ORIGINAL ARTICLE

Use of frontal sinus and nasal septum patterns as an aid in personal identification: A digital radiographic pilot study

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Abstract

Objectives: To examine and classify the variations in the pattern of frontal sinus and nasal septum as observed on the posterior anterior Cephalometric radiographs, and to propose the possible use of the same in personal identification. **Materials and Methods:** This study was conducted on 50 individuals visiting the department, whose age ranged from 25 to 50 years. The radiographs of 25 males and 25 females were recorded using a Kodak 8000 C and Dental Imaging Software Viewer 6.3.4. Frontal sinus (symmetry and lobulations) and nasal septum patterns (deviations) were observed and classified. **Results:** Frontal sinus symmetry was observed in 29 (58%) individuals and asymmetry was observed in 16 (32%). Frontal sinuses were absent (bilateral aplasia) in two individuals (4%). Unilateral aplasia was seen in three individuals (6%). Straight nasal septum was seen in 11 (22%), right deviation in 21 (42%), and left deviation in 15 (30%) individuals. Sigmoid was seen in one male (2%), reverse sigmoid in one male (2%), and other pattern type in one female (2%). Both frontal sinus and nasal septum patterns were assessed together for each individual. Out of 50 individuals, 41 unique combinations of frontal sinus and nasal septum were found. However, there were nine individuals whose patterns matched one of the patterns of the 41 individuals. **Conclusion:** We observed that the frontal sinus and nasal septum patterns had considerable individual variation. A combined use of both the patterns, as observed on the radiographs, could serve as an adjunct to other methods of personal identification.

Key words: Forensic dentistry, frontal sinus, nasal septum, posteroanterior cephalogram, personal identification

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Introduction

Human identification is a mainstay of civilization and the identification of unknown individuals has always been of paramount importance to the society. Not only it is important to identify the deceased to ensure a proper burial, but there are also issues such as criminal investigations, insurance settlements, and military proceedings that can be resolved only with positive identification. The most reliable means of identification include fingerprints, dental comparison, and biological methods such as DNA profiling.[1] However, when the soft tissue of the human remains became putrid or is burnt, or the DNA is severely degraded, fingerprint identification and DNA analysis cannot be carried out, and the identity of the remains can only be determined by the anthropological method. The radiograph is commonly accepted as a key tool of personal identification.[1-3]

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Frontal sinuses are pneumatic cavities that become radiologically evident at the age of five or six years and develop fully by the age of 20 years.[4] Studies have suggested that the frontal sinuses are slightly bigger in males than in females, and the presence of a metopic suture is associated with the absence of the frontal sinuses.[5,6] Evaluation of frontal sinuses, even in monozygotic and dizygotic twins, have been found to be different, always.[7,8] Thus, the reliability of comparing ante- and post-mortem radiographs of the frontal sinus for identification is well founded.[9] They have been found to have individual morphological variations. It has been suggested that frontal sinus patterns have a potential to be used as aids for personal identification, age estimation, and sexual dimorphism.[2,4,7,10-12]

Similar findings were also observed for the nasal septum.[13-15]

Also a combined use of different frontal sinus and nasal septum patterns aids in a more precise identification, than by the use of either of them alone.[11]

With this background, this study was undertaken to examine and classify variations in frontal sinus and nasal septum patterns as observed on a posteroanterior (PA) cephalogram, and to propose the possible use of the same in personal identification.

Materials and Methods

PA cephalograms of 50 individuals (25 males and 25 females) between the age group of 25 and 50 years, visiting the Department of Oral Medicine and Radiology, M R Ambedkar Dental College, Bangalore, were recorded. The radiographs were then observed for frontal sinus and nasal septum patterns. The frontal sinus was classified according to symmetry, right or left dominant asymmetry, and unilateral (right or left) and bilateral aplasia. The greatest horizontal dimension was measured from the central septum on either side. The difference in the right and left side dimensions was divided by the greatest dimension and multiplied by 100. If the percentage was more than 20% then it was classified as asymmetrical. They were also assessed for the number of lobulations on each side. The nasal septum was classified according to the deviations in the septa as straight, simple deviation to right or left, sigmoid type, reverse sigmoid type, and others. The combined nasal septum and frontal sinus pattern was recorded for each individual.

Result

Frontal sinus symmetry was observed in 29 individuals (13 males and 16 females) (58%).

Frontal sinus asymmetry was observed in 16 individuals (32%) (10 males and 6 females; 3 right and 13 left).

Frontal sinus was absent (bilateral aplasia) in two individuals (4%) (one male and one female). Unilateral aplasia was seen in three individuals (6%) (one male and two females; two right and one left), [Table 1, Figure 1].

Straight nasal septum was seen in 11 individuals (22%) (three males and eight females).

Right deviation of the nasal septum was seen in 21 individuals (42%) (11 males and 10 females).

Left deviation of the nasal septum was observed in 15 individuals (30%) (nine males and six females).

Sigmoid was seen in one individual (2%) (one male), reverse sigmoid in one individual (2%) (one male), and other types in one individual (2%) (one female), [Table 2, Figure 2].

Out of 50 individuals, 41 unique combinations of frontal sinus and nasal septum were found. However, there were nine individuals whose patterns matched one of the patterns of the 41 individuals [Table 3, Figure 3].

Table 1: Frontal sinus patterns

Classification	Number of individuals (males, females)	Percentage
Symmetry	29 (13,16)	58
Total	16 (10,6)	32
Asymmetry		
Right	3 (1,2)	6
Left	13 (9,4)	26
Aplasia unilateral		
Right	2 (0,2)	4
Left	1 (1,0)	2
Total	3 (1,2)	6
Aplasia bilateral	2 (1,1)	4

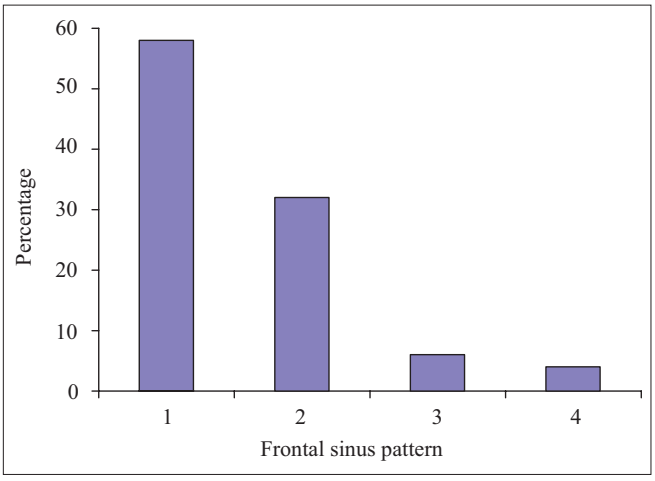

Figure 1: 1-symmetry; 2-asymmetry; 3-unilateral aplasia and 4-bilateral aplasia

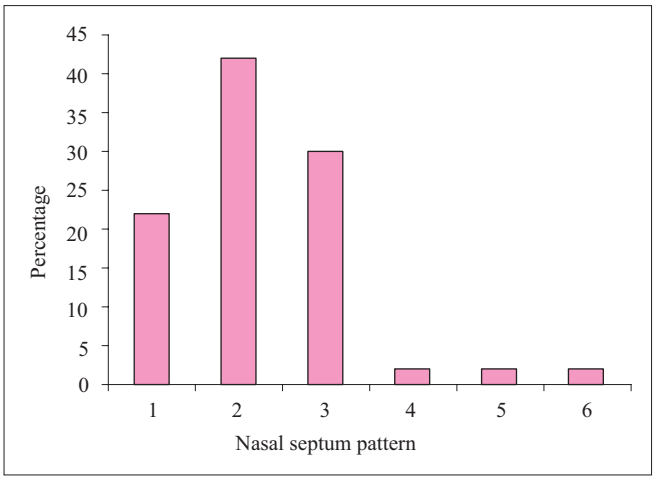

Figure 2: 1-straight; 2-right deviation; 3-left deviation; 4-sigmoid; 5-reverse sigmoid and 6-others

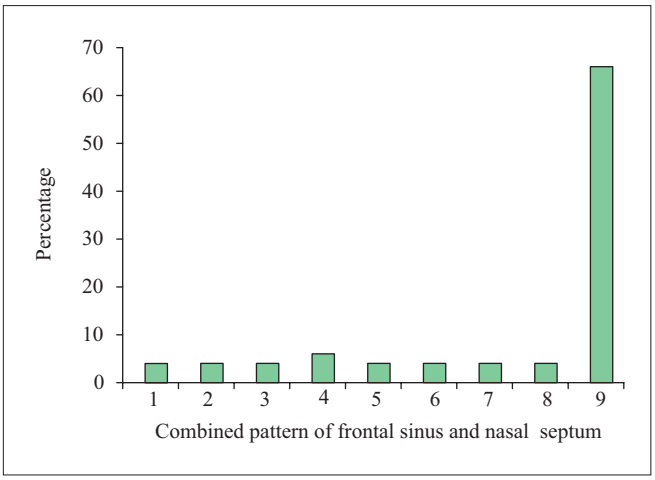

Figure 3: 1–8 similar combinations and 9 unique combination

Table 2: Nasal septum patterns

Classification	No. of individuals (males, females)	Percentage
Straight	11 (3,8)	22
Right deviation	21 (11,10)	42
Left deviation	15 (9,6)	30
Sigmoid	1 (1,0)	2
Reverse sigmoid	1 (1,0)	2
Others	1 (0,1)	2

Table 3: Combined pattern of frontal sinus and nasal septum

Classification	No. of individuals
Frontal sinus (no. of lobulations) nasal septum pattern	
S(R-2,L-3)R	2
S(R-3,L-5)R	2
S(R-1,L-4)R	2
S(R-2,L-2)L	3
A(L)(R-2,L-3)R	2
A(L)(R-1,L-1)R	2
A(L)(R-2,L-6)L	2
A®(R-4,L-3)R	2

A - Asymmetry, S - Symmetry

Discussion

Ever since Zuckerkandl established the uniqueness of frontal sinus in 1895, many have worked to establish frontal sinus morphology for personal identification, in forensic science.[4] Our study utilized PA cephalograms, as frontal sinus and nasal septum patterns could be assessed with minimal distortion from a single radiograph.[7]

Individuals were selected randomly between the ages 25 and 50 years, owing to the fact that the development of the frontal sinus goes up to 20 years. This was in accordance with the studies done by Libersa and Faber (1957), Krogman (1962), and Porbonikova (1974).[4,6,16-22] Also the growth of the nose increases until the age of 18, as suggested by Antoszewski *et al*.[13,14] Quatrehomme *et al.* suggested that advancing age could lead to changes due to bone resorption, hence, individuals up to the age of 50 years were included in the study.[7]

In our study, symmetry of the frontal sinus was found in 58% of the individuals, whereas, Taniguchi *et al.* obtained 43.1% symmetry in the Japanese population. Frontal sinus asymmetry was observed in 32% in our sample, whereas, Taniguchi *et al.* observed 56.6% asymmetry.[11] Unilateral aplasia was seen in 6% of the individuals and bilateral aplasia in 4%. The results were consistent with those of Krogman, who observed frontal sinus absence in 5% of the adults, while Gulisano *et al*. observed its absence in 4.8% of the cases.[4,18,23]

Schuller suggested that the presence of a metopic suture was associated with the absence of the frontal sinus.[4,5,24]

Nasal septum patterns revealed various forms in our study. A straight nasal septum was present in 22% of the individuals in contrast to Taniguchi *et al.*, who observed 13.4% straight nasal septum. Right deviation was noticed in 42%, whereas, Taniguchi *et al.* noticed 35.3%. We observed 30% left deviation of the nasal septum in concordance with Taniguchi *et al.* who observed 37.6%. A.R. Talaiepour *et al.* observed 63% nasal deviation (28% to the right, 31.5% to the left, and 3.5% others).[11,25]

Sigmoid, reverse sigmoid, and other patterns were assessed in 2% of the individuals in our study. On the other hand Taniguchi *et al.* assessed 6%, 6.3%, and 1.4%, respectively.[11]

When the combined usage of both frontal sinus and nasal septum patterns was assessed, we obtained 41 unique combinations, and nine individuals, whose patterns matched one of the patterns of the 41 individuals.

There are certain limitations, however, for the use of frontal sinus and nasal septum patterns in personal identification. The size of the frontal sinus may be related to environmental and genetic factors. They may be affected by pathology, craniofacial configuration or thickness of the frontal bone. Also, growth hormone levels influence frontal sinus morphology.[7]

Conclusion

We observed that frontal sinus and nasal septum patterns had considerable individual variation. From our study we could conclude that a combined use of frontal sinus and nasal septum patterns, as seen on the PA cephalogram, could be used as one of the aids for personal identification. Moreover, the method used for identification was simple and not time consuming. It could be easily employed by a general dentist, as it did not require expertise. It made use of two patterns, which could be covered in one radiograph. Alternately, the potentially matching frontal sinus images could be examined by a qualified radiologist conversant in the radiographic anatomy of the region. Furthermore, a literature review did not reveal the combined use of frontal sinus and nasal septum patterns for identification in the Indian population, and hence, this study has marked an initial attempt for personal identification based on a combination of the two patterns.

However, to establish the same we suggest further studies, with implementation of newer parameters for the determination of gender, age, and ethnicity, in larger samples.

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