CASE REPORT

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Radiographic Identification Using the Clavicle of an Individual Missing from the Vietnam Conflict

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ABSTRACT: A case is reported in which radiographic comparison of a clavicle was used to establish the identification of a civilian missing from the Vietnam conflict. While the use of radiographic comparison of skeletal features is not a newly developed technique for personal identification purposes, this case outlines a unique set of circumstances surrounding the disappearance of an individual during the Vietnam conflict and his eventual identification. A radiographic comparison of a right clavicle was critical in the identification process of this individual almost 34 years after he was reported missing. The use of digital technology for radiographic comparison greatly facilitated the process.

KEYWORDS: forensic science, radiographic (X-ray) comparison, clavicle, forensic anthropology, digital technology, Vietnam, CILHI

Radiographic comparison of antemortem and postmortem records is a well-established technique for forensic identification that has been utilized for decades (1). While forensic odontologists commonly employ radiographs of the dental structures to establish identity, in some situations antemortem dental records may not be available for comparison or the teeth may be missing postmortem from a set of remains. In these instances it may be possible for a forensic scientist to radiographically compare unique features of the skeleton for identification purposes. The human skeleton provides vast possibilities for radiographic comparison and any skeletal element could conceivably be utilized for identification purposes, provided the antemortem radiographs are available. This case presents a unique set of circumstances stemming from a helicopter crash during the Vietnam conflict. Based in part on radiographic evidence derived from an antemortem chest X-ray, an identification was eventually made nearly 34 years after the incident occurred.

Case History

On the afternoon of August 9, 1967, a single seat RF-101C aircraft collided with a U.S. Army UH-1B helicopter (Huey) in the Republic of Vietnam and both aircraft were destroyed. The RF-101C pilot ejected from his aircraft and sustained major injuries, but survived. At the time of the incident, it was believed that five individuals were on board the helicopter (four crew members and one passenger) and that all received fatal injuries. Shortly after the crash, five bodies were recovered from the crash site area and were taken to the U.S. Army Mortuary at Tan Son Nhut (Saigon). The four members of the helicopter flight crew were readily identified based on identification cards, identification tags, nametapes on their shirts, fingerprints, and dental records. The fifth individual (believed to be the passenger) was found wearing jungle fatigues that did not include a nametape, nor was there any associated identification media. Fingerprints were not obtainable from the fifth body and dental records were inconclusive; however, since there was only one individual unaccounted for from the flight manifest and biological characteristics (race, build, stature, and hair color) were consistent, the remains were presumptively identified as the passenger. The body was subsequently buried in Boston, MA, at the family's request.

Approximately four months after the crash, an American team passing through the Huey crash site discovered a sixth set of human remains. Found in association with the body were two identification ("dog") tags and an identification card belonging to the fifth individual who had already been identified and buried in Boston, MA. The remains of this sixth individual were sent to the U.S. Army Mortuary at Tan Son Nhut for analysis and identification. Based on the available evidence it was then clear that the crew and two passengers, one listed on the manifest and one unmanifested, had been aboard the aircraft at the time of the crash. It became critical to establish the identity of the newly discovered individual and determine if the previous identification was erroneous. By the time the Tan Son Nhut Mortuary was finally closed, this sixth set of remains was still unidentified and was transferred first to the U.S. Army Central Identification Laboratory, Thailand (CILTHAI), and eventually to the U.S. Central Identification Laboratory, Hawaii (CILHI) in 1976.

In 1982, the CILHI had enough circumstantial evidence to conclude that a misidentification had occurred in 1967. Based on this new information, the remains that had been incorrectly interred in Boston were exhumed and were transferred to the CILHI for analysis. Despite repeated attempts, analysis at the CILHI failed to associate the remains of this unmanifested passenger with any U.S. serviceman unaccounted for from the Vietnam conflict.

In 2000, a CILHI Casualty Data Analyst researching the case established a tentative association between Jerry Degnan, a civilian

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missing from the Vietnam conflict, and the unidentified set of remains at CILHI. This association was based on general biological agreement (age, race, height, and hair color) and the fact that the suspected individual's job entailed frequent travel as an unmanifested passenger on board military helicopters. In order to test this possible association, bone samples were submitted to the Armed Forces DNA Identification Laboratory (AFDIL), Maryland, for mitochondrial DNA (mtDNA) analysis. Results of the mtDNA comparison between the sequence data from the bone samples and a maternal relative (brother) of the missing civilian showed that they were consistent. Furthermore, the sequence data were unique to the mtDNA database used by the AFDIL and could thus be assumed to be relatively rare within the general population.

Although there was then an anthropological and mtDNA link between the unidentified set of remains and Jerry Degnan, discrepancies regarding the circumstances surrounding the date of his disappearance and the date of the crash remained. A reconstruction of events by Mr. Degnan's employer, which was primarily based on witness testimony, placed Mr. Degnan in Saigon on August 26 or 28, at least 17 days after the crash. Subsequent investigation into the disappearance by the Degnan family indicated that the witness testimony might be in error. Obviously there was some confusion as to Mr. Degnan's whereabouts in August 1967 and the specifics of his disappearance. For this reason, additional evidence was needed to positively identify the remains at the CILHI as Jerry Degnan.

Anthropological analysis of the skeletal remains revealed that the remains are those of a 23 to 30-year-old Caucasian male, approximately 70.2 in. tall, who experienced perimortem trauma consistent with a slow-moving aircraft crash. A review of Jerry Degnan's antemortem records indicated that he was a 28-year-old Caucasian male who stood 71 in. tall at the time of his disappearance. Although the remains contained several restored (filled) teeth, none of Mr. Degnan's dental records could be located for comparison. The only piece of antemortem radiographic evidence that could potentially be used for a comparison was a chest X-ray that had been provided by the family (Fig. 1). The radiograph was taken on March 1, 1967, approximately five months prior to his disappearance, but the quality of the radiograph had deteriorated as a result of more than three decades of storage. Due to the inconsistent resolution of the radiograph and the limited availability of the skeletal elements for comparison, the right clavicle was determined to be the best candidate for a radiographic comparison as it provided the most detail. Additional skeletal elements (e.g., ribs and vertebrae) that may have been viable candidates for comparison were missing.

A single clavicle has been utilized for identification purposes in previous case reports (2–5) based on the trabecular pattern and overall morphology of the bone. Digital superimposition of the antemortem and postmortem images in the present case revealed a near exact match in both shape and size, providing the final piece of evidence in order to identify an individual who had been missing for over three decades and whose disappearance had always been a mystery to his family.

Radiographic Comparison

The right clavicle was taken to Tripler Army Medical Center, Oahu, Hawaii for digital radiography and, with the assistance of a radiologist, the X-ray equipment was arranged in order to duplicate the standard operating procedures that would have been performed with the original chest X-ray (e.g., the equipment was located at a distance of approximately 72 in. from the clavicle and the ray was not focused directly on the bone). In order to approximate the correct anatomical orientation of the clavicle, several radiographs were taken with slight rotation of the element each time. The postmortem image that most closely approximated the antemortem orientation of the chest X-ray was then selected for comparison.

Both the antemortem chest X-ray (Fig. 1) and the postmortem X-ray of the clavicle (Fig. 2) were scanned on a flatbed scanner at 300 DPI resolution and were compared using Adobe Photoshop 6.0, in a manner similar to that outlined by Johansen and Bowers (6) for bite mark comparison. Neither radiograph was altered concerning scale, as the anatomical orientation in both antemortem and postmortem situations would place the clavicles very close to the film and provide nearly a 1:1 perspective. Computerized enhancements to the images (e.g., brightness, contrast, and black/white reversal) were performed in order to achieve the optimum clarity of the radiographic details. Adobe Photoshop 6.0 also allows for the simple rotation of the overlay image in order to position the postmortem image in the same orientation as the

FIG. 1—*Portion of the antemortem radiograph showing right clavicle (note the poor resolution quality).*

FIG. 2—*Postmortem radiograph of right clavicle.*

FIG. 3—*Comparison of antemortem image and postmortem image showing overall similarity in size and shape ("black bone" image used for better definition of bones).*

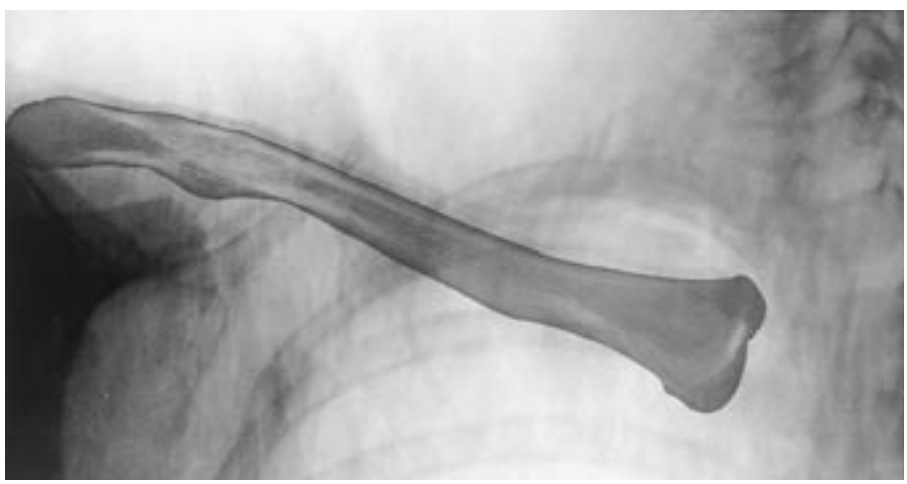

FIG. 4—*Near overlay of antemortem image and postmortem image (semi-transparent) showing the similarity in shape, especially visible at the lateral end ("black bone" image used for better definition of bones).*

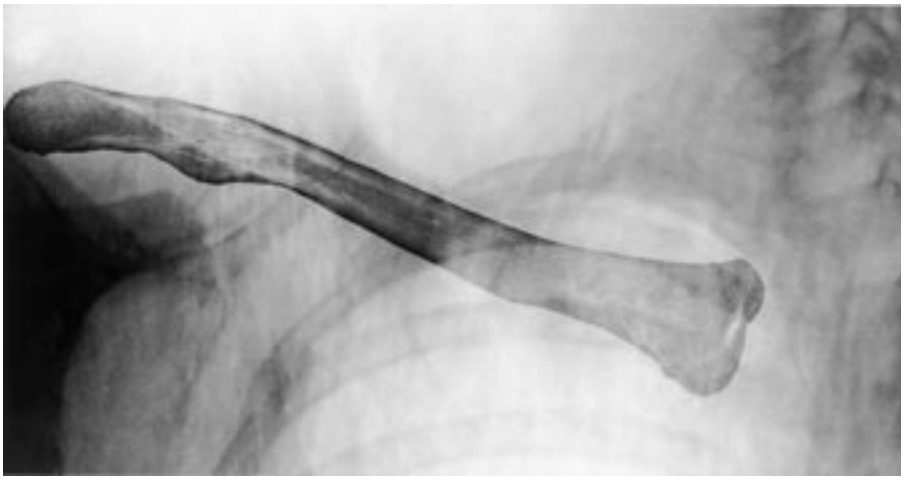

FIG. 5—*Complete overlay of the antemortem image and postmortem image (semi-transparent) showing near exact match ("black bone" image used for better definition of bones).*

antemortem image. Gross comparison of the antemortem and postmortem radiographs showed marked congruence in both size and shape (Figs. 3–5). In particular, the undulating shape of the supero-lateral end of the clavicle in both radiographs provided a convincing match (Fig. 4). Furthermore, striking similarities existed in the trabecular patterns on the lateral end that were visible in both images (Fig. 3). The most convincing evidence for a match between the two radiographs was performed by overlaying the two images (Fig. 5). No unexplainable inconsistencies were noted between the antemortem and postmortem images. It was determined that the two images were of the same clavicle and, as such, represented the same individual.

Discussion

The first published case report involving radiographic comparison of skeletal features for personal identification was in 1927 (1) and involved matching features from the frontal sinus and mastoid region of the cranium. In turn, this case set the medicolegal precedent for the use of radiographic comparison in establishing identity. Concerning the identification of deceased soldiers, the authors of this pioneering report even suggested that cranial radiographs should be archived to aid in the identification process and stated, "If such roentgenograms had been taken, for example, of men going into war, there would have been far fewer bodies of unknown soldiers, since identification would be possible from mere fragments of the anterior or lateral skull" (Ref 1, p. 1636). It is interesting to note in this early case report that the utility of skeletal features for identification purposes was emphasized, but there was no mention of the possibility of using dental radiographs, even though most dentists had X-ray machines in their office by the early 1920s (7).

Today the use of skeletal features in radiographic comparison is commonplace for forensic identification throughout the world. The reliability of the technique has been scientifically tested and the individualistic nature of the features examined and confirmed (3,8–14). The results of numerous identifications, involving various bones of the skeleton, have subsequently been presented as examples of the utility and accuracy of this technique (e.g., 2–5,15–25). It would seem that radiographic comparisons are limited only by the availability of antemortem radiographs, the preservation of the postmortem remains, and the expertise of the examiner. With the advances in digital technology, useful information can even be derived from the computer enhancement of poorly preserved radiographs that, in the past, may have been deemed useless (26,27).

Summary

Radiographic comparison provides an excellent opportunity to utilize unique features of the human skeleton to establish an identification or exclusion of a missing individual. In the present example, even a poorly preserved radiograph from the Vietnam conflict was sufficient to reveal unique morphological features that could be radiographically compared against a postmortem image. As a result, the identification of a missing individual from the Vietnam conflict was made based in large part on the identical radiographic morphology of a clavicle. The remains of Jerry Degnan were returned to his brother and were subsequently buried on May 5, 2001 in Youngstown, Ohio, nearly 34 years after his disappearance. This case presents an interesting example on many different levels, from the use of an uncommon skeletal element for radiographic comparison to the strengths of digital technology and the use of computers in the comparison.

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References

1. Culbert WL, Law FM. Identification by comparison of roentgenograms. JAMA 1927;88:1634–6.
2. Sanders I, Woesner ME, Ferguson RA, Noguchi TT. A new application of forensic radiology: identification of deceased from a single clavicle. Am J Roentgenol Radium Ther Nucl Med 1972;115(3):619–22.
3. Martel W, Wicks JD, Hendrix RC. The accuracy of radiologic identification of humans using skeletal landmarks: a contribution of forensic pathology. Radiology 1977;124(3):681–4.

4. Brogdon BG. Radiological identification of individual remains. In: Brogdon BG, editor. Forensic Radiology. Boca Raton: CRC Press, 1998; 149–87.
5. O'Connor WG. Briefly unidentified: a study of a peculiar source of identification. J Forensic Sci 1999;44(4):713–5.
6. Johansen RJ, Bowers CM. Digital Analysis of Bite Mark Evidence. Santa Barbara: Forensic Imaging Services, 2000.
7. Ring ME. Dentistry: An illustrated history. New York: Harry N. Abrams, Inc., 1993.
8. Mann RW. Use of bone trabeculae to establish positive identification. Forensic Sci Int 1998;98(1–2):91–9.
9. Kahana T, Hiss J, Smith P. Quantitative assessment of trabecular bone pattern identification. J Forensic Sci 1998;43(6):1144–7.
10. Kullman L, Eklund B, Grundin R. Value of the frontal sinus in identification of unknown persons. J Forensic Odontostomatol 1990;8(1):3–10.
11. Reichs KJ. Quantified comparison of frontal sinus patterns by means of computed tomography. Forensic Sci Int 1993;61(2–3):141–68.
12. Law FM. Roentgenograms as means of identification. Am J Surg 1934; 26:195–8.
13. Hogge JP, Messmer JM, Doan QN. Radiographic identification of unknown human remains and interpreter experience level. J Forensic Sci 1994;39(2):373–7.
14. Sauer NJ, Brantley RE, Barondess DA. The effects of aging on the comparability of antemortem and postmortem radiographs. J Forensic Sci 1988;33(5):1223–30.
15. Jablonski NG, Shum BS. Identification of unknown human remains by comparison of antemortem and postmortem radiographs. Forensic Sci Int 1989;42(3):221–30.
16. Jensen S. Identification of human remains lacking skull and teeth. A case report with some methodological considerations. Am J Forensic Med Pathol 1991;12(2):93–7.
17. Valenzuela A. Radiographic comparison of the lumbar spine for positive identification of human remains. A case report. Am J Forensic Med Pathol 1997;18(2):215–7.
18. Kahana T, Ravioli JA, Urroz CL, Hiss J. Radiographic identification of fragmentary human remains from a mass disaster. Am J Forensic Med Pathol 1997;18(1):40–4.
19. Rouge D, Telmon N, Arrue P, Larrouy G, Arbus L. Radiographic identification of human remains through deformities and anomalies of postcranial bones: a report of two cases. J Forensic Sci 1993;38(4):997–1007.
20. Angyal M, Derczy K. Personal identification on the basis of antemortem and postmortem radiographs. J Forensic Sci 1998;43(5):1089–93.
21. Rhine S, Sperry K. Radiographic identification by mastoid sinus and arterial pattern. J Forensic Sci 1991;36(1):272–9.
22. Owsley DW, Mann RW, Chapman RE, Moore E, Cox WA. Positive identification in a case of intentional extreme fragmentation. J Forensic Sci 1993;38(4):985–96.
23. Owsley DW, Mann RW. Positive personal identity of skeletonized remains using abdominal and pelvic radiographs. J Forensic Sci 1992;37 (1):332–6.
24. Marlin DC, Clark MA, Standish SM. Identification of human remains by comparison of frontal sinus radiographs: a series of four cases [see comments]. J Forensic Sci 1991;36(6):1765–72.
25. Atkins L, Potsaid MS. Roentgenographic identification of human remains. Jama 1978;240(21):2307–8.
26. McKenna CJ. Radiography in forensic dental identification—a review. J Forensic Odontostomatol 1999;17(2):47–53.
27. Fitzpatrick JJ, Shook DR, Kaufman BL, Wu SJ, Kirschner RJ, MacMahon H, et al. Optical and digital techniques for enhancing radiographic anatomy for identification of human remains. J Forensic Sci 1996;41(6): 947–59.

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