# FRONTAL SINUS: A TOOL FOR PERSONAL IDENTIFICATION

**Anatomy**

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## ABSTRACT

**Introduction:** It is required to have a precise knowledge of dimensions of frontal sinus anatomy in relation to age side and gender to establish it's forensic importance and application.

**Aim and Objectives:** To study was to assess variations in frontal sinus anatomy in a given population.

**Material and Methods:** A retrospective study was undertaken on head CTs PNS(Computed Tomography Paranasal sinuses) of 119 patients. Various parameters of frontal sinus like Antero-posterior diameter, Height, Width, Anterior wall thickness, total width and Volume were measured and compared age wise, sidewise & gender wise

**Result:** No significant difference in parameters were seen when gender wise comparison was made. However a significant difference was observed when width of right and left side frontal sinus, total width and AP diameter (Antero posterior) of right side were compared amongst certain age groups.

**Conclusions:** The sound knowledge of frontal sinus morphometry and variability is very useful in personal identification which applied in medico-legal issues.

## KEYWORDS

Frontal Sinus, AP diameter, Height, Width, Volume

## INTRODUCTION

The frontal sinus is funnel-shaped cavity, unique to individual and separated by septum.[1] Frontal sinus has great variability and structure doesn't change after the age of twenty years. 7. Because of its irregular shape , individual characteristics and uniqueness in every individual even in monozygotic twins just as with the fingerprints [2, 3, 4] Frontal sinuses holds an important role in forensic investigations, mainly in cases where only fragments of the skull remains.

There are many studies conducted to know the morphometric differences of frontal sinuses but these studies are conducted on dry skull and by X-ray's which does not give us a three dimensional view of the frontal sinuses. CT scan provides a three dimensional view of the sinuses hence enabling us to know the depth of sinuses along with its length, breadth. [5]

Therefore this study was conducted to know the morphometric dimensions of frontal sinuses which is a useful means of forensic identification of humans using CT scans.

## MATERIAL & METHODS

A retrospective cross sectional study was carried out in the department of Anatomy, in Dr. Shankarrao Chavan , Government Medical College, Nanded, Maharashtra in collaboration with the department of Radiology during the period of 6 months after prior approval of the ethics committee. The material for the study comprised of Dual Slice Siemens Volume Access (SOMATOM) CT Scan Machine (Computerized Tomography scans) available in the department of Radiology.

Patients between 11 – 70 years, without any congenital facial asymmetry and patients in whom frontal sinus anatomy is found to be normal in PNS CT scans were included in the study.

Patients<11 yrs , patients with history of previous sinus surgery, injured frontal sinus ,any space occupying lesion, carcinoma, patients with endocrinal disorders and patients with agenesis of frontal sinus (bilateral) were excluded from the study.

A normal head CTs PNS (67 males & 52 females) of 119 patients in the age group of 11 to 70 yrs were collected from the department of radiology. The sample contained different Coronal and Axial slices with 0.6 mm, 1.25 mm and 4 mm thickness. From the sample antero-

posterior diameter, width, total width, height, anterior wall thickness and Volume were taken at their maximum measurements as shown in Figure No. 1,2 ,3 and data on antero-posterior diameter, width and height in axial section, and width in coronal section were measured. If, only axial sections were taken in any patient then, height = $\sum$ thickness of all axial sections in which frontal sinus was visible.

Total width was calculated by drawing a perpendicular median line along septum. Distance between median line and lateral most point over right and left sinus were measured and noted

Formula for Volume of Frontal sinus is,
According to Trapezoidal rule by Ikeda A, et al.,[6] Fernandez SJM, et al. [7]

$$V = [(A1 + A2) h/2] + [(A2 + A3) h/2] + [(A3 + A4) h/2] + \ldots\ldots\ldots\ldots$$

Where,
V - Volume of frontal sinus.
A1, A2, A3, A4, .... - Cross-sectional areas of successive CT sections.
h - Thickness of slice.

Continuous variables were presented as mean standard deviation. Categorical variables were expressed in percentages. Unpaired t test , One way ANOVA were used for group comparison . Dunn's Method of Multiple Comparison was used for pairwise comparison. Data was analysed on statistical software IBM SPSS STATISTICS VERSION 20.
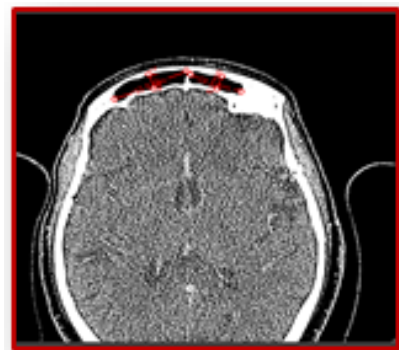


**Figure No. 1: AP & Transverse diameter (CT - axial section)**

**Figure No. 2: Anterior wall thickness, AP & Transverse diameter (CT – coronal section)**



**Figure No. 3: Method for calculation of cross-sectional area**

## OBSERVATIONS AND RESULT

A normal head CTs PNS (67 males & 52 females) of 119 patients in the age group of 12 to 70 yrs were collected from the department of radiology. Amongst 119 cases 67 were males (56.3%) and 52 (43.7%) were females. Of this 32.8% were in the age group of 21-30 years, 21.8% were in age group of 11-20 years, 21% in 31-40 years, 10.1% in 51- 60 years, 9.2 % in 41-50 years and 5.0 % in 61-70 years.

In 96.6% cases frontal sinus was present whereas in 3.4 % of the patient there was absence of sinus on either right or left side.

The measurement of different variables was analysed of different variables were measured in Mean ± SD **(Table 1)**

A gender wise comparison of AP diameter, height, width, anterior wall thickness and volume of right and left side of frontal sinus was done showed no significant difference.

**Table 2.**
**Also** when the **AP diameter ,** height and anterior wall thickness of left side and volume of both sides were compared among different age groups the values were found to be non-significant. **Table 3**

**But w**hen **AP diameter (right side)** of 31-40 was compared with 51 to 60 years the values were found to be significant. (p value <0.05). Also when **Anterior wall thickness (right side)** of 11-20 years was compared with 31-40 years the values were found to be significant. (p value <0.05). **Table 4**

**W**hen width of right and left side of 11-20 years were compared with 21- 30 years and 51- 60 years the values were found to be significant(p value <0.05). Similarly comparison of total width in age group of 11-20 years with 21- 30 years , 31- 40 years and 51- 60 years were found to be significant. (p value <0.05). **Table 5**

**Table No. 1 : Different variables**

| Variables | Right side (Mean ± SD) | Left side (Mean ± SD) |
|---|---|---|
| AP diameter (mm) | 13.73 ± 6.58 | 13.13 ± 5.97 |
| Height (mm) | 14.80 ± 6.65 | 15.38 ± 7.15 |
| Width (mm) | 22 ± 8.92 | 22.43 ± 9.63 |
| Anterior wall thickness (mm) | 2.38 ± 1.29 | 2.43 ± 1.34 |
| Volume (cm3) | 3.15 ± 1.49 | 2.96     1.45 |

**\*Values are expressed in Mean ± SD**

**Table No 2. Gender and side wise comparison of different variables**

| Comparison pairs (years) | Sex | Right | | Left | |
|---|---|---|---|---|---|
| | | Mean Difference | Significance | Mean Difference | Significance |
| AP diameter (mm) | M | 14.38 ± 6.61 | Not significant | 13.9 ± 6.52 | Not significant |
| | F | 12.89 ± 6.50 | Not significant | 12.15 ± 5.07 | Not significant |
| Height (mm) | M | 15.63 ± 6.92 | Not significant | 15.83 ± 7.38 | Not significant |
| | F | 13.74 ± 6.18 | Not significant | 14.79 ± 6.85 | Not significant |
| Width (mm) | M | 21.58 ± 8.76 | Not significant | 23.28 ± 9.88 | Not significant |
| | F | 22.54 ± 9.17 | Not significant | 21.34 ± 9.27 | Not significant |
| Anterior wall thickness (mm) | M | 3.21 ± 1.67 | Not significant | 3.06 ± 1.48 | Not significant |
| | F | 3.08 ± 1.24 | Not significant | 2.83 ± 1.42 | Not significant |
| Volume (cm³) | M | 3.21 ± 1.67 | Not significant | 3.06 ± 1.48 | Not significant |
| | F | 3.08 ± 1.24 | Not significant | 2.83 ± 1.42 | Not significant |

**\*Unpaired t- test is used for comparison between two groups and p value <0.05 is considered as significant**

**Table No. 3: Comparison of AP diameter (Left side), Height (Left side), Anterior Wall Thickness (Left side) and Volume (Right and Left side) in different age groups**

| Age (years) | AP diameter (Left side) | | Height (Left side) | | Anterior Wall Thickness (Left side) | | Volume | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Right | | Left | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| 11 to 20 | 12.86 | 5.89 | 12.04 | 8.01 | 1.83 | 0.94 | 2.56 | 1.55 | 2.75 | 1.26 |
| 21 to 30 | 13.86 | 6.55 | 14.93 | 6.04 | 2.49 | 1.56 | 3.40 | 1.46 | 2.90 | 1.61 |
| 31 to 40 | 13.50 | 4.24 | 16.30 | 5.69 | 2.91 | 1.23 | 3.49 | 1.40 | 2.81 | 1.57 |
| 41 to 50 | 14.93 | 8.53 | 13.36 | 4.58 | 2.28 | 1.26 | 3.03 | 0.97 | 3.12 | 0.65 |
| 51 to 60 | 9.88 | 4.79 | 10.28 | 5.84 | 2.65 | 1.36 | 3.58 | 1.45 | 3.62 | 1.55 |
| 61 to 70 | 11.28 | 4.14 | 10.08 | 6.79 | 2.47 | 1.32 | 2.08 | 1.93 | 3.23 | 1.60 |
| P value | 0.430 | | 0.804 | | 0.08417 | | 0.05027 | | 0.29144 | |

**One Way ANOVA is used for comparison amongst various age groups and p value <0.05 is considered as significant**

**Table No. 4: Comparison of AP diameter (Right side) and Anterior Wall Thickness (Right side) among different age groups**

| Comparison pairs (years) | AP diameter (Right) | | Anterior Wall Thickness (Right) | |
|---|---|---|---|---|
| | Mean Difference | Significance (p value) | Mean Difference | Significance (p value) |

| 11 to 20 vs. 21 to 30 | 15.583 | > 0.05 | 16.218 | > 0.05 |
|---|---|---|---|---|
| 11 to 20 vs.31 to 40 | 24.602 | > 0.05 | 35.911 | **<= 0.05** |
| 11 to 20 vs.41 to 50 | 9.442 | > 0.05 | 24.094 | > 0.05 |
| 11 to 20 vs.51 to 60 | 11.391 | > 0.05 | 25.231 | > 0.05 |
| 11 to 20 vs.61 to 70 | 11.058 | > 0.05 | 21.814 | > 0.05 |
| 21 to 30 vs.31 to 40 | 9.019 | > 0.05 | 19.693 | > 0.05 |
| 21 to 30 vs.41 to 50 | 6.141 | > 0.05 | 7.876 | > 0.05 |
| 21 to 30 vs.51 to 60 | 26.974 | > 0.05 | 9.013 | > 0.05 |
| 21 to 30 vs.61 to 70 | 26.641 | > 0.05 | 5.596 | > 0.05 |
| 31 to 40 vs.41 to 50 | 15.160 | > 0.05 | 11.816 | > 0.05 |
| 31 to 40 vs.51 to 60 | 35.993 | **<= 0.05** | 10.680 | > 0.05 |
| 31 to 40 vs.61 to 70 | 35.660 | > 0.05 | 14.097 | > 0.05 |
| 41 to 50 vs.51 to 60 | 20.833 | > 0.05 | 1.136 | > 0.05 |
| 41 to 50 vs.61 to 70 | 20.500 | > 0.05 | 2.280 | > 0.05 |
| 51 to 60 vs.61 to 70 | 0.333 | > 0.05 | 3.417 | > 0.05 |

\*Post Hoc Multiple Comparison Dunn's Test is used for pair-wise comparison and p value <0.05 is considered as significant

**Table No 5: Comparison of Width (Right & Left side) and Total Width among different age groups**

| Comparison pairs (years) | Width (Right) | | Width (Left) | | Total Width | |
|---|---|---|---|---|---|---|
| | Mean Difference | Significance (p value) | Mean Difference | Significance (p value) | Mean Difference | Significance (p value) |
| 11 to 20 vs.21 to 30 | -6.677 | **0.031** | -6.922 | 0.045 | -13.599 | **0.008** |
| 11 to 20 vs.31 to 40 | -6.646 | 0.070 | -5.791 | 0.237 | -12.437 | **0.048** |
| 11 to 20 vs.41 to 50 | -5.399 | 0.502 | -4.118 | 0.822 | -9.517 | 0.510 |
| 11 to 20 vs. 51 to 60 | -9.579 | **0.021** | -8.710 | 0.087 | -18.289 | **0.010** |
| 11 to 20 vs. 61 to 70 | -5.987 | 0.638 | -10.110 | 0.166 | -16.097 | 0.189 |
| 21 to 30 vs. 31 to 40 | 0.031 | 1.000 | 1.131 | 0.997 | 1.162 | 1.000 |
| 21 to 30 vs. 41 to 50 | 1.278 | 0.998 | 2.804 | 0.950 | 4.082 | 0.969 |
| 21 to 30 vs. 51 to 60 | -2.902 | 0.909 | -1.789 | 0.992 | -4.690 | 0.937 |
| 21 to 30 vs. 61 to 70 | 0.690 | 1.000 | -3.189 | 0.970 | -2.499 | 0.999 |
| 31 to 40 vs. 41 to 50 | 1.247 | 0.999 | 1.673 | 0.996 | 2.920 | 0.995 |
| 31 to 40 vs. 51 to 60 | -2.933 | 0.925 | -2.919 | 0.948 | -5.852 | 0.883 |
| 31 to 40 vs. 61 to 70 | 0.659 | 1.000 | -4.319 | 0.910 | -3.661 | 0.995 |
| 41 to 50 vs. 51 to 60 | -4.180 | 0.851 | -4.592 | 0.845 | -8.772 | 0.738 |
| 41 to 50 vs. 61 to 70 | -0.588 | 1.000 | -5.992 | 0.802 | -6.580 | 0.957 |
| 51 to 60 vs. 61 to 70 | 3.592 | 0.960 | -1.400 | 1.000 | 2.192 | 1.000 |

\*Post Hoc Multiple Comparison Dunn's Test is used for pair-wise comparison and p value <0.05 is considered as significant

## DISCUSSION

A retrospective cross-sectional study was carried out in 119 samples of CT Pns.

When gender wise and side wise comparison of Antero-posterior diameter, height and width were done it was found the Mean ± SD in both the sexes on both sides were found to be non-significant. Similarly in the study conducted by **Tatlisumak E, et al** similar comparison were made and they were non- significant but our study values were towards higher side in comparison to the values of **Tatlisumak E, et al[8]**. This difference may be due to ethnic variability.

In our study gender wise and side wise comparison of anterior wall thickness showed no significant difference which were similar to the study conducted by Mathew KL, et al .[9] and Pernilla SJ, et al. [10]

When similar comparison of volume were done no significant difference were found which was in contrast to the study done by Sacide K, et al. [11] that may be due to difference in sample size. **Table 2.**

When AP diameter (left side), height (left side), anterior wall thickness (left side) and volume (both sides) were compared in different age groups no significant difference were seen which was in contrast to the study conducted by **Tiwari P et al** [5] who found a significant difference in frontal sinus height (left side) when 15- 25 years were compared with 36-45 years and 46- 55 years and 26-35 years was compared with 46-55 years of age group. **Table 3.**

**But s**imilar comparison of AP diameter (right side), width (both side) and total width showed a significant difference. **Table 4** In significant parameters, pairwise Multiple Comparison by Dunn's Method were done. In AP diameter ( right side) significant difference was between 31-40 years vs. 51-60 years, in anterior wall thickness (right side) significant difference was between 11-20 years vs. 31-40 years, in width (right side) it was between 11-20 years vs. 21-30 years and 11-20 years vs. 51- 60 years , in width (left side) between 11-20 years vs. 21- 30 years and in total width between 11-20 years vs 21-30 years, 11-20

years vs. 31- 40 years and 11-20 years vs. 51-60 years. **Table 5** In study conducted by **Tiwari P et al**. [5] no significant difference was found when similar parameters were compared in different age groups.

## CONCLUSION

The sound knowledge of frontal sinus morphometry and variability is very useful in personal identification when applied in medico-legal issues.

Computerized tomography is better than the conventional methods for measurement of different dimensions of frontal sinuses. Hence in our study we tried to find difference of various frontal sinus parameters between the genders and amongst different age groups using CT PNs. We found few significant difference when we compared the parameters amongst different age groups but still for a more detailed knowledge a continuous study with larger sample sizes are necessary.

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