



## Review article

## Forensic application of the frontal and maxillary sinuses: A literature review



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## ABSTRACT

This study aimed to point out the contribution of the frontal and maxillary sinuses for Forensic Sciences, specifically in Forensic Dentistry. For this, a review was performed with 30 articles comprised in the period 2003–2014, about the application of the frontal and maxillary sinuses for human identification and sex determination, using the search words: Frontal Sinus, Maxillary Sinus, Human Identification, and Sex Differences. It was observed that the frontal and maxillary sinuses are useful for human identification. In relation to sex determination, there is no agreement about the applicability of the frontal sinus, although authors suggest that further studies should be performed to verify if it can be employed as an auxiliary method; but regarding the analysis of the maxillary sinus, this has shown satisfactory results. Thus, it is possible to conclude that the frontal and maxillary sinuses provide important information to the forensic context in cases involving human identification and, in the case of the maxillary sinus, allow the sex determination.

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## Contents

1. Introduction	105
2. Material and methods	109
3. Results	109
4. Discussion	109
5. Conclusions	109
References	110

## 1. Introduction

The identification is a systematic and organized process, which primary function is to establish the identity. For this purpose, various methods have been applied [1,2]. In the Forensic Sciences, different methods have been developed for human identification based on comparisons between *ante* and *post mortem* data [1,3].

The fingerprint is an accurate identifying method, widely applied; however, in some cases, the collection becomes difficult or even impossible, such as in decomposed, fragmented or charred corpses [1,3–7]. Regarding DNA, although their techniques are

accurate and propitiate reliable results, the method is time consuming and requires laboratory infrastructure, besides being impossible if the remains are badly degraded or exposed to environmental conditions [2,6–8].

In cases where these traditional methods are unfeasible, there is the study of anthropometric characteristics, as a secondary method in human identification, and, this method is reliable and essential to guide the identification procedure [8,9] and still gains importance when combined with Forensic Dentistry [1,3,5,7,8,10,11], can avail of information able to set the identity [7,8,12–14] from comparative analysis of anatomical variations [1,6,13,15].

An example of this analysis is the identification using the frontal and maxillary sinuses. The frontal sinus has become quite solidly in the literature as a safe method [1,4,8,12,16] for comparative radiographic studies to get the identification [1,2,4,8,12,14,16–22]. Regarding the use of the maxillary sinus, their characteristics

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**Table 1**  
Papers about human identification and sex determination through the frontal and maxillary sinuses.

Authors	Year	Article Type	Examined Cases	Modality Used	Anatomical Region	Analyzed Implication	Results	Conclusions
Taniguchi et al. [17]	2003	Research	24	Radiograph	Frontal sinus	Human identification	Comparison of the ante and postmortem films ( $n=24$ ) gave an identical result in about 75%.	Frontal sinus radiographic patterns are useful for human identification.
Christensen [26]	2005	Research	808	Radiograph	Frontal sinus	Human identification	Results show that Euclidean distances between outlines of different individuals are significantly larger than those between replicates of the same individual, and typicalities show that the probability of finding two different individuals with Euclidean distances less than that between a particular case's replicate is very small.	The differences between the frontal sinuses are significant and measurable between individuals.
Camargo et al. [28]	2007	Research	100	Radiograph	Frontal sinus	Sex determination	The mean values of the frontal sinus were greater in males and the left area was larger than the right area, based on Student's <i>t</i> -test at the 5% level of significance. The mathematical model based on logistic regression analysis gave a concordance index for gender of 79.7% in the cases studied.	The frontal sinus analysis may be useful in sex determination.
Iordan and Ulmeanu [29]	2008	Review	–	Radiograph	Frontal sinus	Human identification	Paranasal sinuses can be explored by different methods, but the most accessible and easy to perform is conventional radiological imaging.	Radiographs can be evaluated to establish the individuality are frontal sinus.
Falguera [4]	2008	Research	90	Radiograph	Frontal sinus	Human identification	The method based on Image-Foresting Transform has shown itself efficient in frontal sinus segmentation from radiograph images. Techniques for extracting frontal sinus geometrical and shape-based descriptors were investigated and implemented as well.	Individuality, accuracy and usability of the frontal sinus for human identification.
Soriano et al. [1]	2008	Review	–	Radiograph	Frontal sinus	Human identification	It was observed that many are the possibilities of radiographic techniques that can be used in order to identify anatomical characteristics, especially of paranasal sinuses and its variants, or even artificial elements present in the analyzed bodies, such as dental restorations, endodontic treatments, implants and fixed or removable prostheses.	The frontal sinuses provide important contributions to the establishment of identity, as meeting the requirements of uniqueness, permanence and immutability.
Silva et al. [18]	2008	Case Report	1	Radiograph	Frontal sinus	Human identification	At work, it was possible to positively establish the identity of the skeletonized body as belonging to the missing victim.	Radiographs allow visualization of the frontal sinus morphology and the establishment of positive identity.
Silva et al. [19]	2009	Case Report	1	Radiograph	Frontal sinus	Human identification	A positive identification of a body by means of corresponding images X-rays before and postmortem.	The frontal sinus radiographs of comparison is a reliable method because of the uniqueness of the sinus in humans.
Tang et al. [20]	2009	Research	165	Radiograph	Frontal sinus	Human identification	The unilateral frontal sinus scalloped with one arcade has few parameters applied to personal identification, and shows the poorer discrimination power.	The frontal sinus can be applied to personal identification.
Silva et al. [8]	2009	Case Report	1	Radiograph	Frontal sinus	Human identification	Associating data anthropological research to those obtained by the frontal sinus analysis was possible to set the positive identification of the body examined.	With the frontal sinus analysis is possible to reach the positive identification.
Carvalho et al. [12]	2009	Review	–	Radiograph and computed tomography	Frontal sinus	Human identification	The analysis of ante-mortem and post-mortem radiographic and tomographic images has become an essential tool for human identification in forensic dentistry, particularly with the refinement of techniques resulting from developments in the field of the radiology itself as well as the incorporation of information technology resources to the technique.	The observation of the frontal sinus pattern is already a good established technique for personal identification.
Musse et al. [23]	2009	Research	328	Radiograph	Maxillary sinus	Human identification and sex determination	The average values were higher in males than in females.	The morphology and measurements of maxillary sinuses can be used for sex determination and human identification.
Besana and Rogers [16]	2010	Research	116	Radiograph	Frontal sinus	Human identification	The research finds that most sinus traits are dependent upon one another and thus cannot be used in probability	Only superimposition pattern matching is an effective method of

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