

Vol 3 Issue 2 March 2013

Impact Factor : 0.2105

ISSN No : 2230-7850

Monthly Multidisciplinary
Research Journal

*Indian Streams
Research Journal*

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RNI MAHMUL/2011/38595

ISSN No.2230-7850

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FRONTAL SINUS APLASIA

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Abstract:

Paranasal sinuses are prone to a great diversity of anomalies. It is important for surgeons to be aware of variations that may predispose patients to increased risk of intraoperative complications and help avoid possible complications and improve success of management strategies. Plane x-rays can be widely used to map sinus anatomy prior to surgical intervention to limit morbidity.

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 sinus in Karnataka region of India. The present study was performed retrospectively on radiographs from a series of 238 cases. A bilateral absence and a unilateral absence of sinuses were found in 6(2.5 %) and 2(0.84 %) of cases, respectively. The clinical significance of the frontal sinuses and their absence are also discussed.

KEY WORDS:

frontal sinus, aplasia, personal identification.

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 ethmoid labyrinth[1,2].

The blood supply originates from the ethmoidal and supraorbital arteries, and the venous drainage takes place at the anastomotic vein located in the supraorbital notch, binding the supraorbital and superior ophthalmic veins. The lymphatic drainage is directed towards the submandibular lymphonodi. The area is innervated by the supraorbital nerve, a branch of the frontal nerve of the first trigeminal division[3].

Although frontal sinuses show a tremendous interindividual variation, some populations exhibit higher frequencies of their absence[4]. In this article, a new series of frontal sinus aplasia from Karnataka individuals is presented. The significance and the developmental anatomy of the frontal sinuses are also briefly reviewed.

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 ethmoid cells, the

anterior part of the frontal recess, or from the frontal furrow[5]. Anatomically, they may appear by age one and grow larger in size after puberty, attaining their almost maximum size by twenty years. A radiographic demonstration prior to the second year of life is rare and they are usually visible by age of seven[6].

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[7]. 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 centimetres in volume to occupying most of the area of the frontal bone.

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[4,6,8] and when taken preoperatively it may be useful to minimize the inadvertent entry into this sinus in patients with a large amount of pneumatization[9].

MATERIALS, METHOD AND TECHNIQUE

This is a retrospective study in which a total number of 238 patients were evaluated. Patients who came with history of trauma to face, previous sinus surgery, and grossly deformed root of nose due to pathological condition were excluded from the present study. 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 years was taken as the minimum age of these cases. The absence of a frontal sinus of both sides was investigated on the radiographs.

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 2.5 %; 1.6 % for males and 0.84 % for females (Figure-1)(Table-1). None of the cases among females showed unilateral frontal sinus aplasia. Shuller[10] reported that a bilateral absence of the frontal sinuses in adults could be found in the radiographs of 5 % of all cases. A study on Japanese adult skulls by Yoshino et al.[7] 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[11], Bushmen, 11% in males and 11% in females; Awarischs, 8% in males and 13% in females[12]; Canadian Eskimos, 43% in males and 40% in females[13]; Japanese, 13% in males and 23% in females[14]; Austrians, 10% in males and 10% in females[15]; Germans, 3.4%[16]. 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 is similar to the German population. In addition, these studies indicate a greater frequency among females than males, contrary to the findings in our study. It is probably caused by the influence of the climatic conditions[13]. There is a direct relationship between the mechanical stresses of mastication and frontal sinus enlargement [17,18,19] and if there is persistence of a metopic suture, the frontal sinuses are small or absent [17,20,21]. The form of the face and forehead in the presence of a metopic suture conforms to the evolutionary trend of the skull [22].

Unilateral absence of frontal sinus

In this study, incidence of a right unilateral frontal sinus absence was 0.84 % in males and 0 % in females. A left unilateral sinus absence was 0.42 % in males and 0 % in females (Figure-2). Yoshino et al[7]

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[16] 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[10] .

Gender and ethnic differences

The Turner and Porter[23] 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[4] . 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 sinus configuration within each population[24] . According to Koertvelyessy[11], who studied the frontal sinuses of 153 Eskimo crania, the degree of pneumatization correlates positively with the degree of 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[25] .

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[26] . 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[4] .

The minimally invasive surgeries have acquired a growing importance in surgical interventions in order to avoid tissue damage and reduce surgical time. When cranial base surgery is made in the frontal region or when the supraorbital mini-craniotomy is realized, the involvement of the frontal sinus may become troublesome. The entrance by means of the craniotomy in the frontal sinus can lead to postoperative complications as CSF leakage, bone flap infections, besides the late consequences of meningitis and brain abscess[3] .

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[27]. 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[9] .

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[27], 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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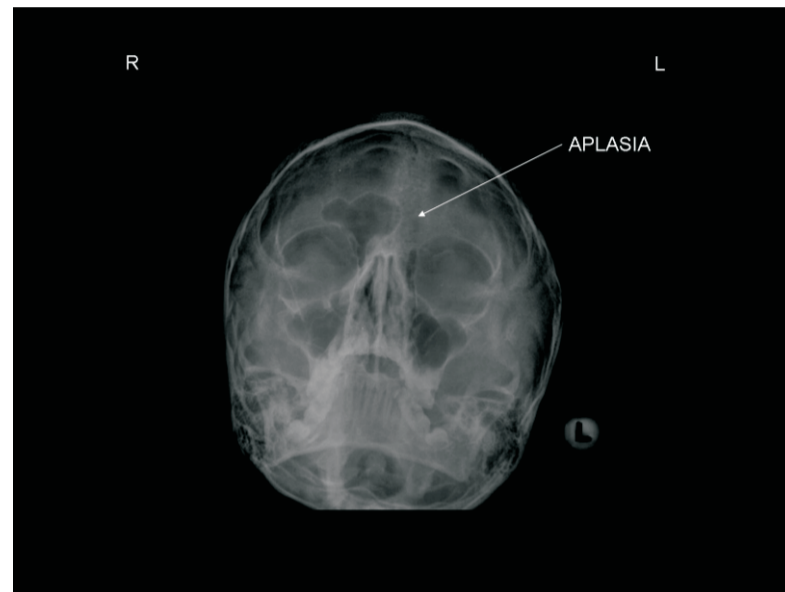
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LEGENDS TO FIGURES

Figure-1. Showing aplasia of both frontal sinuses.



Figure-2. Showing aplasia of left frontal sinus.



TABLES

Table-1. Showing distribution of frontal sinus aplasia in both males and females

Sex	n	Bilateral Frontal Sinus Aplasia n (%)	Unilateral	
			On Right Side	On Left Side
Males	119	4 (1.68 %)	1 (0.42 %)	1 (0.42 %)
Females	119	2 (0.84 %)	0 (0.0 %)	0 (0.0 %)
Total	238	6 (2.5 %)	2 (0.84 %)	

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