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Do altitude and climate affect paranasal sinus volume?

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ABSTRACT

Objective: The aim of this study was to evaluate the effect of climate and altitude differences on the volume of paranasal sinuses and on the frequency of anatomic variations by comparing the paranasal sinus tomograms (PNSCT) of patients who were born and living in a cold, dry climate at high altitude with those of patients who were born and living on the coast at sea level in a temperate climate. We also aimed to determine differences relating to gender.

Material and methods: A total of 55 PNSCTs of 55 patients from the city center of Antalya and 60 PNSCTs of 60 patients from the city center of Agrı were evaluated and compared prospectively. The study included a total of 115 patients with a mean age of 44.75 ± 9.64 years (range, 27–63 years). Group 1 (Antalya) comprised 26 females (47.3%) and 29 males (52.7%) with a mean age of 36.7 ± 12.4 years. Group 2 (Agrı) comprised 25 females (41.7%) and 35 males (58.3%) with a mean age of 35.1 ± 13.4 years. Maxillary sinus volumes were 18.27 cm^3 (range, 5.04–37.62) and 15.06 cm^3 (4.11–41.40); sphenoid sinus volumes were 7.81 cm^3 (1.80–20.63) and 6.35 cm^3 (0.54–16.50); frontal sinus volumes were 5.51 cm^3 (0.50–29.25) and 3.76 cm^3 (0.68–22.81) respectively.

Results: There was no statistically significant difference between the groups in term of volumes ($p > 0.025$). Both maxillary and frontal sinus volumes were greater in males compared to females ($p < 0.025$). The mean value of the maxillary sinus volume was 15.7 ± 5.3 cm^3 and was significantly larger in males than in females ($p = 0.004$). There was no statistically significant correlation between the volume of maxillary sinuses with age or side. There was no statistically significant difference between the groups in terms of septum deviation and concha bullosa rates ($p = 0.469$ and $p = 0.388$).

Conclusion: There have been many studies of nasal cavity changes due to climatic conditions but this is the first study to measure the difference of paranasal sinus volumes. No difference was determined in the anatomic variations and volumes of the maxillary, frontal, sphenoid sinuses on PNSCT of patients from different climates and altitudes.

1. Introduction

The mechanisms for paranasal sinus growth are not yet fully understood (Legent et al., 1991). The size of the sinus depends on the extent of pneumatization (Fatua et al., 2006) The development of the paranasal sinuses may differ according to age and between individuals, and sinuses may even demonstrate different development patterns on the two sides on an individual basis (Jun et al., 2005).

The anatomy of the paranasal sinuses is highly complex, with many anatomic variations. Understanding this anatomy is very important to avoid complications during surgery. A detailed knowledge of anatomic variations in the paranasal sinus region is critical, especially for surgeons performing endoscopic sinus surgery. Variations or anomalies of the paranasal anatomic structures and mucosal abnormalities can be detected easily with coronal plane paranasal computed tomography (CT) imaging. Radiology also plays a major role in the preoperative evaluation (Kantarci et al., 2004).

It has been suggested that nasal airflow and positive air pressure in the nasopharynx have an effect on the development of the paranasal sinuses and craniofacial skeleton (D'Ascanio et al.,

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2010; Kim et al., 2010). Nasal cavity shape is expected to show climatic adaptation (Noback et al., 2011). There have been many studies focusing on how the upper airway and the nasal region adapt to climate variations, and many have demonstrated climate-dependent differences. However, to date, there have been no studies of the climatic and environmental effect on paranasal sinus volumes.

The aim of this study was to evaluate the effect of the climate and altitude on the volume of the paranasal sinuses and on the frequency of anatomic variations by a comparison of PNSCTs of patients who were born and living in different climate conditions and at different altitudes. An additional aim was to determine differences relating to gender.

2. Materials and methods

The study was performed at Agrı State Hospital, Otolaryngology Clinic and Antalya Research and Education Hospital, Otolaryngology and Radiology Clinics. Approval for the study was granted by the Agrı State Hospital Local Ethics Committee. Written informed consent was obtained from all the patients included in the study. The study included a total of 115 consecutive patients between the ages of 18 and 67 years with paranasal sinus CT between March 2010 and March 2012. The Antalya and Agrı groups comprised 55 and 60 patients respectively without sinonasal morbidity who were investigated for cephalgia etiology.

Prospective evaluation was made of 55 paranasal sinus tomographies of 55 patients who were born and living in the city center of Antalya, which is on the Mediterranean coast at an altitude of 30 m. The climate is temperate with a mean annual temperature of 18.7 °C (maximum 44.6 °C; minimum −1.9 °C) between 1954 and 2013. The second group comprised 60 paranasal sinus tomograms of 60 patients who were born and living in the city center of Agrı in the northeastern region of Turkey at an altitude of 1642 m in the mountain range that includes the highest peak of Anatolia, Mount Agrı (5137 m). The climate is cold and dry, with a mean annual temperature of 5.3 °C (maximum 39.9 °C, minimum −45.6 °C) between 1954 and 2013. The PNSCT of the two groups were compared (www.dmi.gov.tr).

On the paranasal scans, height, depth, and width were measured, and a cubital approximation of volume was determined for each maxillary, frontal, and sphenoid sinus. The patients' coronal and axial CT images of the paranasal sinuses were obtained, and measurements were performed using the point where the diameter of the sinus was largest. For each patient, the right and left frontal and the right and left maxillary and sphenoid sinus volumes were separately calculated using the formula (axbxcx 0.52) (Figs. 1–3).

Exclusion criteria were acute or chronic rhinosinusitis, previous nasal and/or paranasal surgery, impact septum deviation, antrochoanal polyp, nasal polyposis, history of maxillofacial trauma, benign or malignant tumors of the paranasal sinuses, recent upper respiratory tract infection, previous history of positive airway pressure treatment, and previous history of any systemic disease and systemic or/and topical drug use that could affect the paranasal sinuses and the nasal cavity. Patients who were born or lived in another city or county were also excluded.

3. Results

The study included a total of 115 patients with a mean age of 44.75 ± 9.64 years (range, 27–63 years). Group 1 (Antalya) comprised 26 females (47.3%) and 29 males (52.7%) with a mean age of 36.7 ± 12.4 years. Group 2 (Agrı) comprised 25 females (41.7%) and 35 males (58.3%) with a mean age of 35.1 ± 13.4 years. The mean age and gender distribution of the patients living in Agrı and Antalya were statistically similar ($p = 0.511$ and $p = 0.546$) (Table 1).

There was no statistically significant difference between the groups in terms of septum deviation and concha bullosa rates ($p = 0.469$; and $p = 0.388$) The incidence of sinus hypoplasia among patients living in Agrı and Antalya showed no statistically significant difference ($p = 1.000$) (Table 2).

Maxillary sinus volumes were 18.27 cm^3 (range, 5.04–37.62) and 15.06 cm^3 (4.11–41.40); sphenoid sinus volumes were 7.81 cm^3 (1.80–20.63) and 6.35 cm^3 (0.54–16.50); and frontal sinus volumes were 5.51 cm^3 (0.50–29.25) and 3.76 cm^3 (0.68–22.81). There was no statistically significant difference between the groups in term of volumes ($p > 0.025$). Both maxillary and frontal sinus volumes were greater in males compared to females ($p < 0.025$). The mean value of the maxillary sinus volume was 15.7 ± 5.3 cm^3 and was significantly larger in males than in females ($p = 0.004$). There was no

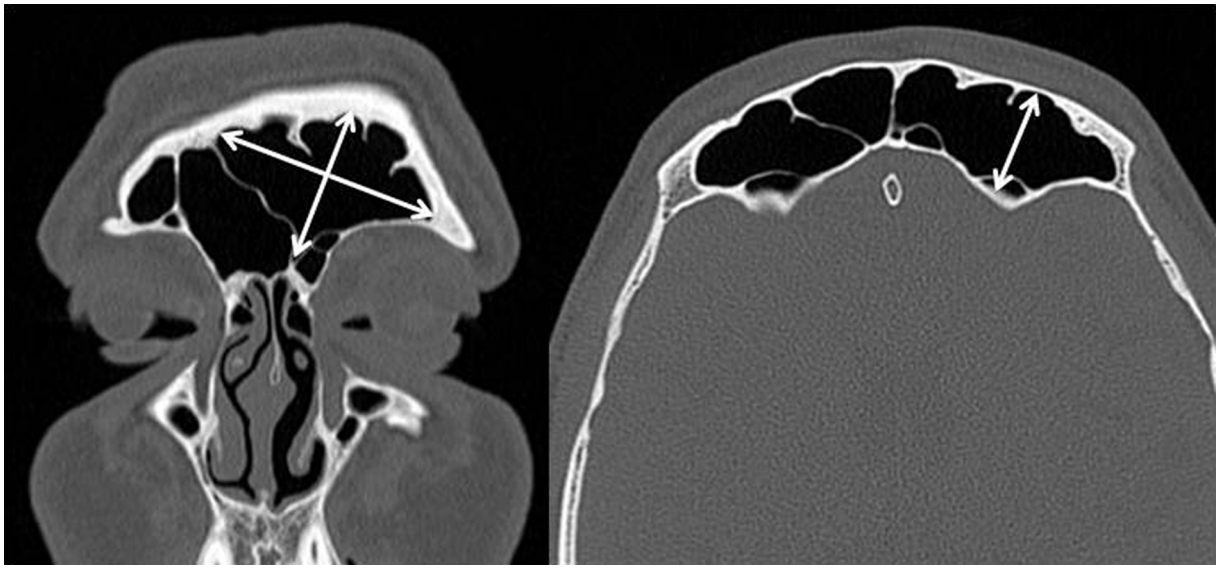

Fig. 1. Coronal and axial paranasal measurements made over the left frontal sinus computed tomographic scan.