

## Absence of Frontal Sinus in Turkish Individuals

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The frontal sinus has been used for personal identification since the early part of the 20th century as a result of its tremendous interindividual variation. The frontal sinus is present in approximately 90% of adults. However, some populations have a higher proportion of people without a frontal sinus. This study investigated the frequency of the absence of frontal sinuses in Turkish individuals. The present study was performed retrospectively on the CT scans of the paranasal sinuses in the axial and coronal planes from a series of 1200 cases. A bilateral absence and a unilateral absence of sinuses were found in 3.8% and 4.8% of cases, respectively. The clinical significance of the frontal sinuses and their absence are also discussed.

**Key Words:** Frontal sinus, aplasia, personal identification, CT

### INTRODUCTION

The frontal sinuses are pneumatized cavities located in the frontal bone. They lie deep in the superciliary arch. Each frontal sinus opens into the anterior part of the corresponding nasal middle meatus by the *ethmoidal infundibulum* or the *frontonasal duct*, traversing the anterior part of the ethmoid labyrinth.<sup>1,2</sup>

Although frontal sinuses show a tremendous interindividual variation, some populations exhibit higher frequencies of their absence.<sup>3</sup> In this article, a new series of frontal sinus aplasia from Turkish individuals is presented. The significance and the developmental anatomy of the frontal sinuses are also briefly reviewed.

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### Significance and developmental anatomy of the frontal sinus

The frontal sinuses begin to develop as an upward extension of the anterior portion of the nasal capsule around the fourth fetal month. They may also arise from laterally placed anterior ethmoidal cells, the anterior part of the frontal recess, or from the frontal furrow.<sup>4</sup> Anatomically, they may appear by age 1 and grow larger in size after puberty, attaining their almost maximum size at age 20. A radiographic demonstration prior to the second year of life is rare and they are usually visible by age 7-9.<sup>5</sup>

The definitive frontal sinuses are paired, irregularly shaped, and located between the outer and inner tables of the frontal bone, and posterior to the superciliary arches

Because the right and left frontal sinuses develop independently, it is common to find one larger than the other, and the larger sinus may cross the midline and even overlap the other. Asymmetry for the frontal sinuses of both sides is a rule because of the unequal reabsorption of the diploe during sinus development.<sup>6</sup> People with more than two frontal sinuses are uncommon. However, incomplete septations of various lengths extending from the roof of the sinus are not rare, and give the sinus its scalloped configuration. The size of the frontal sinus is highly variable, ranging from a couple of cubic centimeters in volume to occupying most of the area of the frontal bone. The height varies from 5 to 66 mm, with an average of 24.3 mm. The lateral distance of the lateral wall from the midline is 29 mm ranging from 17 to 49 mm.<sup>4</sup>

A radiological examination of the bone structures of human remains provides a means of

positive identification when compared to radiographs taken during the life of that person. The significance of a frontal sinus variation has been recognized since the early part of the 20th century. There is a great range of normal variation in the configuration of the frontal sinuses among different individuals, and no two people have the same frontal sinus configuration. Several authors have concluded that a frontal sinus radiograph could be a useful means of personal identification<sup>3,5,7</sup> and that preoperative CT scans including the frontal sinus may be useful during a pterional craniotomy to minimize the inadvertent entry into this sinus in patients with a large amount of pneumatization.<sup>8</sup>

## MATERIALS AND METHODS

This study was retrospectively performed on the paranasal sinus CT (Hitachi W450 CT scan) scans of 2 mm thickness in the axial and coronal planes, which were obtained using a high-resolution technique from a series of 1200 cases (610 male, 590 female), most of whom suffered from a nasal infection. Because the growth of the frontal sinus is slow and the sinus does not attain the adult size and form until puberty, the age of 15 was taken as the minimum age of these cases. The absence of a frontal sinus of both sides was investigated on the radiograms examined by three observers who are the authors of this article. There was always agreement on the yes/no choice among the authors.

## RESULTS

The results from the present study are summarized in Table 1.

## DISCUSSION

### Bilateral absence of frontal sinus

In this study, the overall frequency of a bilateral absence of the frontal sinus was 3.8%; 1.3% for males and 5.1% for females (Fig. 1A and 1B)(Table 1). Schuller<sup>9</sup> reported that a bilateral absence of the frontal sinuses in adults could be found in the radiographs of approximately 5% of all cases. According to Leicher's definition, where a sinus absence is defined as a sinus with an area  $< 0.8 \text{ cm}^2$ , the bilateral absence of a frontal sinus was found in 10% of samples.<sup>10</sup> A study on Japanese adult skulls by Yoshino et al.<sup>6</sup> reported an absence of a sinus in 4.8% male samples. The frequency of a bilateral absence of the frontal sinuses in several populations were reported as: Alaskan Eskimos, 25% in males and 36% in females;<sup>11</sup> Bushmen, 11% in males and 11% in females; Awarischs, 8% in males and 13% in females;<sup>10</sup> Canadian Eskimos, 43% in males and 40% in females;<sup>12</sup> Japanese, 13% in males and 23% in females;<sup>13</sup> Austrians, 10% in males and 10% in females;<sup>14</sup> Germans, 3.4%.<sup>15</sup> According to the literature, the frequency of a bilateral absence of the frontal sinuses from this study was lower than that reported for most ethnic populations and dissimilar to the German population. In addition, these

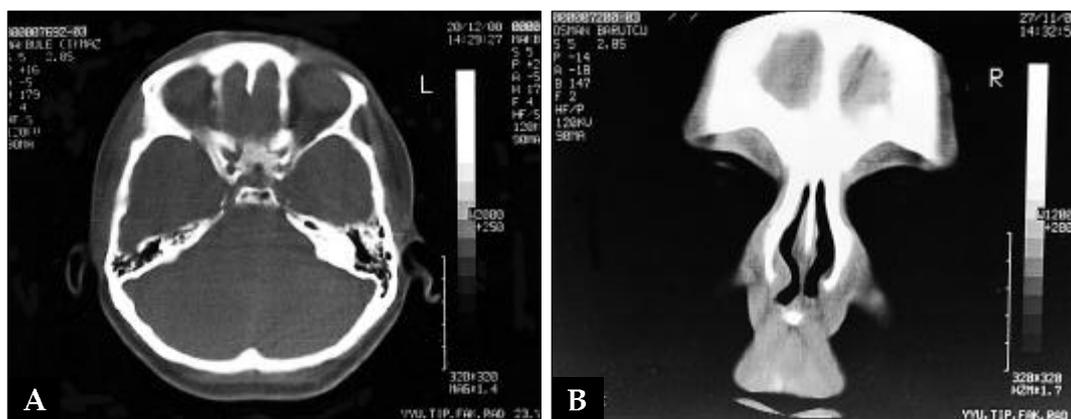
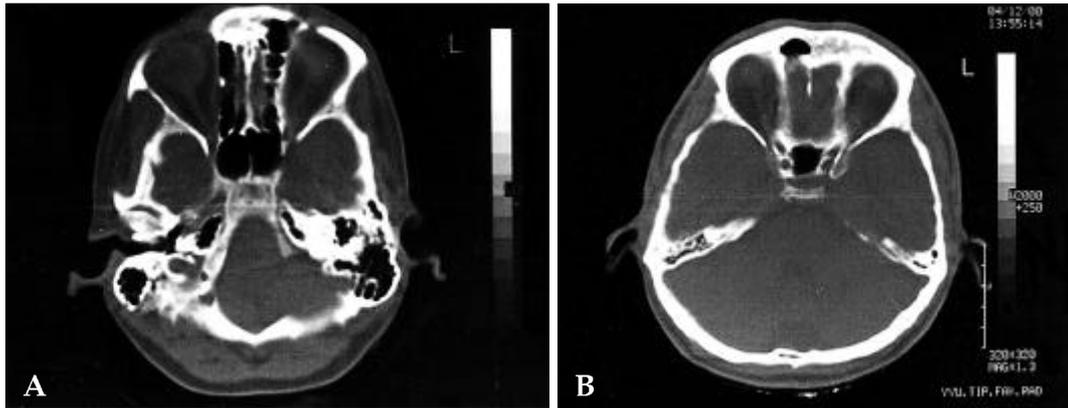


Fig. 1. (A) Bilateral absence of the frontal sinuses, axial view. (B) Bilateral absence of the frontal sinuses, coronal view.

**Table 1.** Frequency of Frontal Sinus Aplasia in Turkish Individuals

Sex	n	Absence of Frontal Sinus			
		Bilateral	Unilateral		Total
			Right	Left	
Male	610	16 (1.3%)	10 (1.6%)	13 (2%)	23 (3.8%)
Female	590	30 (5.1%)	24 (4%)	11 (1.9%)	35 (5.9%)

**Fig. 2.** (A) On the right, the absence of frontal sinus, axial view. (B) On the left, the absence of frontal sinus, axial view.

studies indicate a greater frequency among females than males, which is similar to the findings in our study.

#### Unilateral absence of frontal sinus

In this study, the incidence of a right unilateral frontal sinus absence was 0.8% in males and 2.0% in females. A left unilateral sinus absence was 1.1% in males and 0.9% in females (Fig. 2A, 2B) (Table 1). Yoshino et al.<sup>6</sup> reported the frequency of a unilateral sinus absence as 14.3% for males (9.5% right, 4.8% left) and 7.1% for females (7.1% right, 0.0% left). A unilateral absence of the left frontal sinus was found by Nowak and Mehls<sup>15</sup> in 7.4% of adults, 4.2% in the right-side and 3.2% in the left-side (in 3.6% of men and 2.8% of women). The frequency of a unilateral absence was reported to be 1% by Schuller.<sup>9</sup>

#### Gender and ethnic differences

The Turner and Porter study<sup>16</sup> indicated that an absence of the frontal sinuses was more common in “mixed races” than in “relatively pure races”.

However, Harris, et al. did not support this claim.<sup>4</sup> They reported the absence of the frontal sinuses in patients of different genders and ethnic groups as: in males; 3.1% of blacks and 3.3% of mixed race members, and 10.3% and 0% in females, respectively. The other sex differences in several populations were mentioned above.

#### Conditions affecting frontal sinus morphology

The size of the frontal sinus may be related to environmental factors. Environmental and genetic factors control the frontal sinus configuration within each population.<sup>17</sup> According to Koertvelyessy,<sup>11</sup> who studied the frontal sinuses of 153 Eskimo crania, the degree of pneumatization correlates positively with the degree of environmental coldness in which the population lives. Three systemic factors, i.e. the craniofacial configuration, the thickness of the frontal bone, and the growth hormone levels influence the frontal sinus morphology.<sup>18</sup>

#### Forensic and surgical significance

An image of the frontal sinus is unique for each

patient and this uniqueness can be exploited in forensic cases. A definitive identification of the deceased can be made by comparing the antemortem and post-mortem radiographs.<sup>3,5,6,19</sup> However, the frontal sinuses are affected by pathology and this method of identification is unsuitable in those individuals lacking a frontal sinus. In such cases, the sphenoid sinus and mastoid air cells may be utilized for identification, as well as the other definitive techniques.<sup>3</sup>

Owing to the anatomical variability of the frontal sinuses, the neurosurgical approach to the orbit by the anterior cranial fossa in a patient with an inflammatory nasal pathology may jeopardize the sterility of the surgical field.<sup>20</sup> In patients with a large pneumatization, the possible inadvertent entry into the frontal sinus may occur during a pterional craniotomy for the microsurgical clipping of aneurysms. This situation may require a frontal sinus cranialization or an osteoplastic frontal sinus operation with fat obliteration.<sup>8</sup>

In conclusion, this study showed a low frequency of frontal sinus aplasia. Although the anatomical variations of the paranasal sinuses may be related to sinus diseases,<sup>20</sup> it is believed that nasal diseases are not responsible for the low incidence observed in this study. However, it has been suggested that the frequency of an absence of the sinus shows racial differences. Environmental factors, i.e. a warm climate, might also be related to the low frequency of frontal sinus aplasia. A lower frequency might be appropriate as an identification procedure. On the other hand, neurosurgeons should be prepared for the possible inadvertent entry during the surgical interventions mentioned above.

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