International Journal of Otorhinolaryngology and Head and Neck Surgery
*Moideen SP et al. Int J Otorhinolaryngol Head Neck Surg. 2017 Jan;3(1):108-111*
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

**Original Research Article**

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20164811

# Incidence of frontal sinus aplasia in Indian population

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**Received:** 26 October 2016
**Accepted:** 21 November 2016

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## ABSTRACT

**Background:** Aplasia or agenesis of frontal sinuses is not uncommon in the literature. Previous studies have shown unilateral aplasia varying from 1-10% and bilateral agenesis of frontal sinus in 3-10% of patients. It is critical for the operating surgeon to be well aware of the normal anatomy and the variations while doing procedures like endoscopic sinus surgeries, cranialisation of frontal sinuses, frontal sinus trephination, and during anterior skull base procedures. The aim of this study is to demonstrate the incidence of anatomic variations of frontal sinus among Indian populations.
**Methods:** We did a cross sectional study on computed tomography (CT) scan of head, nose and paranasal sinuses in 730 patients above the age of 10 years. We excluded pregnant ladies, patients with prior sinus surgeries, sinonasal tumors, nasal polyposis, craniofacial trauma.
**Results:** We observed an incidence of 6.2% of unilateral aplasia of frontal sinus (2.2% in males and 4.0% in females, 3.7% right side and 2.5% left side) and 2.5% of bilateral frontal sinus aplasia (0.95% in males and 1.5% in females).
**Conclusions:** Frequent occurrence of frontal sinus aplasia highlights the need to gain a thorough knowledge of the normal anatomy and its variations in order to navigate safely through the nose during basic endoscopic sinus or anterior skull base surgeries to avoid complications.

**Keywords:** Frontal sinus, Aplasia, FESS, Paranasal sinus, Skull base

## INTRODUCTION

The paired frontal sinuses are situated within the anterior cranial vault, posterior to supraciliary arches and enveloped between the anterior and posterior tables of frontal bone. Since the right and left frontal sinuses develop independently, they rarely become symmetrical.[1] The two sinuses are separated by an intersinus septum, which is usually deviated from the median plane. Among all paranasal sinuses, frontal sinus is the only sinus which appears after birth and reaches its full size only after puberty. Frontal sinus opens into the middle meatus via the frontonasal recess. Based on the attachment of uncinate process, the frontal sinus may drain medial to uncinate process (88%) and lateral to uncinate in 12% cases.[2]

Bilateral and unilateral aplasias of frontal sinuses are not uncommon in the literature. Previous studies show bilateral agenesis of frontal sinus in 3-10% of patients.[3]

Among the paranasal sinuses, management of frontal sinus diseases is the most difficult, because of its complex anatomy and close proximity to adjacent vital structures. The most preferable management of frontal sinus diseases is via endoscopic approach. The surgeons,

especially while doing anterior skull base surgeries or frontal recess surgeries, should be aware of the normal anatomy of frontal sinus and its variations to understand the disease, its spread, and for the safe surgical outcomes.

In this article, we are presenting a new series of frontal sinus aplasia among Indian population. The aim of this study was to demonstrate the incidence of anatomic variations of frontal sinus.

## METHODS

This prospective study consists of 730 patients including both sexes, who were referred for CT scan of head and neck region, from the department of otorhinolaryngology and ophthalmology. The data was collected from the department of radio diagnosis at Sri Siddhartha Medical College, Tumakuru during the period between June 2015 and July 2016.

We excluded patients with prior sinus surgeries, sinonasal tumors, nasal polyposis and craniofacial trauma. All pregnant women were also excluded from the study. Patients younger than 10 years were excluded from the study because according to Duque CS the frontal sinuses will attain an adult configuration by the age of 8 -10 years only.

CT scan was done using a single "GE Single slice spiral CT Machine" with optimal exposure settings of 125 kVp and 80–160 mAs. The images were obtained in coronal and axial sections with a 3 mm thickness. Anatomical variations of frontal sinuses were studied using both soft part window and bony density window. Aplasia of frontal sinus was absence of frontal bone pneumatisation above a line drawn tangential to the supraorbital margin.

## RESULTS

The study was carried out in 730 patients including both male (n= 390) and females (n =340). We observed unilateral as well as bilateral absence of frontal sinuses. Incidence of frontal sinus aplasia was observed more among females (5.5%) than males (3.15%). The results from our study are summarized in Table 1.

**Table 1: Frequency of frontal sinus aplasia.**

| Sex | Total cases | Absence of frontal sinus | | | |
|---|---|---|---|---|---|
| | | Bilateral | Unilateral | | |
| | | | Right | Left | Total |
| **Male** | 390 | 7 (0.95%) | 10 (1.4%) | 6 (0.82%) | 16 (2.2%) |
| **Female** | 340 | 11 (1.5%) | 17 (2.32%) | 12 (1.64%) | 29 (4.0%) |

**Table 2: Incidence of aplasia of frontal sinus based on gender in different populations.**

| Author | Unilateral | | | Bilateral | | |
|---|---|---|---|---|---|---|
| | Males | Females | Total | Males | Females | Total |
| **Schuller (1943)** | - | - | 1% | - | - | 5% |
| **Nowak and Mehls (1977)** | - | - | 7.4% | - | - | 3.4% |
| **Yoshino (1987)** | 14.3% | 7.5% | 21.8% | - | - | - |
| **Aydinlioglu(2003)** | 1.9% | 2.9% | 4.8% | 1.3% | 2.5% | 3.8% |
| **Binali Cakur (2007)** | 0.49% | 0.73% | 1.22% | - | - | 0.73% |
| **Sarita Choudhary(2015)** | 1.84% | 3.42% | 5.3% | 0.52% | 0.79% | 1.3% |
| **Present study** | 2.2% | 4.0% | 6.2% | 0.95% | 1.50% | 2.5% |

**Table 3: Incidence of aplasia of frontal sinus based on laterality in different populations.**

| Author | Unilateral | | |
|---|---|---|---|
| | Right | Left | Total |
| **Schuller (1943)** | - | - | 1% |
| **Nowak and Mehls (1977)** | 4.2% | 3.2% | 7.4% |
| **Yoshino (1987)** | 4.9% | 16.8% | 21.8% |
| **Aydinlioglu(2003)** | 2.8% | 2.0% | 4.8% |
| **Binali Cakur (2007)** | 0.73% | 0.49% | 1.22% |
| **Sarita Choudhary (2015)** | 4.2% | 1.1% | 5.3% |
| **Present study** | 3.7% | 2.5% | 6.2% |

## DISCUSSION

Frontal sinus shows tremendous inter individual variations due to incomplete pneumatisation. The paranasal sinuses are formed by the invagination of cranial bones by epithelial cells from the nasal cavity. All the paranasal sinuses except frontal sinuses are present at birth because pneumatisation of frontal bone is a slow process. Invagination of frontal bones starts during the 16th week of gestational age as a direct elongation of infundibulum (frontal recess) or by the cranial migration of anterior ethmoidal air cells between the anterior and posterior tables of frontal bones. The pneumatisation of frontal sinus is a two-step process – primary and secondary. The primary pneumatisation occurs within the first year of life. Up to two years of age, the frontal sinus remains as a small blind sac (cellulae ethmoidalis). The secondary pneumatisation starts by second year of life and continues till eight years of age. By this age, frontal sinus appears in most of the radiological studies. The pneumatisation continues even after puberty and completes their definitive configuration by eighteen years.[4]

The pneumatisation of frontal sinus is also influenced by the race, gender, geography and climate.[3-5] Previous studies done on aplasia of frontal sinuses are summarized in Table 2 and 3.

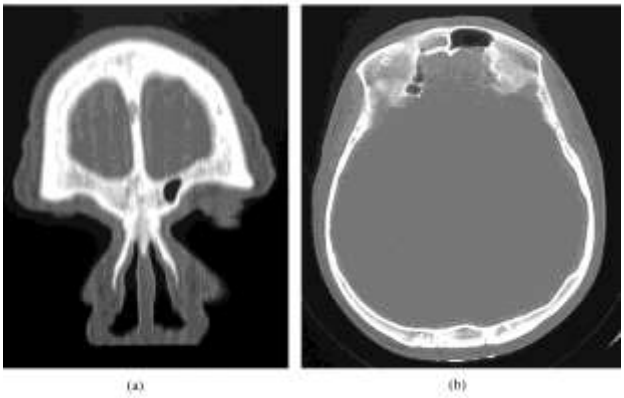

**Figure 1: Unilateral absence of frontal sinus. (a) coronal view (b) axial view.**

In the present study, the incidence of unilateral frontal agenesis was 2.2% in males and 4.0% in females. Our findings were very similar to Aydinlioglu et al and Sarita Choudhary et al who also reported unilateral absence of frontal sinus more in females than in males.[3,6] Aydinlioglu et al (2003) in their retrospective study on CT scans of 1200 subjects reported unilateral absence in 4.8% subjects and bilateral absences in 3.8% of subjects.

Sarita Choudhary et al (2015) carried out a cross sectional study on 380 subjects with CT scans and observed unilateral aplasia in 5.3% subjects and bilateral aplasia in 1.3% subjects.

We also found that incidence of right side aplasia (3.7%) was more common than left side (2.5%). Search of literature revealed similar findings.[3,6-8] But it was contradicting to Yoshino et al findings, who reported unilateral left frontal sinus absence (16.8%) was more common than in right side (4.9%).[9]

In this study, the overall frequency of bilateral frontal sinus absence was 2.5%. The frequency of bilateral sinus absence was reported to be 5% by Schuller (1943).[10] Nowak and Mehls (1977) reported bilateral absence of frontal sinus in 3.4% of adults.[7] A bilateral absence of frontal sinus was found by Cakur (2007) in 0.73% individuals.[8]

Bilateral absence of frontal sinus was more common in females (1.50%), than in males (0.95%). These results were similar with Aydinlioglu et al (females – 2.5%, males – 1.3%) and Sarita et al (females – 0.79%, males – 0.52%).

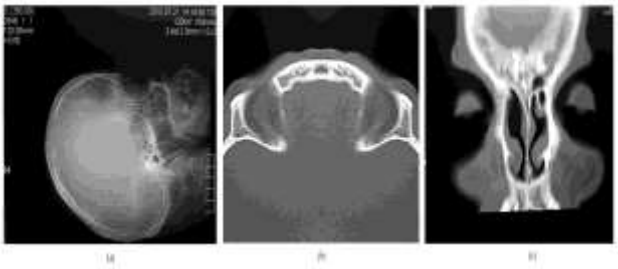

**Figure 2: Bilateral frontal sinus aplasia. (a) scout view (b) axial view and (c) coronal view.**

The different anatomical configurations of frontal sinus can seriously affect the access to anterior skull base. The operating surgeon should be well aware of the normal anatomy and their variations while doing procedures like endoscopic sinus surgeries, cranialisation of frontal sinuses, frontal sinus trephination, and during anterior skull base procedures.

## CONCLUSION

The anatomy of frontal sinuses can be very challenging even for the most experienced surgeons. A thorough knowledge of the normal anatomy, and the normal variations are critical in order to navigate safely through the nose during basic endoscopic sinus surgeries or anterior skull base surgeries to avoid complications.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: Not required*

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**Cite this article as:** Moideen SP, Khizer Hussain Afroze M, Mohan M, Regina M, Sheriff RM, Moideen CP. Incidence of frontal sinus aplasia in Indian population. Int J Otorhinolaryngol Head Neck Surg 2017;3:108-11.