ORIGINAL RESEARCH

Significance of Frontal Sinus and Nasal Septum Patterns in Personal Identification in Forensics: A Retrospective CBCT Study

K Saraswathi Gopal[1], B Prakash Vijayan[2]

1- MDS, Prof and Head, Dept of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Chennai. 2- P.G. Student, Dept of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Chennai.

Correspondence to:
Dr. B Prakash Vijayan, P.G. Student, Dept of Oral Medicine and Radiology, Meenakshi Ammal Dental College, Chennai.
Contact Us: www.ijohmr.com

ABSTRACT

Background: Skull radiographic examination is a very useful procedure for personal identification in cases of mass disasters and crimes where fragments of skull persist with no chance of identification based on dental structures. **Aim:** The study was performed to determine the uniqueness and reliability of combined frontal sinus (FS) and nasal septum (NS) patterns as observed on full skull projection on CBCT for personal identification. **Material and Method:** The retrospective study comprised of randomly selected 80 full skull projection on CBCT taken on Planmeca Proface Mid taken for other diagnostic purposes were evaluated for patterns of FS and NS. 80 healthy individuals with no history of previous head and neck trauma who were above the age of 20 years were included in the study. Individuals with a history of surgery of the frontal or nasal region and those below the age of 20 were excluded from the study. The study was conducted from 2014 to 2016. **Results:** Frontal sinus symmetry was observed in 35 (43.75%) individuals and asymmetry in 39 individuals (48.75%). Frontal sinuses were absent (bilateral aplasia) in four individuals (5%). Unilateral aplasia was seen in two individuals (2.5%). Straight nasal septum was seen in 27 (33.75%), right deviation in 24 (30%), and left deviation in 18 (22.5%) individuals. Sigmoid was seen in 4 individuals (5%), reverse sigmoid in 7 individuals (8.75%). Both frontal sinus and nasal septum patterns were assessed together for each individual. **Conclusion:**The combined usage of FS and NS patterns can be used as a method for personal identification in forensics.

KEYWORDS: Frontal Sinus, Nasal Septum, Forensic Science, CBCT

INTRODUCTION

Individual identification is of prime importance in mass disasters, road traffic accidents, fire accidents and in criminal case investigations.[1] French police officer Alphonso Bertillion (1853-1914) created the first anthropometric scientific system based on physical measurements for identifying criminals in 1880.[2]

Fingerprint analysis, DNA matching, and anthropological studies can facilitate the process of individual identification. However, in cases of remains being burnt or decomposed, or where DNA is severely damaged, finger print analysis and DNA identification does not prove useful. In these cases, anthropological methods with the help of comparative radiography have proved to be a major tool.[1]

Oral & Maxillofacial radiography is a common procedure followed nowadays in dental clinics and in hospitals. These are taken at different time periods. Which can be collected from the dental office and can be compared with the radiographs made of the remains available.[1]

The skull, pelvis, and femora are most useful for forensic identification. Radiographic exploitation of these for aiding in ascertaining and categorizing human remains have been done since early 1900. Skull is of particular importance in having the potential to identify an individual, which is attributed to the presence of several structures that can be used in identification, such as dentition, cranial suture pattern, frontal sinus and nasal septum.[2]

The frontal sinuses are two in number, which is situated in the posterior part of the superciliary arc and lies in between the external and internal faces of the frontal bone.[3] They are never symmetrical; generally, there lies a septum between both, which deviates from the midline. This uniqueness had made the frontal sinus an important tool in forensic science. It is widely accepted by researchers that the frontal sinuses are unique for each individual. They begin to develop at the age of 2 and continue to develop, which completes by the age of 20.[2] Nasal septum patterns can be used as an adjunct in the identification process along with frontal sinuses.

The present study was performed to examine and identify the various frontal sinus patterns and nasal septum patterns present and evaluate their usefulness in forensic identification of a patient.

How to cite this article:
Saraswathi GK, Vijayan BP. Significance of Frontal Sinus and Nasal Septum Patterns in Personal Identification in Forensics: A Retrospective CBCT Study. Int J Oral Health Med Res 2016;2(6):57-61.

MATERIALS AND METHODS

Full skull CBCT projections of 80 individuals between the age group of 20 and 50, visiting visiting the Department of Oral Medicine and Radiology, at Meenakshi Ammal Dental College and Hospital, Chennai, were recorded. The radiographic images were then observed for frontal sinus and nasal septum patterns. The frontal sinus (Figure 1) was classified as, symmetrical, asymmetrical (right or left), unilateral aplasia (right or left) and bilateral aplasia. [4] The formula used for calculation of symmetry is, the greatest dimension horizontally was measured from the central septum on both sides. The difference between the right and left side dimensions were divided by the greatest dimension and then multiplied by 100. [4]

Eg:

- Right side - 34.69 mm
- Left side - 18.59 mm
- Difference - 16.1 mm
- 16.1 / 34.69 x 100 = 46 % [4]

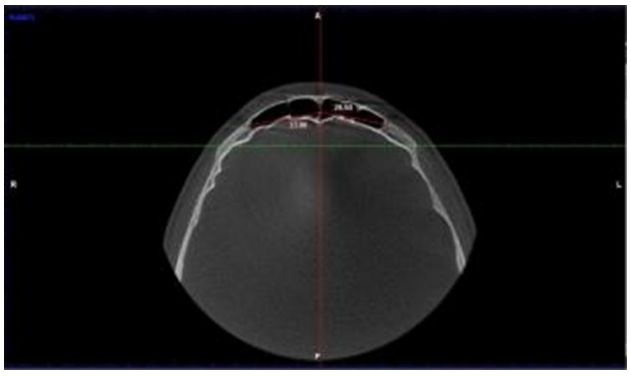


Figure 1: Frontal sinus

If the percentage was below 20 it was considered symmetrical and vice versa.

Figure 2: Nasal septum

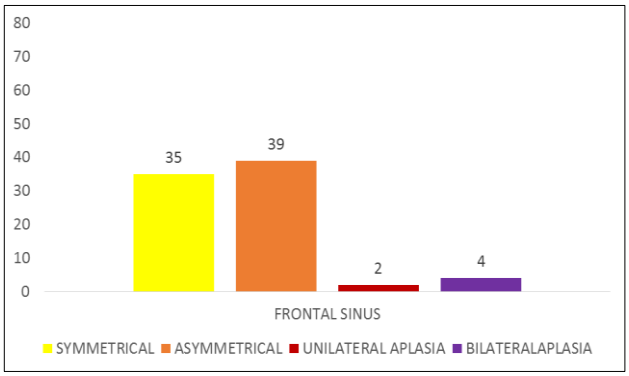
The nasal septum (Figure 2) was classified according to deviations in septa as straight, simple deviation to the right or left side, sigmoid & reverse sigmoid types. (4) The combined frontal sinus and nasal septum patterns were recorded for each individual.

RESULTS

Frontal sinus symmetry was observed in 35 individuals (23 males and 12 females) (43.75%).Asymmetry was observed in 39 individuals (29 males and 10 females) (48.75%) Frontal sinus was absent (bilateral aplasia) in 4 individuals (5%) (2 males and 2 female). Unilateral aplasia was seen in 2 individuals (2.5%) (2 male). (Graph & Table 1)

Classification	Number Of Individuals			Percentage (%)
	Male	Female	Total	
Symmetry	23	12	35	43.75
Asymmetry	29	10	39	48.75
Aplasia – unilateral	2	0	2	2.5
Aplasia bilateral	2	2	4	5

Table 1 – Number of individuals exhibiting each type of frontal sinus pattern

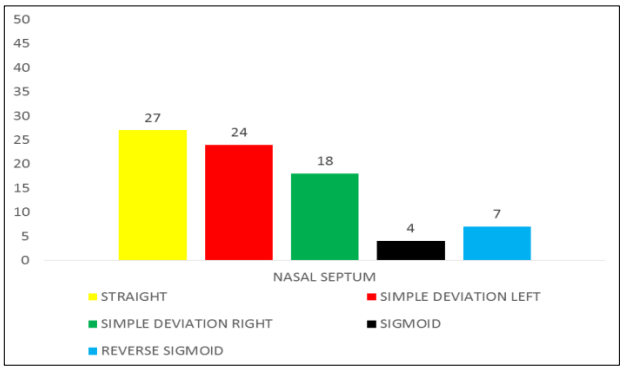


Graph 1 – Number of individuals presenting with each type of frontal sinus

Straight nasal septum was seen in 27 individuals (33.75%) (20 males and 7 females). Right deviation of nasal septum was seen in 24 individuals (30%) (15 males and 9 females). Left deviation of nasal septum was observed in 18 individuals (22.5%) (15 males and 3 females). Sigmoid pattern was noticed in 4 individuals (5%) (2 males & 2 females) and reverse sigmoid pattern was 7 individuals (8.75%) (2 male and 5 females) (Graph & Table 2)

Classification	Number Of Individuals			Percentage (%)
	Male	Female	Total	
Straight	20	7	27	33.75
Right deviation	15	9	24	30
Left deviation	15	3	18	22.5
Sigmoid	2	2	4	5
Reverse sigmoid	2	5	7	8.75

Table 2 – Number of individuals exhibiting each type of Nasal septum pattern



Graph 2 – Number of individuals presenting with each type of nasal septum

Various combined patterns of frontal sinus and nasal septum were obtained in the study (Table 3, 4, 5, 6& 7).

Classification (Fs) (Ns)	Male	Female	Total	Percentage (%)
Symmetry – Straight	10	4	14	17.5
Asymmetry – Straight	8	4	12	15
Unilateral aplasia – Straight	1	-	1	1.25
Bilateral aplasia – Straight	-	-	-	-

Table 3 – Combination of frontal sinus patterns with straight nasal septum

Classification (Fs) (Ns)	Male	Female	Total	Percentage (%)
Symmetry – Simple deviation left	4	2	6	7.5
Asymmetry – Simple deviation left	11	1	12	15
Unilateral aplasia – Simple deviation left	-	-	-	-
Bilateral aplasia – Simple deviation left	-	-	-	-

Table 4 – Comb. of frontal sinus patterns with left deviated nasal septum

Classification (Fs) (Ns)	Male	Female	Total	Percentage (%)
Symmetry – Simple deviation right	6	6	12	15
Asymmetry – Simple deviation right	7	3	10	12.5
Unilateral aplasia – Simple deviation right	1	-	1	1.25
Bilateral aplasia – Simple deviation right	1	1	2	2.5

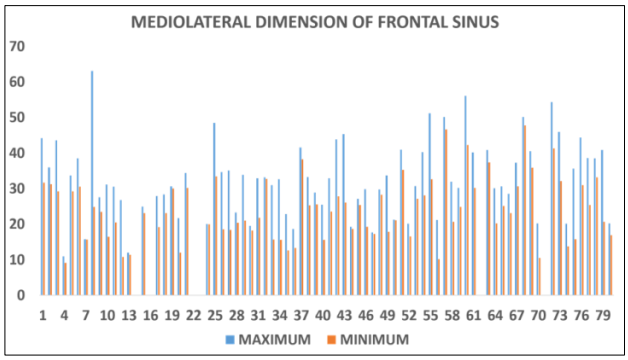
Table 5 – Comb. of frontal sinus patterns with right deviated nasal septum

Classification (Fs) (Ns)	Male	Female	Total	Percentage (%)
Symmetry – Sigmoid	1	-	1	1.25
Asymmetry – Sigmoid	-	1	1	1.25
Unilateral aplasia – Sigmoid	-	-	-	-
Bilateral aplasia – Sigmoid	1	1	2	2.5

Table 6 – Comb. of frontal sinus patterns with sigmoid nasal septum

Classification (Fs) (Ns)	Male	Female	Total	Percentage (%)
Symmetry – Reverse sigmoid	-	2	2	2.5
Asymmetry – Reverse sigmoid	1	3	4	5
Unilateral aplasia – Reverse sigmoid	-	-	-	-
Bilateral aplasia – Reverse sigmoid	-	-	-	-

Table 7 – Comb. of frontal sinus patterns with reverse sigmoid nasal septum



Graph 3– Graph depicting the individual variations in frontal sinus dimensions

S.No	Sex	Frontal Sinus Dimension		Percentage (%)	Nasal Septum Pattern
		Maximum	Minimum		
1	M	44.19	31.68	28.3	Reverse Sigmoid
2	M	36	31.21	13.3	Sigmoid
3	M	43.59	29.22	32.9	Right Deviation
4	F	10.92	9.14	16.3	Right Deviation
5	M	33.67	29.23	13.18	Straight
6	M	38.52	30.59	20.5	Right Deviation
7	M	15.78	15.65	.8	Straight
8	M	63.12	24.90	60.5	Left Deviation
9	F	27.59	23.42	15	Right Deviation
10	M	31.15	16.44	47.2	Straight
11	M	30.52	20.51	32.7	Left Deviation
12	F	26.83	10.77	59.8	Straight
13	F	12.03	11.37	5.4	Reverse Sigmoid
14	F	Bilateral Aplasia		-	Right Deviation
15	F	24.92	23.09	7.3	Straight
16	M	Bilateral Aplasia		-	Right Deviation
17	M	27.89	19.14	31.3	Straight
18	M	28.37	23.08	18.6	Straight
19	M	30.62	30.05	1.8	Left Deviation
20	M	21.69	12.03	44.5	Right Deviation
21	M	34.42	30.24	6.7	Straight
22	M	Unilateral Aplasia (Rt)		-	Right Deviation
23	M	Bilateral Aplasia		-	Sigmoid
24	M	20.09	19.93	.7	Straight
25	M	48.48	33.41	31	Left Deviation
26	F	34.69	18.59	46	Straight
27	F	35.07	18.35	47	Straight
28	M	23.32	20.40	12.5	Right Deviation
29	M	33.90	21	38	Straight
30	M	19.53	18.24	6.6	Left Deviation
31	M	32.88	21.78	33.7	Reverse Sigmoid
32	F	33.15	32.76	1.1	Straight
33	M	30.99	15.68	50.5	Straight
34	M	32.63	15.56	52.3	Left Deviation
35	M	22.83	12.63	44	Left Deviation
36	M	18.68	13.30	28.8	Left Deviation
37	M	41.54	38.28	7.8	Right Deviation
38	M	33.28	25.34	23.8	Right Deviation
39	M	28.91	25.56	11.5	Straight
40	M	25.46	15.62	38.6	Left Deviation
41	M	32.89	23.54	28.4	Right Deviation
42	F	43.83	27.84	36.4	Right Deviation
43	F	45.34	26.09	42.4	Left Deviation
43	F	45.34	26.09	42.4	Left Deviation
44	F	19.23	18.63	3.12	Left Deviation
45	M	27.16	25.40	6.48	Left Deviation
46	M	29.81	19.24	35.4	Straight
47	F	17.72	17.23	2.7	Right Deviation
48	M	29.73	28.31	4.7	Left Deviation
49	M	33.67	17.86	46.9	Straight
50	M	21.29	21.12	0.7	Right Deviation
51	M	40.97	35.26	13.9	Straight
52	M	20.18	16.54	18	Straight
53	M	30.76	27.12	11.8	Right Deviation
54	M	40.22	28.12	29.6	Straight
55	M	51.21	32.65	36.2	Right Deviation
56	M	21.20	10.16	52	Left Deviation
57	F	50.12	46.61	7	Straight
58	F	31.92	20.64	32.7	Right Deviation
59	F	30.24	24.82	17	Straight
60	F	56.12	42.31	24.6	Right Deviation
61	F	40.17	30.24	24.7	Sigmoid
62	M	Un.Aplasia	-	Straight	
63	M	40.9	37.4	8.5	Right Deviation
64	M	30.1	20.21	32.8	Right Deviation
65	M	30.64	25.10	18	Straight
66	F	28.54	23.10	19	Right Deviation
67	F	37.28	30.64	17.8	Reverse Sigmoid
68	M	50.17	47.82	4.6	Straight
69	M	40.5	35.9	11.3	Reverse Sigmoid
70	M	20.21	10.56	47.7	Left Deviation
71	F	Bi.Aplasia		Sigmoid	
72	M	54.35	41.30	24	Left Deviation
73	F	45.9	32.13	30	Reverse Sigmoid
74	M	20.12	13.75	31.6	Straight
75	M	35.62	15.78	55.6	Straight
76	M	44.40	30.97	30.2	Right Deviation
77	F	38.6	25.4	34.1	Reverse Sigmoid
78	M	38.5	33.17	13.8	Left Deviation
79	M	40.87	20.69	49.3	Left Deviation
80	M	20.27	16.87	16.7	Right Deviation

Table 8 – The individual variations in values in frontal sinus dimensions.

Figure 3,4 shows various patterns of frontal sinus and nasal septum as seen in CBCT images. The mediolateral dimensions of each individual was noted and found to be unique which clearly states the uniqueness of the frontal sinus in forensic identification (Table 8 & Graph 3).

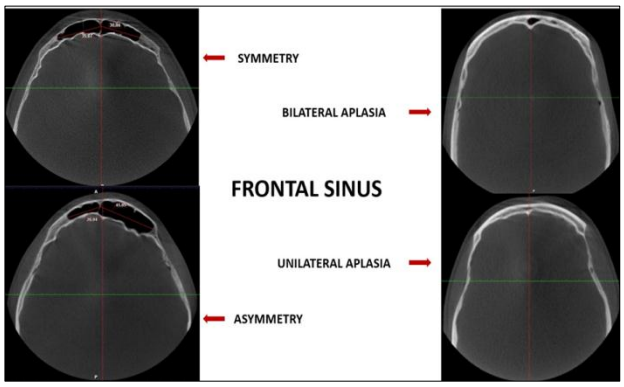


Figure 3 – Various patterns of frontal sinus as seen in CBCT images

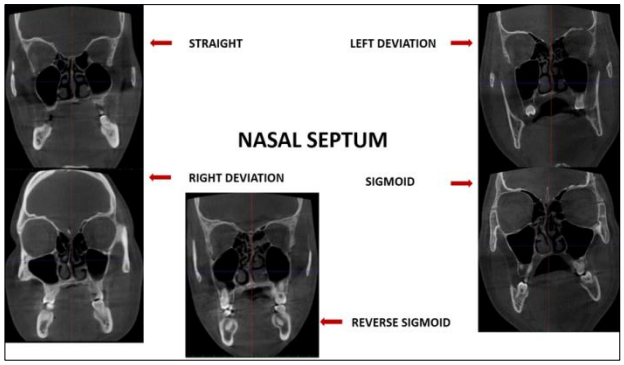


Figure 4 – Various patterns of nasal septum as seen in CBCT mages

DISCUSSION

The uniqueness of frontal sinus was described by Zukerkandl in 1895.[5] It is unique for every individual which was confirmed by Christensen using the elliptical Fourier analysis. It is a relatively stable structure during adult life and is well preserved in human remains owing to its strong walls.[4]

Individuals included in the study were chosen from the age group of 20 - 50. It was done keeping in mind the fact that the development of frontal sinus goes up to 20 years. The growth of nose increases till the age of 18 according to Antoszewski et al.[6,7]

In our study, frontal sinus symmetry was noticed in 43.75% of the patients which was in accordance with that of a study by Taniguchi et al. in the Japanese population. Frontal sinus asymmetry was observed in 48.75% of the individuals whereas Taniguchi et al. obtained 56%.[4] Unilateral aplasia and bilateral aplasia were present in 2.5% and 5% of our study group respectively. The results were similar to those obtained by Krogman, who observed bilateral aplasia in 5% and Gulisano et al. who observed 4% presence of the same parameter in his study group.[5,9,10] Neha Patil et al. observed bilateral aplasia in 1% of the study group.[1]

A straight nasal septum was present in 33.75% of the patients whereas Taniguchi et al. encountered it in only 13% of his study group.[8] Right deviation of nasal septum was observed in 30% of the cases which was in accordance to that observed by Taniguchi et al. who observed it in 35.3%. In our study, 22.5% had left deviation of nasal septum, whereas Taniguchi et al. observed it in 36.7%.[8,11] Sigmoid and reverse sigmoid pattern of nasal septum were observed in 5% and 8.75% of our study group respectively. This was consistent with those observed by Taniguchi et al. who observed the same in 6% and 6.3% of his study group.[8]

Certain limitations are present in using these parameters. They are the size of the frontal sinus associated with environmental factors, those affected due to pathology, cranial configuration or dimensions of the frontal bone.

CONCLUSION

In our study, we observed that the frontal sinus and nasal septum patterns had considerable individual variations. The usage of these parameters as seen in a full skull CBCT image can be used as one of the aids in personal identification. The method utilized was very simple and utilized in-built measurement tools in the CBCT viewer software. We would like to suggest further studies, with larger sample sizes and with the implementation of newer parameters for the determination of gender, age and ethnicity.

REFERENCES

1. Neha Patil, Freny R. Karjodkar. Subodh Sontakke, Kaustubh Sansare, Rohini salvi. Uniqueness of radiographic pattrens of the frontal sinus for personal identification.Imaging Science in Dentistry 2012;42: 213-7
2. Saumya Verma, V. G. Mahima, Karthikeya Patil. Radiomorphometric analysis of frontal sinus for sex determination. J forensic dental sci. 2014 Sep-Dec; 6(3): 177-182.
3. Jose Marcos Ponde; Raimundo Nonato Andrade; Jose Maldonado Via; Patrick Metzger & Ana Clara Teles. Anatomical Variations of the frontal sinus. Int. J. Morphol. 26(4):803-808, 2008.
4. Maria Priscilla David, Runjuhn Saxena. Use of frontal sinus and nasal septum patterns as an aid in identification: A digital radiographic pilot study. Journal of Forensic Dental Sciences / July-December 2010 / Vol 2 / Issue 2
5. Silva RF, Pinto RN, Ferreria GM, Daruge Juniour E. Importance of frontal sinus radiographs for human identification. Braz J Otorhinolaryngol 2008;74:798
6. Howie TO. Identical deformities in the nasal septum of a pair of identical twins. Br Med J 1946. p. 760-1.
7. Grymer LF, Pallisgaard C, Melsen B. The nasal septum in relation to the development of the nasomaxillary complex: A study inidentical twins. Laryngoscope 1991;101:863
8. Taniguchi M, Sakoda S, Kano T, Zhu BL, Kamikodai Y, Fujita MQ, *et al.* Possible use of nasal septum and frontal sinus patterns to radiographic identification of unknown human remains. Osaka City Med J 2003;49:31-8.
9. Gulisano M, Pacini P, Orlandini GE. Frontal sinus dimensions in relation to the cranial index:

Anatomoradilogic findings. Boll Soc Ital Biol Sper 1978;54:66-9.
10. Krogman WM. The human skeleton in forensic medicine. Thomas, Springfield, 1962.
11. Talaiepour AR, Sazgar AA, Bagheri A. Anatomic variations of the paranasal sinuses on CT scan images. J Dent 2005;2:142-6.

Source of Support: Nil
Conflict of Interest: Nil