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Human identification study by means of frontal sinus imaginological aspects

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ABSTRACT

The objective of this study was to evaluate the applicability of human identification parameters, established by Tatlisumak et al. (2007), by means of cone-beam computed tomography and extraoral radiographs of the frontal sinus region. From a total of 58 dry skulls, 26 were selected. Posteroanterior, profile cephalometric radiographs and cone-beam computed tomography images were acquired, adopting a specific method for reproducibility purposes. The images were evaluated by two examiners, previously calibrated, in a darkened environment and at two distinct sessions, with a minimum of 15 days between them. The characteristics of the frontal sinus were analyzed using the Cohen's kappa test, for categorical variables, and Lin's concordance correlation coefficient (CCC) for continuous variables. Acceptable values of inter method variability for the categorical variables were found, while same cannot be told for continuous variables. The parameters evaluated for the frontal sinus on extraoral radiographs and cone-beam computed tomographs were mostly concordant, with the exception of three. Categorical and discrete variables showed an intra- and interexaminer concordance ranging from good to perfect, and the quantitative continuous variables showed concordance ranging from moderate to excellent. The parameters examined are applicable and reproducible using multiplanar reconstructions of cone-beam computed tomography and extraoral radiographs of the frontal sinus.

1. Introduction

Comparison of ante mortem and post mortem radiographic and computed tomography (CT) images have attained acceptance for the identification of unknown dead bodies [1,2]. Radiographic comparison is a scientifically secure identification method and useful in cases where the bodies are in various stages of decay, skeletization, or carbonization, or when limited remains are available. In those situations, conventional identification methods cannot be applied; thus, comparison of radiographic images and CT scans ante mortem and post mortem are a viable option [1,3], given the appropriate technical conditions [4].

The sinuses are pneumatic cavities existing in some skull bones, which relate directly to the nasal cavity. The nomenclature for these anatomic landmarks is given according to the bones in which they are located [5]. These structures are one of the most interesting parts of the human body due to the morphological diversity presented [5]. Like fingerprints, the frontal sinuses are so different and unique that the chance of two people having the same morphology is extremely rare [6].

The use of dental radiographs to provide human identification is quite common [7]. Intraoral and panoramic radiographs are commonly used for this purpose [8–10]. CT is the recommended for the study of the intrinsic morphology of the paranasal sinuses. CT images provide a higher resolution without overlapping elements, allowing a three-dimensional scan of these structures [11]. Furthermore, it allows precise measurements that cannot be obtained with other methods [12].

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Cone-beam computed tomography (CBCT) uses relative low-cost equipment with lower doses of radiation compared with multislice CT acquisitions. Coupled with the quality and fidelity of its images, CBCT has an important position in diagnostic imaging in all specialties of dentistry [13]. Beyond the limitations imposed by extraoral radiographs, such as two-dimensional images, the quality of which still depends on the technique and equipment used, CBCT programs provides views of axial, coronal, sagittal, and oblique image reconstructions, as well as three-dimensional reconstruction [14].

Several studies have evaluated the sinuses with the objective of human identification [2,12,15–18] by means of extraoral radiographs [2,16,19] or conventional CT multiplanar [12,16,18] or tridimensional [15,17] reconstructions. However, there are no researches using multiplanar reconstructions of CBCT for the same purpose or comparing different imaging modalities.

Some methods have been proposed for human identification by means of frontal sinus imaginological aspects [16,20–23]. Among those, the method proposed by Tatlisumak et al. [17] stands out. Tatlisumak et al. [17] defined a simple identification system for humans using tridimensional multislice CT reconstructions of the frontal sinus and found improved identification by adding measurements to it. The FSS system evaluates basic features such as the presence or absence of the sinus (F), intrasinus and intersinus septa (S), and scalloping (S). However, access to multislice CT images is more difficult because of the dose of ionizing radiation and the cost of the examination.

Therefore, the aim of this study was to evaluate the applicability of Tatlisumak et al.'s (2007) method in frontal sinus extraoral radiographic images as well as multiplanar CBCT reconstructions, since there is a better chance of an individual undergoing extraoral radiography and CBCT.

2. Methods

Ethical approval for the present study was obtained from the Ethics Committee in Research with human beings at the Lauro Wanderley Hospital, João Pessoa, PB, Brazil (protocol number 640/2010).

The sample consisted of 58 disjointed dry skulls from which 26 with frontal sinuses within the aspects of normality were selected. The skulls were provided by the Legal Medicine Management of Paraíba (*Gerência de medicina legal da Paraíba, GEMOL-PB*) with no information regarding sex or age at death. Skulls with any evidence of fractures or perforations that would compromise the imaginological assessment of the frontal sinuses were excluded from the final sample.

After selection, the skulls were subjected to posteroanterior and profile cephalometric radiographic examinations and CBCT scans. Because radiographic and tomographic techniques are operator-dependent tests, all imaging examinations were performed by the same operator in order to ensure the reproducibility of the study.

2.1. Acquisition of the radiographic images

Posteroanterior and profile cephalometric radiographs were performed using a panoramic X-ray machine Rotograph Plus (Dabi Atlante, Ribeirão Preto, SP, Brazil) and T-Mat Kodak films (size 24 cm × 30 cm). The cephalostat was used to position the skulls at a 1.52 m focus-film distance. Four occlusal lead plates were positioned in the initial path of the primary X-ray beam in order to avoid complete opacification of the film. Plumber letters were placed in the top right corner of the chassis in order to identify the skulls. 85 kVp and 15 mA with 0.4 s of time exposure was used for the posteroanterior technique and 85 kVp, 15 mA with 0.36 s of time exposure for the cephalometric profile were used as exposure parameters. After exposure, the films were processed using the manual time–temperature method.

2.2. Acquisition of the tomographic images

CBCT reconstructions were obtained using an i-CAT Next Generation (Imaging Sciences International, Pennsylvania, USA). The skulls were placed in the machine on top of an acrylic platform at the proper height for this examination. They were also placed inside a polyvinyl chloride container and submerged in distilled water for soft tissue simulation [24–26]. The images were acquired using a medium size FOV (field of view) – enough to contain the maxillary sinus region – with the following exposure parameters: 120 kVp, 5 mA, and 0.25-mm voxels.

In some cases, foam was required to prevent the skull from floating in the distilled water. After scanning, the images were saved and exported in Xoran format for further evaluation. All images were evaluated by two calibrated examiners.

2.3. Calibration

20 radiographic images, 10 of each radiographic technique (posteroanterior and cephalometric profile) and 10 tomographic images were assessed. All the images used for the calibration came from the database of a private Dental Radiology service. The calibration lasted 2 weeks and to ensure the reproducibility of the study, intra- and interexaminer agreement was assessed using Cohen's kappa test for categorical and discrete variables, and Lin's concordance correlation coefficient (CCC) for continuous variables. A 5% level of significance was adopted.

2.4. Images for evaluation

The two examiners assessed the images at two different times with week minimum time interval between evaluations. Assessments took place in a darkened environment with the aid of a 23 in. LED monitor for the CBCT images and 600 lux light box with mask for the radiographic images. In order to avoid eyestrain, only 10 images/day were assessed.

2.5. Radiographic evaluation

With the film on the light box, the left and right frontal sinuses were outlined using Ultrafan paper and a pencil with a 0.5-mm diameter tip, overlapping the radiograph. Then, a morphological and dimensional assessment of the frontal sinus took place.

To obtain linear measurements, a digital caliper Mitutoyo series 167 (Mitutoyo, Suzano, Brazil), designed with a maximum range of 300 mm and 0.3-mm-thick long position, was used.

The radiographs were evaluated by adapting the methodology of Tatlisumak et al. [17], which advocates the use of the FSS system and some measurements. This system enabled us to evaluate the following morphological characteristics: presence or absence of frontal sinus (F), septa (S) and scalloping (S).

The following anatomic structures were observed and cataloged: the presence of the right frontal sinus; the presence of the left frontal sinus; the presence of the central frontal sinus; the presence of intersinus septum; the type of intersinus septum, complete or incomplete; the type of deviation within the cross-septum, to the right side, to the left side, or the absence of deviation; the number of incomplete intrasepta within the right sinus; the number of incomplete intrasepta within the left sinus; the number of full intrasepta within the right sinus; the number of full intrasepta within the left sinus; the number of scalloping on the right sinus; the number of scalloping on the left sinus.