Comparing CT scout and simulated radiographs on reliability of frontal sinus measurement

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Introduction

Frontal sinuses vary greatly between individuals, similar to fingerprints. This variability can be used as a unique identifier and thus can be useful in the field of forensic anthropology. In order to do so, there must have been an imaging study done of their skull (or frontal sinuses) antemortem to act as comparison for any postmortem imaging studies done. However, while CT images are increasing for clinical (antemortem) images, most postmortem images are radiographs. Measurements or views could vary between the imaging modalities based on their method of action, so finding a dependable way to make comparisons must be found. Potential options are scout radiographs from a CT scan to compare to a simple radiograph of an individual, when available. Additionally, several programs can create a simulated radiograph ("pseudo x-ray") from CT scans.

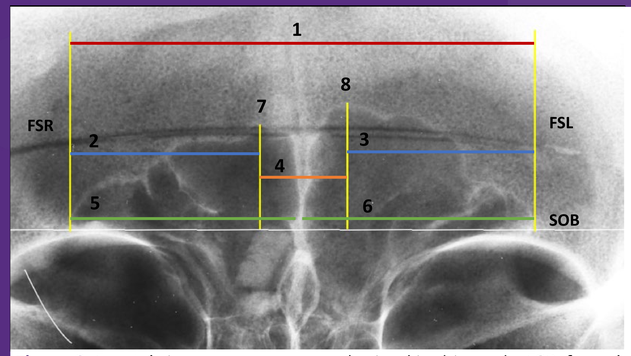
The purpose of this study was to compare frontal sinus measures across CT scout radiographs and pseudo-radiographs generated using *3DSlicer*. The use of this as a forensic tool is important because it could greatly improve identifications using a freeware software as a way to compare different image modalities.

Figure 1. *3DSlicer* images for scout (left) and the generated pseudo x-ray (right) of one individual.

Methods

The current study utilizes 15 individuals form the New Mexico Descendent Image Database (NMDID)[2]. For each individual, pseudo x-rays were created from the CT slices using modules in *3DSlicer;* these radiographs were oriented to match the associated Scouts (**Fig. 1**). Pseudo x-ray and Scout images were then opened in the program *ImageJ*. The supraorbital line was used to demarcate the inferior border of the sinus. Nine frontal sinus measurements were obtained on the two images by two observers (**Fig. 2**).

Paired t-tests were performed to compare these data. 1. Intraobserver data was compared using measurements taken from the pseudo x-ray two separate times by the same measurer. 2. Interobserver data was compared using measurements taken from the pseudo x-ray by two separate observers. 3. Intermodality data was compared using measurements between one measurer across the pseudo x-ray and scout images.



Frontal Sinus Dimensions

1. Maximum sinus breadth
2. Right lateral edge to highest peak breadth
3. Left lateral edge to highest peak breadth
4. Interpeak breadth
5. Right breadth (lateral edge to septum)
6. Left breadth (lateral edge to septum)
7. Right height (vertical peak)
8. Left height (vertical peak)
9. Maximum height (not pictured)

Figure 2. Frontal sinus measurements obtained in this study; FSR, frontal sinus right, FSL, frontal sinus left, SOB, supraorbital line.

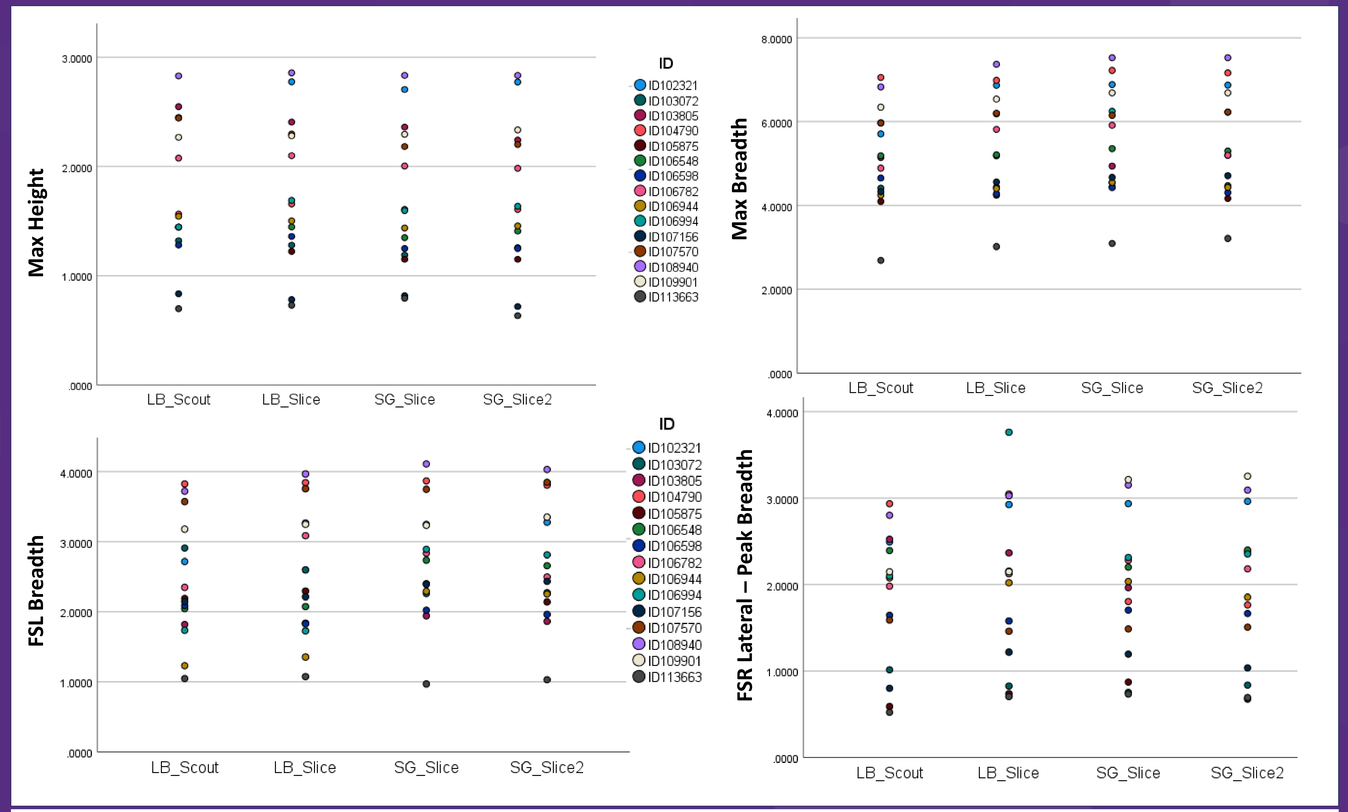


Figure 3. Scatter plots of sinus data for selected sinus dimensions (see Figure 2) across the observers (LB, SG) and image modalities (Scout radiographs and Slice, Slicer generated pseudo x-rays).

Results

Intraobserver error: paired t-tests indicate all p-values between compared measurements were >0.05, meaning there were no significant differences in intraobserver error.

Interobserver error: paired t-tests indicate significant differences in several measures: FSRL max breadth (p=0.10) and FSL lateral peak distance (0.040).

Intermodality error: paired t-tests indicate significant differences in several measures, similar to interobserver error: FSRL max breadth (p=0.023) and FSR breadth (p<0.001). respectively. It is likely that the error in FSRL max breadth is related to the error in the FSR breadth measurements, similar to the interobserver error.

Scatter plots in **Figure 3** illustrate these varying observer data in selected measures.

Conclusions

When comparing each measurement, the differences seem to come from one or two outlier individuals. An outlier can be seen in scatterplot in individual **ID 102321** (light blue dot) in the scatter plots of FSRL max breadth and FSL breadth, as well as individual **ID108940** (purple dot) in the scatter plots (**Fig 3**). All other measurements had no statistically significant error, and therefore can be assumed to be reliable between imaging modalities. Potential reasons for the disparities include difficulty seeing lateral edges of the sinus, due to varying translucency of the sinus cavity, or the precise angle of the skull at the time of measurement.

Overall, the ability to use *3DSlicer* and *ImageJ* to take these measurements is mostly reliable and could potentially be a good free tool for researchers to take these measurements. It was not difficult to use once getting oriented, and it is a freely accessible tool. However, more research is required before initiating this as a common practice. There is a margin of error that could potentially be problematic for current post-mortem identification and pose risk of making an incorrect identification or to incorrectly exclude a correct identification.

References

1. Edgar, H. J. H., Daneshvari Berry, S., Moes, E., Adolphi, N. L., Bridges, P., Nolte, K. B. (2020). New Mexico Decedent Image Database. Office of the Medical Investigator, University of New Mexico.

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