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ORIGINAL ARTICLE

Contribution of the computed tomography of the anatomical aspects of the sphenoid sinuses to forensic identification

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Sphenoid sinus;
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Summary
Introduction: Body identification is the cornerstone of forensic investigation. It can be performed using radiographic techniques, if antemortem images are available. This study was designed to assess the value of visual comparison of the computed tomography (CT) anatomical aspects of the sphenoid sinuses, in forensic individual identification, especially if antemortem dental records, fingerprints or DNA samples are not available.
Material and methods: This retrospective work took place in a French university hospital. The supervisor of this study randomly selected from the picture archiving and communication system (PACS), 58 patients who underwent one (16 patients) or two (42 patients) head CT in various neurological contexts. To avoid bias, those studies were prepared (anonymized, and all the head structures but the sphenoid sinuses were excluded), and used to constitute two working lists of 50 (42 + 8) CT studies of the sphenoid sinuses. An anatomical classification system of the sphenoid sinuses anatomical variations was created based on the anatomical and surgical literature. In these two working lists, three blinded readers had to identify, using the anatomical system and subjective visual comparison, 42 pairs of matched studies, and 16 unmatched studies. Readers were blinded from the exact numbers of matching studies.
Results: Each reader correctly identified the 42 pairs of CT with a concordance of 100% [97.5% confidence interval: 91—100%], and the 16 unmatched CT with a concordance of 100% [97.5% confidence interval: 79—100%]. Overall accuracy was 100%.

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Conclusion: Our study shows that establishing the anatomical concordance of the sphenoid sinuses by visual comparison could be used in personal identification. This easy method, based on a frequently and increasingly prescribed exam, still needs to be assessed on a postmortem cohort.

Introduction

Identification of a body is the cornerstone of forensic investigation. If primary methods of identification [1] are impossible (absence of comparative DNA samples, fingerprints, and teeth records [2,3]), it can be performed using radiographic techniques, whenever antemortem images are available. Visual comparison of antemortem and postmortem images, such as dental computed tomographies (CT) [4], frontal sinuses radiographies and CTs [5], can allow identification, if concordance of specific anatomical findings is established. If antemortem radiologic images are missing, the sex and/or the age of the corpse can be assessed using X-ray imaging of skull or postcranial elements [6—9].

Severely damaged bodies can be difficult to identify, and various factors can delay the identification [10,11]. In violent traumatic contexts, teeth and frontal sinuses can be missing, or separated into small pieces from the rest of the body, which limits their contribution to identification.

Sphenoid sinuses, on the other hand, are better protected from traumatic degradation. They appear in the third year of life, contrary to frontal sinuses, which are not aerated before the age of 6 years [12,13]. As they are deeply positioned in the center of the cranial base [14] they are well protected from degradation resulting from external causes. Their pneumatization, well documented as extremely variable in degrees and directions [15—18], could contribute to the radiologic identification of a dead person [19].

CT is today the reference imaging modality to study the paranasal sinuses, and the appropriate technique to investigate a large panel of neurological conditions: it is frequently and increasingly prescribed in developed countries. Unlike conventional radiography, CT allows an excellent visualization of the anatomical features of the sphenoid sinuses.

Sphenoid sinuses are therefore well protected, anatomically variable, and perfectly examinable on any head CTs. Their possible contribution to identification was reported [20], but to our knowledge, the accuracy of their forensic use has not yet been assessed.

The aim of this study was to assess the value of visual comparison of the CT anatomical aspects of the sphenoid sinuses, in individual identification.

Material and methods

The local ethics committee gave its approval to this study.

Population

This monocentric retrospective study was conducted between June 2012 and January 2013, in a university hospital, on 58 randomly selected patients. The first group consisted in 42 patients who underwent two medically justified, unenhanced head CT, in various neurological circumstances, at two different times. The second group included 16 patients who underwent only one head CT. The mean time between the two different CTs of the first group of patients was 130 days (range: 3—1325). This cohort was extracted from our hospital's Picture Archiving and Communication System (PACS).

One actor played the role of supervisor (European Diploma in Radiology issued by the European Board of Radiology, Doctor of Medicine, 7 years experience) of the study, and did not participate in the identification process. Each CT was anonymized by hiding the Dicom fields (Function Anonymize, Advantage Windows 4.2 General Electrics Healthcare, Barrington, USA), and a number was assigned to each anonymous CT.

For each of the 42 patients of the first group, one of the two head CTs was randomly selected by the supervisor. In the second group, eight CTs were also randomly selected. From these first 50 randomly selected CTs (21 males, 29 females, average age: 77 years, age range: 16—91), a first working list was created with each CT assigned a number from 1 to 50.

The 50 remaining anonymous CTs (42 from the first group, 8 from the second group) constituted the second working list, assigned numbers from 51 to 100.

Random selection was performed using the Hat program (Harmony Hollow Software, Covington, Louisiana, USA).

These two CT working lists were created on two contiguous interpretation consoles (Advantage Windows 4.2 General Electrics Healthcare, Barrington, USA) (Fig. 1).

Readers were blinded from the number of existing matches between the two work lists.

Exclusion criteria

Patients with head fractures, tumors, or any pathological process involving the sphenoid bone and the other surrounding cranial base bones, but also with sinuses mucosa thickening, or any abnormality of the sinuses contents, were not included in the study, as well as patients with metallic material (aneurysm clips or coils).

Imaging protocols and reconstruction

Head CT were performed on a helical, multi-detector CT scanner (Somatom Definition AS (64 slices), Siemens, Forchheim, Medical Solutions, Germany): raw data acquisition at 120 kV, 370 mAs, using a care-dose, 1 mm collimation. CT image reconstruction was performed with a slice thickness