.57 mm, and 38.84 ± 3.90 mm, respectively. There was a significant difference in height (P = 0.001), depth (P = 0.004), and width (P = 0.012) between the right and left orbits. The mean value of the orbital index was 88.65 ± 8.90 mm in this population.

Conclusions: The orbital index of this sample Iranian people is Mesoseme according to our study results, the expected characteristic of the white race. The right orbits are determined to be larger than the left ones.

Keywords: Orbital index; Computed tomography (CT) scan; Skull protocol; Orbit

Introduction

Blow out fracture is the result of globe trauma and causes an increase in dimensions of the orbital cavity. This increase may lead to diplopia and enophthalmos with functional or cosmetic abnormalities which are also complications of orbital reconstruction.[1,2] Reconstruction of the bony orbit is a challenging issue in the management of post-traumatic orbital cavity as well as in the treatment of several pathologic conditions, such as decompression surgery in Graves' ophthalmopathy.[3] Thus the measurement of the orbital cavity is a useful tool for pre-operative planning and operation of orbital reconstruction.[3]

Several methods have been tried out to determine the dimensions of the orbit over the years.[4] Choosing the preferred method depends on its speed, accuracy, reproducibility, and versatility.[5] In the past, computer softwares have been developed that can segment the orbit (semi) automatically using computed tomography (CT) scan.[6–9] Late generation CT scanners are able to demonstrate small differences in the contrast.[10] Summation of pixel counts based on contrast (density) ranges can provide three dimensions of orbital structure.[11]

The aim of this study was to measure the dimensions of the orbital cavity in the unaffected bony orbits in a sample of Iranian population by CT scan sections and investigate the relevant results in different ages and genders.

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Methods

In this retrospective study, CT scan data of both orbits of 120 patients were gathered from the Department of Radiology of Ayatollah Khansari Hospital, Arak, Iran. The orbital CT scan was part of a routine standardized protocol performed following intravenous contrast administration on Helical Volume X-ray CT Scanners (Toshiba X-vigor, Tokyo), by using acquisition parameters of 120 kV (peak) (kVp), 200 mA, 160-mm display FOV, and pitch of 0.8−1.0. The axial views were contiguous 3-mm sections parallel to the infraorbitomeatal line, and coronal views were reconstructed orthogonal to this plane.[12] This research was designed following indications of the ethics committee of Arak University of Medical Science. When available, a retrospective review was made of the patient's chart for clinical data. All CT examinations were reviewed retrospectively. Data were collected from individuals with normal orbits who were studied for suspicion of brain tumors. According to our exclusion criteria, neither of them had any underlying craniofacial anomaly, congenital malformations, local or systemic conditions that may affect the measurements such as hyperthyroidism, exophthalmos, orbital mass, etc.

The aim of this study was determination of orbital entrance dimension. To calculate the volume, three dimensions (width, height, and depth of the orbit) are required to be defined first. In horizontal sections of skull base CT scan images, we measure[1]: the distance between anterior lacrimal crest and orbital border of zygomatic bone, called the width of orbit and[2]: the distance between the plane passing across the orbital entrance to optic canal (orbital apex), called the depth of orbit. Sagittal sections of CT scan demonstrate the distance between frontal and maxillary bones, called the height of the orbit. From these indicated quantities, orbital index was determined by the following simple formula:

$$I = H/W*100$$

where "dI" is the orbital index, "H" the height of the orbit and "W" its width. Orbital index has been categorized as three types[13]: 1) "microseme": having broad orbits, with orbital index below 83, the characteristic of yellow race; 2) "mesoseme": having neither broad nor narrow orbits, with medium orbital index between 83 and 89, the characteristic of white race; 3) "megaseme" : having narrow orbits with orbital index of 89 or more, the characteristic of black race.

Determination of the width, height, and depth of bony orbit was done for all 240 normal cases with DOSISOFTWARE ISOGRAY (version 4.1) based on the definition of orbital distances introduced above. Limitations were due to observer error in determining the borders and overlapping contrast ranges of the borders.

The results of this study were analyzed in IBM SPSS Statistics (version 19.0; IBM Corp., USA). The orbital dimensions such as width, height, depth, and orbital index were inserted, and descriptive indices, including minimum, maximum, mean and standard deviation (SD) were calculated.

Table 1
Comparison of left and right bony orbital distances.

		Mean measurement (mm)	*P* value
Pair1	Width of right orbit	38.73 ± 0.55	0.012
	Width of left orbit	38.60 ± 0.08	
Pair2	Depth of right orbit	44.66 ± 0.25	0.004
	Depth of left orbit	44.58 ± 0.13	
Pair3	Height of right orbit	33.33 ± 1.70	0.001
	Height of left orbit	32.67 ± 1.53	

The correlation between the calculated dimensions of the right and left orbits was analyzed using mean difference, SD and sig. 2-tailed (*P* Value). Finally, simple scatter plot graphs of width, height, and depth of bony orbit and age set markers by sex were taken to correlate significantly orbital distances with age.

Results

CT scans of 53 women and 67 men, ranging age from 9 to 22 (mean, 55.06 ± 19.50 mm) were assessed. The mean measurements, median grading score for orbital width, height, and depth, were 28.49 ± 2.35 mm (range: 24.00−34.80 mm), 32.14 ± 1.57 mm (range: 27.90−37.50 mm), and 38.84 ± 3.90 mm (range: 26.40−49.00 mm), respectively. There was a significant difference between the orbital height ($P = 0.001$), depth ($P = 0.004$), and width ($P = 0.012$) of the right and left eyes (Tables 1 and 2). Mean measurements of bony orbital index (H/W *100) was 88.65 ± 8.90. Linear measurements clarified the age-dependent correlation of the width, height, and depth of the orbit in both genders (Fig. 1). The orbital width and height decrease while its depth increases with age in both genders.

Discussion

Despite so many studies evaluating the bony orbital content to optimize the pre-operative planning, to our knowledge, the acute measurement of orbital parameters for all kinds of races has not been previously investigated. The purpose of this study was to assess the orbital entrance of unaffected bony orbits in Iranian population for the first time. There is a wide variation in size of healthy individuals' bony orbits. The variation has been seen not only between males and females, but also in both right and left orbits in different ages. The most significant positive relationship was seen between the width and the depth of the orbit. There was a significant negative correlation

Table 2
Correlations of bony orbital distances.

	Width of orbit	Depth of orbit	Height of orbit
Width of orbit		.423[a]	−.161[b]
Depth of orbit	.423[a]		−.208[a]
Height of orbit	−.161[b]	−.208[a]	

[a] Correlation is significant at the 0.01 level (2-tailed).
[b] Correlation is significant at the 0.05 level (2-tailed).