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CASE REPORT

ANTHROPOLOGY

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Anthropological and Radiographic Comparison of Antemortem Surgical Records for Identification of Skeletal Remains*

ABSTRACT: This case review illustrates the important contributions of forensic archeological methods and forensic anthropological analysis to the identification of found skeletal remains. After reassociation of skeletal remains found in two locations, anthropological analysis provided the basis for a presumptive identification and a request for antemortem medical records. Partial DNA profiles were supportive but not conclusive and antemortem dental records were not available. Comparison of antemortem traumas, skeletal morphology, and surgical artifacts with antemortem radiographs and surgical records led to positive identification of an individual missing for almost a decade.

KEYWORDS: forensic science, forensic anthropology, radiographic comparison, personal identification, human remains, surgical artifacts

Examination and comparison of antemortem medical records with postmortem remains has long been an established and accepted basis of identification for forensic odontologists and, increasingly, forensic anthropologists. In many cases, radiographic comparison is utilized for a presumptive identification, which is often later verified with DNA testing (1). The case presented here is unique in that DNA comparison with presumptive family members provided inconclusive results, and antemortem dental records were not available. Anthropological examination of skeletal morphology and recovered artifacts, and comparison of such with antemortem medical records provided evidence upon which identification was partially based. In a field which relies increasingly on DNA for identification, it was the forensic anthropological analysis which had the greatest contribution to identification of found skeletal remains.

Case History

In late 2006, a cranium was discovered submerged in a semi-urban recreational lake. Several antemortem fractures crossed the craniofacial skeleton in a Le Fort II pattern and exhibited evidence of remodeling. A surgical trephination of the left parietal also showed signs of healing. Approximately 6 months later, the postcranial remains and associated personal effects of an unknown individual were discovered in a brushy, semi-urban setting *c.* 2 km from the lake. The postcranial remains exhibited a large number of antemortem rib fracture calluses and osteophytic growth in the intercostal spaces. Standard operating protocol necessitated the initial treatment of the remains as two distinct cases by the British Columbia Coroners Service (BCCS). BCCS requested analysis of the two sets of remains from the forensic anthropologists at the Centre for Forensic Research at Simon Fraser University to investigate the relationship between them and for identification. Agreement between biological profiles, morphological fit, and injury patterns supported the suspicion that the two sets of remains represented the same individual, who had likely suffered a single, traumatic event responsible for the constellation of antemortem injuries (2).

Both cranial and postcranial remains were consistent with a male individual. The cranial suture closure suggested an age range of 30–60 at the time of death, while fourth rib ends, pubic symphyses and auricular surfaces suggested an age of 45–60 years of age. The craniofacial morphology was consistent with European ancestry. Metric examination of the postcranial remains estimated the stature to be 5′7″ ± 2.5″. The severity of cranial and postcranial injuries, the obvious surgical trephination, and internal surgical hardware recovered from the soil matrix surrounding the postcranial skeleton suggested medical intervention for the injuries (2). The likelihood of antemortem medical records documenting the injuries provided the best hope for identification of the unknown remains, and this information was provided to BCCS and investigating police.

The biological profile and injury pattern matched the description of L.K., a 55-year-old male of European ancestry who was last seen in November 1998. Comparative DNA testing against L.K.'s mother yielded a partial profile which was supportive, yet inadequate for conclusive identification. The family subsequently allowed access to antemortem medical records for comparison. These medical records would prove invaluable in the identification process, and provided antemortem documentation of the injuries visible in the unidentified skeletal remains.

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Materials and Methods

Anthropological comparison of ante- and postmortem evidence was performed with the intention of identification. The materials under consideration included the skeletonized human remains, postmortem radiographs taken by the examining anthropologists, and several classes of associated artifacts recovered with the unidentified remains. The most important of these artifacts were a maxillary dental bridge and surgical hardware recovered from the soil matrix surrounding the remains. The antemortem records under consideration included thoracic and cranial radiographs, cranial CT scans, and the associated medical notes written by doctors and radiograph examiners during L.K.'s hospitalization.

Results

In December of 1998, 1 month after his last known appearance, L.K.'s wallet containing identification was found and given to local police. L.K. struggled with addiction, eventually leading to a mostly transient lifestyle. His family told police that on one occasion, L.K. had been severely beaten and left with extensive injuries. There are no police records of the event, and L.K. did not seek medical treatment for the injuries at that time. He was, however, admitted into hospital in early May 1998 after losing consciousness, presumably the result of complications caused by the personal attack. He was diagnosed with an intracranial hemotoma or hygroma (the records state both, written by different doctors), for which he was treated with surgical drilling of the left parietal and insertion of a peritoneal shunt, which is visible in the CT scans (Fig. 1). The cranium recovered from the lake had a surgical trephination on the left parietal posterior to the coronal suture, from which a small notch ran inferior-posteriorly. The location, size, and orientation of the trephination in the antemortem CT scans matched that of the surgical scar on the found cranium (Fig. 2).

During L.K.'s hospitalization, a pulmonary empyema was discovered on the left side of his chest, which had apparently been progressing untreated for some time. Osteophytic growth in the intercostal spaces between the mid-upper left ribs (Fig. 3) likely developed in response to this large infected cavity in the left lung (3–5). Of significant interest is the inability to see these osteophytes in either antemortem chest radiographs of L.K. or postmortem radiographs of the ribs taken during anthropological examination of the unidentified skeletal remains. According to his antemortem hospitalization records, L.K. was treated for his pulmonary empyema with a surgical lobectomy and wedge resection. Postoperative thoracic radiographs clearly show the presence of two surgical clips and several lines of internal surgical staples resulting from this surgery (Fig. 4). From the soil matrix surrounding the found skeletal remains the authors recovered one surgical clip and seven surgical staples which are consistent in size and shape to those seen in L.K.'s postoperative chest X-rays (Fig. 5). Several healed rib fractures of the lower left ribs are visible in anterior-posterior chest radiographs taken during L.K.'s hospitalization. These correspond in number and location to some of the many healed fractures of the unidentified skeletal remains (Fig. 6).

Additional artifacts recovered from the matrix surrounding the skeletal remains included a four-unit metal-ceramic fixed bridge replacing the upper left central and upper left lateral incisors. This is not only consistent with the dentition of the found cranium (2), but is also consistent with a maxillary bridge visible in antemortem cranial radiographs of L.K. Antemortem radiographs taken during

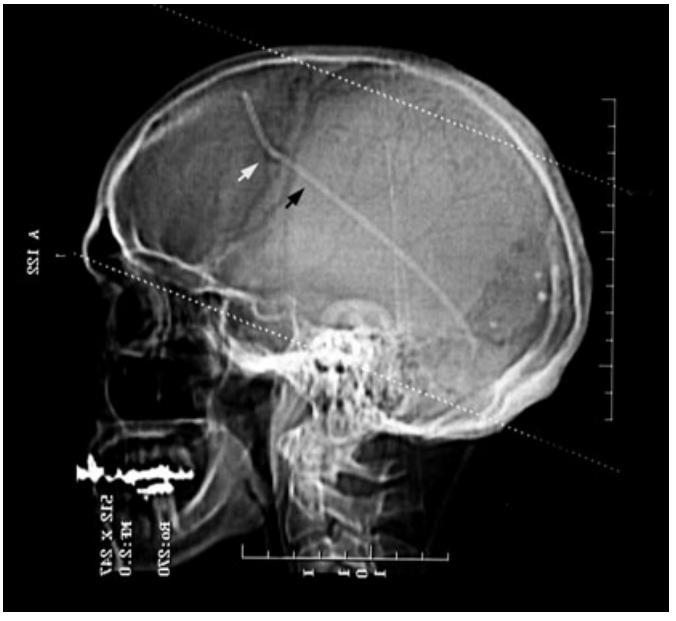

FIG. 1—*Antemortem CT scan of L.K.; white arrow indicates location of surgical trephination, black arrow indicates peritoneal drainage shunt exiting cranium inferior-posteriorly.*

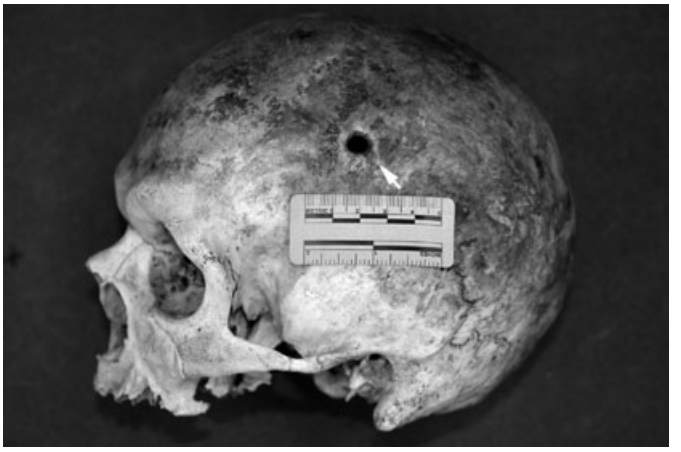

FIG. 2—*Found cranium, note location of surgical trephination; white arrow indicates location and orientation of shunt groove.*

FIG. 3—*Lower left ribs of unidentified skeletal remains. Note osteophytic growth unrelated to fractures. Scale at bottom margin is in centimeters.*

FIG. 4—*Close-up of antemortem thoracic radiograph of L.K. (anterior is to left); white arrow indicates surgical clip, black arrows indicate line of multiple internal surgical staples.*

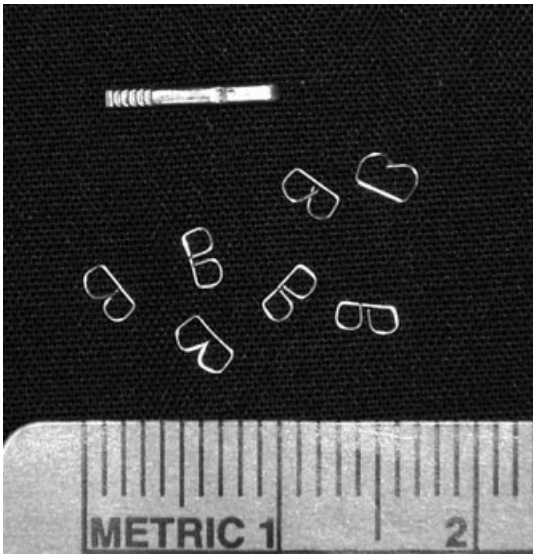

FIG. 5—*Surgical artifacts recovered from soil matrix surrounding found skeletal remains. Scale at bottom margin is in centimeters.*

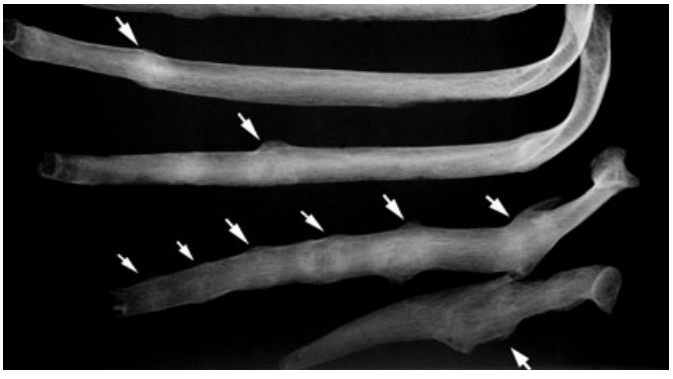

FIG. 6—*Lower left ribs of unidentified remains; white arrows indicate locations of healed rib fractures.*

hospitalization also reveal obvious anterior lipping on the centra of L.K.'s 5th and 6th cervical vertebrae. The unidentified male's cervical vertebrae show this anterior lipping quite clearly (Fig. 7).

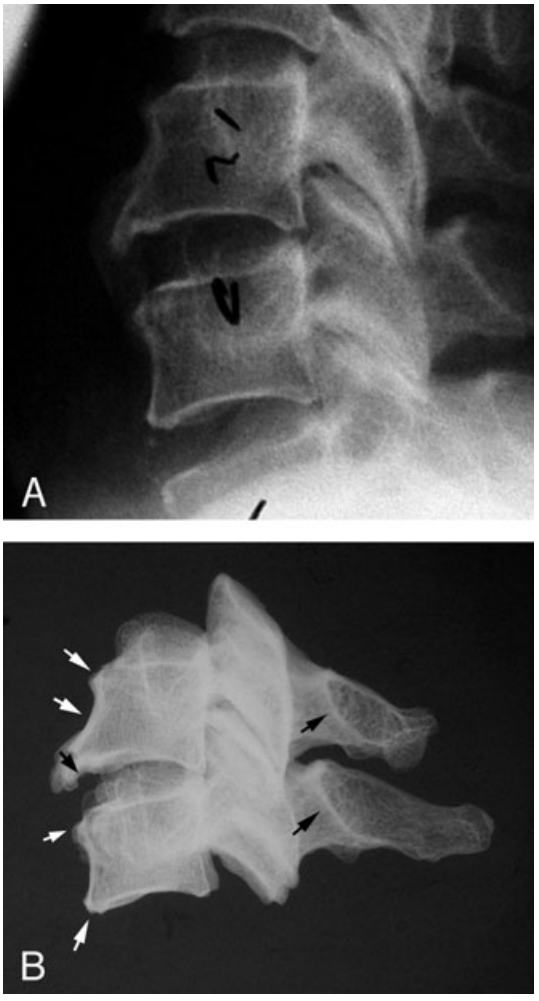

FIG. 7—*Comparison of antemortem and postmortem radiographs. (A) Antemortem radiograph of L.K.'s cervical vertebra (anterior is to left; black markings are result of hospital radiograph examiner). (B) Postmortem radiograph of cervical vertebrae 5 and 6 of the found skeletal remains (anterior is to left). White and black arrows indicate locations of morphological consistency between L.K. and the unidentified male.*

Discussion

There has been recent discussion of the propriety of using radiograph comparison for identification in forensic cases, especially in regards to proper orientation of the elements (6). One challenge faced by many examiners in these situations is the inconsistency of orientation between antemortem and postmortem radiographs (7). In the thoracic radiographs taken immediately after his admission to hospital, L.K. is seated, causing significant overlap of the lower ribs with the ilium and internal organs. This complicated visualization of the lower ribs, although the outline of ribs 10 and 11 are clear enough to discern the undulations of the multiple rib fractures (2). Similarly, the antemortem cervical spine radiographs were taken of L.K. with his head bent back, causing curvature of the cervical spine. While this prevented *perfect* agreement between the orientation of cervical vertebrae in the ante- and postmortem radiographs, the necessity of perfect orientation agreement has recently been questioned (1,7,8), and the analysts feel confident in the overall morphological agreement. Kuehn et al.'s (5) study on radiographic comparison for identification purposes suggests that the morphology of skeletal elements provides a much stronger basis for identification than pathology or diagnostic features, and

surprisingly, that forensic anthropologists may be better trained for this type of comparison than forensic pathologists.

There has been similar discussion in recent years regarding the use of degenerative and/or age-related morphological changes such as osteophytic lipping as a basis for identification (1,9). While it is clear these changes should not be relied upon heavily for identification if the antemortem records are several years old, L.K.'s radiographs were taken only 6 months prior to his disappearance and presumed time of death. We feel the interval is adequately conservative for the correspondence between ante- and postmortem radiographs to be relevant.

The recovery of surgical artifacts in this case offers a warning to forensic anthropologists and archeologists regarding on-site recovery of remains. The authors were not present at the recovery, but received the surrounding soil matrix along with the skeletal remains for examination. The eight surgical artifacts were recovered from the soil matrix *after* having been passed through a 1/8th inch screen. It was only during the course of discarding screened soil that a small surgical staple was noticed. The soil was then searched by hand after screening, leading to the recovery of seven more artifacts. It is therefore quite reasonable to conclude that the second clip and many more staples were present but eluded recovery. Although significantly fewer staples were recovered than are visible in the antemortem radiographs, the postmortem number does not exceed the antemortem number and therefore is not exclusionary. We wish to emphasize the serendipitous nature of the surgical artifact discovery, and extend a cautionary warning to forensic anthropologists in similar situations to not rely exclusively on what has heretofore been considered adequate screening methods for recovering cultural artifacts from soil matrix surrounding skeletal remains.

With the advancing methods and increased reliability of DNA comparison, many practitioners have begun to rely on DNA matches for identification. However, in many instances, comparative DNA is unavailable or the DNA in question fails to provide a full profile sufficient for positive identification (10). In this particular case, the coroner relied on a combination of anthropological morphological examination, consistency between antemortem radiographs and postmortem artifact recovery, and partial DNA profiles to conclude that the individual had been positively identified. While the DNA comparison between the unidentified individual and the presumptive mother supported the identification, it was the agreement with the constellation of consistencies found during anthropological examination and investigation upon which the coroner's determination of identification was heavily based.

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