Journal of Forensic Radiology and Imaging 6 (2016) 8–13

Contents lists available at ScienceDirect

Journal of Forensic Radiology and Imaging

journal homepage: www.elsevier.com/locate/jofri

"Assessment of frontal sinus dimensions using CBCT to determine sexual dimorphism amongst Egyptian population"

Shimaa M. Motawei [a,*,1], Bassem A. Wahba [b], Wael M. Aboelmaaty [c], Eyad M. Tolba [d,e]

[a] Lecturer of Forensic Medicine & Clinical Toxicology, Faculty of Medicine, Mansoura University, Egypt
[b] Lecturer of Oto-Rhino-Laryngology - Head and Neck Surgery, Faculty of Medicine, Mansoura University, Egypt
[c] Assistant Professor of Oral and Maxillofacial Radiology, Faculty of Dentistry, Mansoura University, Egypt
[d] Lecturer of Anatomy, Faculty of Medicine, Mansoura University, Egypt
[e] Lecturer of Anatomy, Faculty of medicine, Taibah University, KSA, Saudi Arabia

ARTICLE INFO

Article history:
Received 16 May 2016
Received in revised form
26 July 2016
Accepted 27 July 2016
Available online 28 July 2016

Keywords:
Frontal sinus
Measurements
Cone beam CT
Egyptian population
Personal identification

ABSTRACT

Background: Personal identification remains a major task of forensic practice. A rapid and reliable method in this respect will be very helpful.
Aim: To test frontal sinus as a system for personal identification using cone beam computerized tomography.
Subjects and methods: The authors examined cone beam CT scans of skulls of 53 subjects (29 male and 24 female) of age range 20–58 years, who had neither apparent sinonasal pathology nor history of head trauma. The simple features of frontal sinus were recorded. Selected measurements for the right and left areas of the sinus were recorded. All the features and measurements were coded by the authors for each case, then compared and statistically analyzed.
Results: No two persons had the same frontal sinus measurements. Frontal sinus shape, size and measurements were unique for every individual. Significant differences between males and females in frontal sinus measurements were demonstrated. Frontal sinus gave accuracy of 76.7% to inform about gender.
Conclusion: Frontal sinus examination is a valuable tool for personal identification and gender differentiation, Cone beam CT examination in addition to being a safe procedure with minimal radiation exposure, proved to be highly accurate in sinus imaging and provide valuable and precise information about frontal sinus and the whole skull.
Limitations: Frontal sinus identification requires comparison with previous antemortem image which is not routinely done in many countries.

1. Introduction

Frontal sinus pattern is known to be unique for each individual. No two individuals, including twins, exhibit the same frontal sinus pattern. However, utilization of frontal sinus as a system for personal identification is still deficient [1].

The frontal sinus is a paired, irregularly-shaped pneumatized cavity located in the frontal bone deep to the super-ciliary arch. It develops by the fourth month of fetal life and appears by the age of 2 years and is visible on x-ray around the age of 5 years [2].

The growth of frontal sinus is slow in childhood until puberty; it grows rapidly until the age of 20 years when its growth is completed. Changes in the adult sinuses are rare and the sinus remains stable throughout life. Only further enlargement of the frontal sinus occurs due to bone resorption during extreme advancement of age. That is why the age of which the antemortem radiograph is taken does not matter after the age of 20 years [3].

Usually frontal sinus parts of the right and left sides are not equal. During the development of the sinus there is unequal reabsorption of the diploe. On the other hand, presence of more than two frontal sinuses is uncommon [4].

Human identification based on examination of osteological structures has been commonly used particularly for bodies that are highly decomposed, burned or disfigured. Sella turcica, mastoid air cells and para-nasal sinuses particularly the frontal sinuses have been utilized for this purpose due to its irregular shape and unique measurements for every individual just like finger prints [5].

Cone beam CT (CBCT) is a medical imaging technique consisting of X-ray computed tomography where the X-rays are divergent,

* Corresponding author.
E-mail addresses: Shimaa_motawei@yahoo.com, sh-mm@mans.edu.eg (S.M. Motawei).
[1] Postal address: Department of Forensic Medicine & Clinical Toxicology, Faculty of Medicine, Mansoura University, El-gomhoria street- Mansoura City, P.O: 35516, Egypt.

http://dx.doi.org/10.1016/j.jofri.2016.07.001
2212-4780/

forming a cone and owning many advantages if compared with conventional CT [6]. CBCT is well suitable for the craniofacial area investigation delivers clear images of highly contrasted structures and useful for evaluating bone. The use of CBCT technology in clinical practice provides many advantages for maxillofacial imaging compared with conventional CT. published reports indicate that the effective dose of radiation is significantly reduced by up to 98% compared with conventional CT [6,7].

The need to establish a reliable, accurate and easily reproducible method for human identification prompted the elaboration of technical, precise and accessible parameters, such as the evaluation of the area, asymmetry, and shape of the frontal sinus. Observations had revealed that no two frontal sinuses are the same, that is, the sinus is unique for each individual [3].

2. Aim of the work

This study aimed at testing the CBCT pattern of frontal sinus as a tool for personal identification in a sample of Egyptian population.

3. Subjects and methods

This study was based on reviewing frontal sinus CBCT scans at (axial and coronal planes) for 53 cases (29 male and 24 female) of age range 20–58 years (average 32.35 ± 10.82 years) who had CBCT for various reasons. For example, patients who had chronic headache and are refereed by the Ear, Nose and Throat (ENT) surgeon to do CBCT to investigate the cause for their headache. Of those patients, the ones who shown nasal sinus disease, mucosal thickening or masses were excluded from the study. The CBCT films of patients who shown completely free nasal sinuses (i.e. the physician should search for another cause of headache rather than nasal sinus disease or abnormality), were included in the study. Subjects of the study were selected carefully during the duration from May 2015 till November 2015. Cases with history of orthodontic treatment, orthognathic surgery, head trauma or surgery, systemic disease or hereditary facial asymmetry were excluded from the study. Also, clinical examination was done to exclude sinus disease or abnormality in any of the subjects included in the study.

After patient consent, careful history taking and medical examination, CBCT was done for the selected subjects. One volume of CBCT was done. The scan films were taken by the same radiologist to overcome any technical error. The device used in this study was iCat Next Generation, Imaging Science International, Hatfield, PA, USA. The imaging protocol used was 16 cm diameter $\times$ 13 cm height (Field of view), 0.25 mm voxel size, with scanning time of 14.7 s. The image analysis is done with Anatomage *In vivo* 5.1 software.

The frontal sinus was examined for its presence or absence, scalloping and presence or absence of sinus septum. In addition, the following measurements in millimeter (mm) were done: sinus width, height, antero-posterior length, total width of two sinuses, the distance between the highest points of the two sinuses and the distance of each sinus to its maximum lateral limit. Measures were done using the maximal distance between the highest points (Fig. 1).

Data were tabulated, coded then analyzed using the computer program SPSS version 17.0. Comparison of values was done using

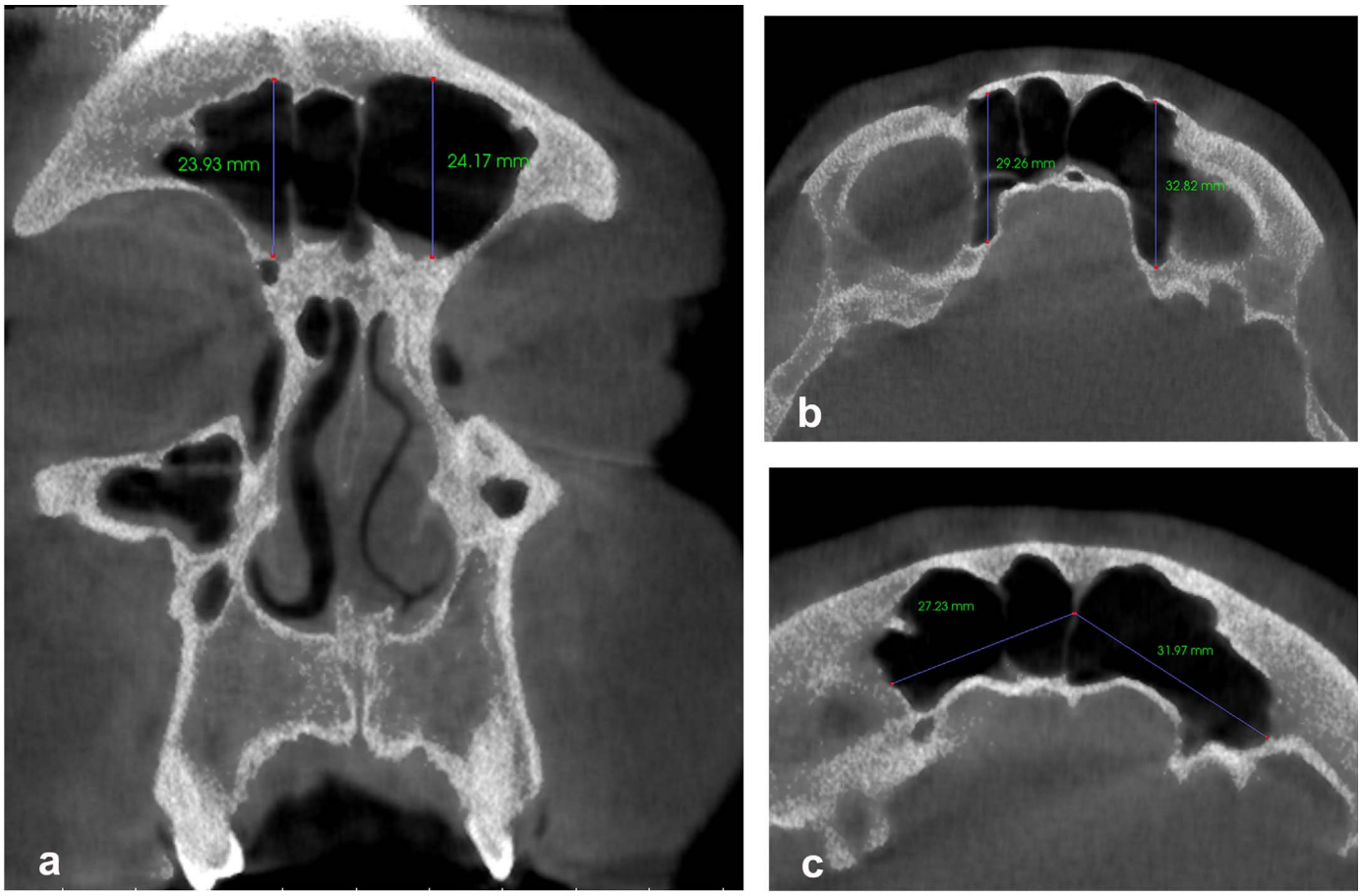

Fig. 1. Different Frontal sinus measurements on coronal (a) and axial CBCT slices (b, c) demonstrating sinus Height (a), Antero-posterior Depth (b) and Width (c).