

CASE REPORT

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Identification of Human Remains by Comparison of Frontal Sinus Radiographs: A Series of Four Cases

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ABSTRACT: The value for identification purposes of the radiographic frontal sinus outline, which is unique to each individual and remains constant throughout that individual's lifetime, is discussed. A general discussion of identification using frontal sinus X-rays is presented, along with four cases.

KEYWORDS: odontology, X-ray analysis, human identification, sinuses, frontal sinuses, skull radiology

Identification of remains through the comparison of antemortem and postmortem dental records is a well-documented, accepted, and widely used procedure [1,2]. Less well known is the fact that the outline of the frontal sinuses seen in dental X-rays can be used in the identification of individuals, even if they are edentulous. It is the purpose of this paper to present a series of cases in which the identification of human remains was accomplished through comparison of frontal sinus outlines found in dental or skull X-rays.

Case Reports

Case 1

This male victim was burned beyond recognition in a hotel fire that claimed three lives. The postmortem dental examination revealed previous cleft palate surgery, gold thimbles on three remaining maxillary teeth, and evidence of mandibular orthognathic surgery. While no prostheses were found with the body, these findings implied an extensive dental

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history. The postmortem anteroposterior (A-P) projection skull radiograph showed some distortion, due to difficulty in positioning the body, but adequately illustrated the dental findings and the frontal sinus outlines (Fig. 1). A tentative identification existed, and a decision was made to use that name in a record search at a nearby medical center where cleft palate surgery was performed. This conversation was overheard by an alert X-ray technician, who checked local hospital files and found a posteroanterior (P-A) skull film taken two years previously during an emergency room visit by this individual (Fig. 2). The positive identification was made on the basis of frontal sinus outlines and dental restorations.

Case 2

The body of this victim was discovered after the local fire department extinguished an apartment fire. The nature of the fire and the condition of the body in this case caused authorities to suspect both murder and arson. A tentative identification existed, and using this information, recent skull films were located in a local hospital. A comparison of the hospital P-A skull film (Fig. 3) and the A-P view made at autopsy (Fig. 4) resulted in a positive identification of this victim based on frontal sinus outlines.

Case 3

The female victim in this case, which involved two murders, was discovered in a northern Indiana river five days after her disappearance. She was positively identified by dental means two days after discovery of the body, and the autopsy report cited several stab wounds of the chest as the cause of death. Her male associate had not been seen since the date of her disappearance and he was formally reported missing two days later. A nude male body was discovered ten days after the missing person report by a fisherman eight miles west of the site of discovery of the first body. The authorities felt that this

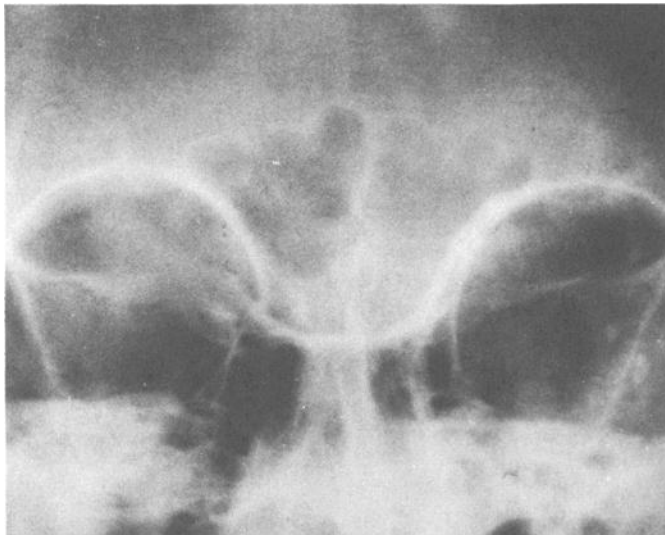


FIG. 1—*Case 1: hospital antemortem film made, at the time of an automobile accident, several months before the victim's death. The uneven arcades and complete extent of the frontal sinuses are well represented in this view.*

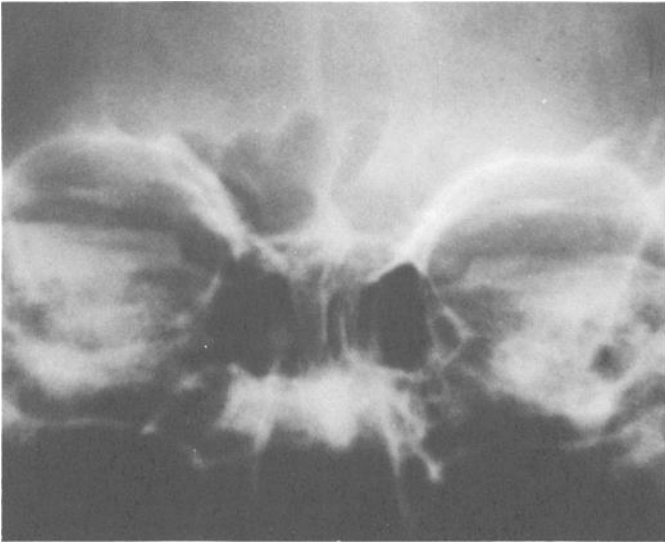


FIG. 2—Case 1: some foreshortening of the frontal sinuses is shown in this postmortem view; however, the outline of the arcades of the frontal sinus, as well as the slightly deviated central septum are easily seen.

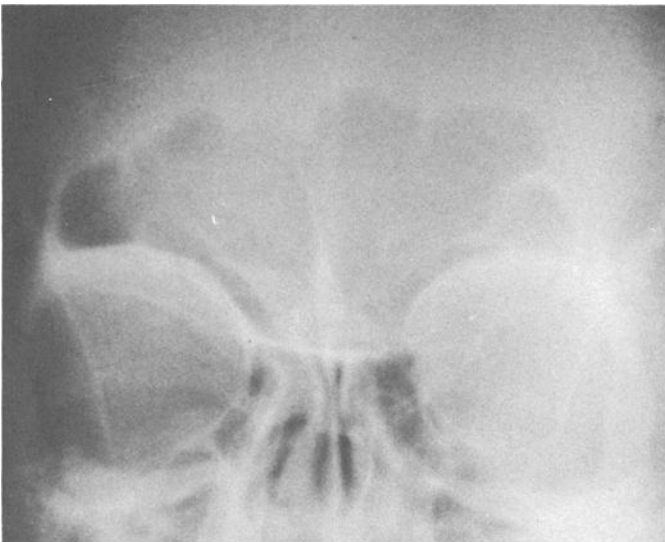


FIG. 3—Case 2: antemortem hospital film of the victim, showing frontal sinuses of considerable size.

body might be that of the missing male, but since it was late spring, the body was in a state of advanced decomposition. Public officials stated that visual identification “was not possible,” and that medical or dental identification procedures would be necessary. An autopsy determined that this victim had also died of multiple stab wounds of the chest. No antemortem records of the putative victim had been found two days later, and

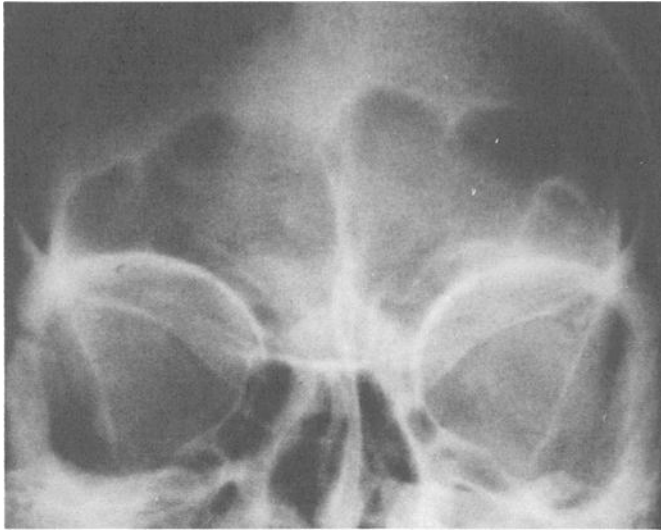


FIG. 4—Case 2: autopsy film revealing complete concordance of the sinus outlines and septae with those in the antemortem radiograph in Fig. 3.

military records were requested. Ten days after the discovery of the body, six-year-old skull films were located in a central Indiana city hospital (Fig. 5). Comparison of these skull films with the postmortem films (Fig. 6) resulted in a positive identification, based primarily on the highly characteristic outline of the frontal sinuses. Twenty days later, the estranged husband of the female victim confessed to both killings.

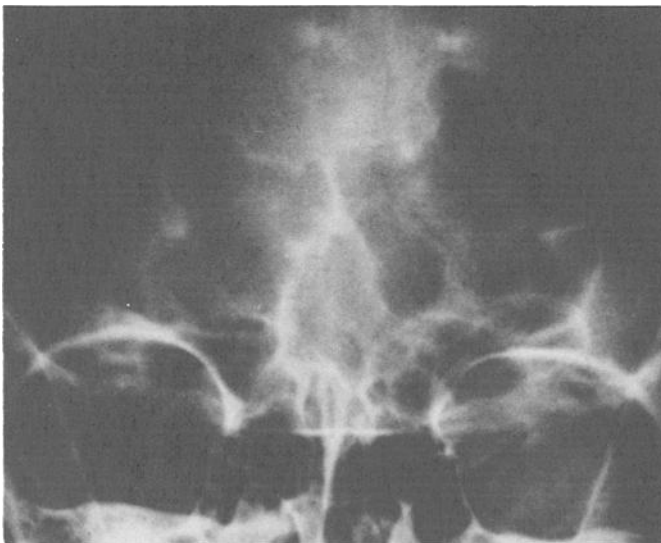


FIG. 5—Case 3: radiograph made six years before the victim's death, revealing highly characteristic (especially the left side) and extensive frontal sinuses.

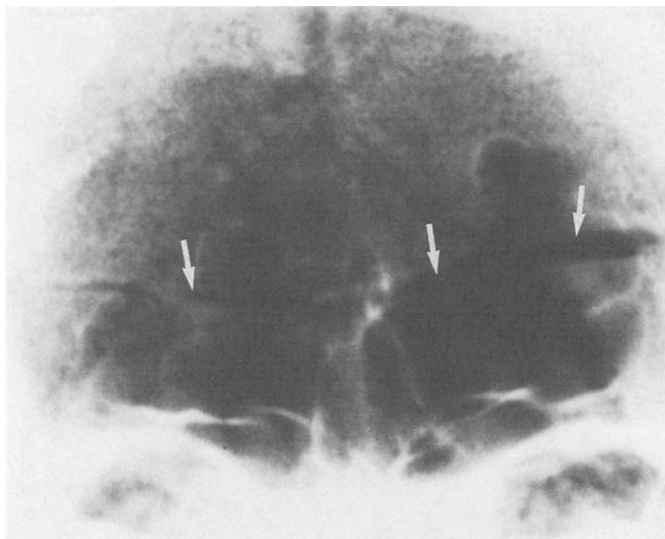


FIG. 6—Case 3: postmortem skull film in which the skull was not as precisely aligned as in the antemortem view, but which still shows outlines and a highly characteristic superior extension of the left sinus. In addition, autopsy saw cuts can be seen in this view (arrows). The heightened contrast seen in this film is due to the absence of soft tissue as a result of decomposition.

Case 4

These skeletonized remains were discovered several months after this individual had been reported missing from an extended care facility. Comparison of the skull film taken at the state hospital (Fig. 7), six years prior to his disappearance, and the autopsy skull film (Fig. 8) resulted in a positive identification.

Discussion

Radiology has played a significant role in medicolegal investigation and the identification of remains subsequent to Roentgen's first report of the effects of X-rays in 1896, but it was not until 1921 that Schuller [3] stated:

The details of form, size and field position (of the frontal sinuses) are evident on the X-rays and are consistent over time. Thus, the comparability of an earlier X-ray with a later one is of great importance to forensic medicine and anthropology. To our knowledge this has not been done before.

In his summary he cites the "specifically characteristic configurations" (of the frontal sinus on X-ray films) "for the absolute identification of skulls." His 1943 article refers to an earlier experiment in which it was proven that the frontal sinuses of 100 skulls showed individual differences [4]. In 1927, Culbert and Law [5] independently arrived at Schuller's earlier conclusions and applied them in a practical manner to a case involving a patient who died in India in 1925. It was known that the patient had undergone conservative mastoid surgery in 1922, and comparison of the patient's postmortem skull X-rays with antemortem records and radiographs revealed 20 points of concordance. Structures whose outlines contributed to this identification included the frontal and sphenoidal sinuses, crista galli, orbits, sella turcica, clinoid processes, and mastoid air cells [6].

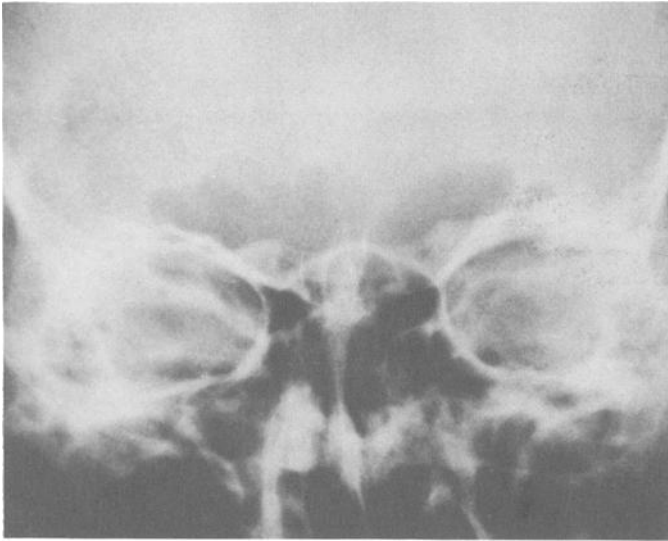


FIG. 7—Case 4: antemortem skull film showing frontal sinuses with little superior extension but several characteristic arcades across their superior aspect.

The use of frontal sinuses for identification again appeared in the literature as recently as 1978. Atkins and Potsaid report superimposing antemortem films of a missing person on postmortem radiographs of a body found in Boston harbor; the points of identity included the frontal sinuses [7].

The extent to which sinus configuration is actually employed in the identification of remains is unknown, but it appears that radiographs of the skull may be underutilized as a source of antemortem records. It is clear that a substantial number of such radiographs

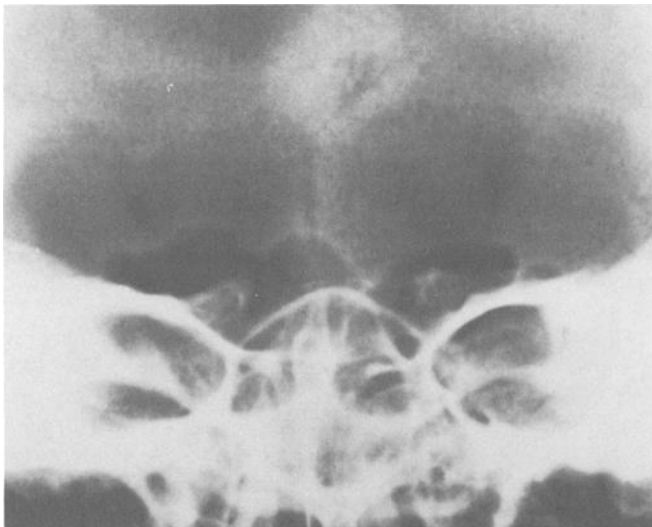


FIG. 8—Case 4: the postmortem skull film of the decomposed body, revealing well-delineated frontal sinuses of the same extent and outline as those shown in Fig. 7.

are available, as was shown by an informal survey of records from the radiology department of a small (154-bed) county hospital. It was found that about 2400 radiographic examinations were made each month for various reasons and that 1 in 25 antemortem films showed craniofacial structures of potential value in identification. While this may not seem to offer a high probability of success in a random search for useful antemortem records, the search at area hospitals becomes worthwhile when a putative identification exists and may produce results when other efforts to obtain antemortem records have failed.

The essence of identification is the comparison of antemortem and postmortem records, but collection of antemortem records can be very time-consuming. Families sometimes may not know the names of medical and dental practitioners visited by a decedent or even that they were receiving care. In recent deaths, postmortem records are assembled first, since the search for antemortem records may take days, weeks, or months. Inasmuch as the kinds of antemortem records that may eventually be discovered are unknown, the postmortem data collection must be comprehensive, and should include a complete autopsy, skull and dental radiographs, tooth charts (with detailed descriptions of prosthetic devices), and appropriate photographs. Postmortem skull films should be made prior to opening the head to avoid the possible superimposition of the autopsy saw cut on frontal sinus outlines.

Radiographs of the head are an important, and often overlooked, source of antemortem records. They become increasingly important if conventional antemortem dental records are unavailable. In general, radiographs provide an objective record of anatomical structures, as well as evidence of pathologic conditions, previous trauma, and surgery. Specifically, cranial and facial structures visible in the various types of extraoral radiographs commonly utilized today may provide numerous features for comparison with appropriate postmortem radiographs of these same structures. It is likewise clear that, while such radiographs can graphically depict structures which are often unique to the individual, their potential has not been fully explored.

Structural variations in the skull are well recognized by the forensic anthropologist, particularly for the determination of race and sex. Individual identification utilizing cranial/facial structures (other than the teeth and frontal sinuses) has received limited attention in the literature. Culbert and Law [5] in their 1927 case report cited irregularities in the sphenoid sinus outline, various contours of both orbits, an unusual air cell in the crista galli, and the shape of the posterior clinoid process as points of concordance, in addition to those listed in the mastoid air cells and frontal sinuses. In another case involving skull films, the diploic venous plexus and the course of the middle meningeal artery were found to be the same at ages 7 and 13 when growth was considered [8]. This author also analyzed three known cases at similar ages and found these vascular patterns to match in those cases as well. In addition to these various specific structures, the relationship, in terms of distance and orientation, of one normal anatomic entity to another is helpful in identification procedures.

Conclusions

In summary, four case reports have been presented to demonstrate the use of frontal sinus morphology in the identification of human remains. The authors emphasize that antemortem radiographs of the head are an important and often overlooked source of antemortem records which can frequently provide objective data useful for comparison.

Acknowledgments

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