CASE REPORT

Douglas W. Owsley,[1] Ph.D.; Robert W. Mann,[2] M.A.; Ralph E. Chapman,[1] M.S.; Elizabeth Moore,[1] M.A.; and William A. Cox,[3] M.D.

Positive Identification in a Case of Intentional Extreme Fragmentation

REFERENCE: Owsley, D. W., Mann, R. W., Chapman, R. E., Moore, E., and Cox, W. A., "**Positive Identification in a Case of Intentional Extreme Fragmentation,**" *Journal of Forensic Sciences*, JFSCA, Vol. 38, No. 4, July 1993, pp. 985–996.

ABSTRACT: The investigation of the first of the murders of young males to which Jeffrey Dahmer confessed led to systematic survey of two acres of semirural property in Bath Township, Ohio. The survey revealed the fragmentary skeleton of a young adult male, as well as bones of several species of animals. Through archaeobiological analysis, the animal bones were identified and taphonomic modifications documented. The human bones were dry and weathered, and many were rodent-gnawed, indicating that they had been exposed for many years. The human bones displayed an extreme degree of splintering, warping, bending, and spiral breakage. The only relatively complete bone was a cervical vertebra. Dismemberment and breakage had been accomplished by cutting, blunt force, and, in the case of the ribs, manual bending. Even in so extreme a case of intentional fragmentation, however, forensic anthropological analysis resulted in positive identification, with the primary criteria based on matching osteological features evident in premortem and postmortem radiographs of a cervical vertebra.

KEYWORDS: physical anthropology, human identification, taphonomic effects, fragmentation, computer imaging

On Friday, May 1, 1992, in Akron, Ohio, Jeffrey Dahmer received a sentence of life imprisonment for the murder, on June 25, 1978, of an 18-year-old male, the first of 17 murders of young males during the ensuing 13 years to which Dahmer had confessed. He stated that this first victim was a hitchhiker whom he had picked up and brought to his parents' home (they were away at the time) in a semirural, so-called bedroom community in Bath Township, Ohio. He confessed to hitting the victim on the back of the head with the rod of a barbell, then strangling him, dismembering the body with a Bowie

Received for publication 28 Oct. 1992; revised manuscript received 10 Dec. 1992; accepted for publication 14 Dec. 1992.

[1]Research Scientist and Curator; Computer Specialist, Automatic Data Processing; and Biological Archaelogist, respectively, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

[2]Physical Anthropologist, US Army Central Identification Laboratory, Fort Kamehameha, Hickham AFB, HI.

[3]Coroner, County of Summit, Akron, OH.

knife in a crawl space under the house, placing the parts in plastic sacks, and about a month later pulverizing the remains with a sledgehammer and scattering the fragments in the underbrush and woods around the residence.

Although the confessed murderer identified his victim, an 18-year-old, white male who had disappeared in June 1978, it was necessary to try to establish identity through osteological examination of the remains and comparison with antemortem radiographs of the alleged victim. The Medical Examiner in Akron, Ohio, sought the assistance of Smithsonian physical anthropologists in accomplishing the needed identification. Specifically, he requested the conduct of a forensic anthropological examination of the remains to determine the individual's age at death, sex, race, stature, and any indication of disease or trauma or cause of death. In addition, he subsequently provided antemortem radiographs of the alleged victim—one lateral view of the head and cervical spine and six periapical dental X-rays—for comparison with postmortem X-rays of the remains.

The bones delivered to the Smithsonian were extremely fragmented and incomplete. For example, there were 27 fragments of femora, 19 of fibulae, 24 of os coxae, and 50 of ribs. The only relatively complete bone was a cervical vertebra; however, it was possible to reconstruct to relative completeness the right scapula, two right ribs, and two left ribs. Only seven fragmentary teeth were present for examination.

The objective in presenting this case is to describe the means used to accomplish a positive identification in this extreme instance of intentional fragmentation, with virtually no intact bone or tooth present.

Background

Site Survey

Prior to seeking the assistance of the Smithsonian anthropologists, the site, a 1.7 acre area, including and surrounding the Dahmer's former residence, plus a small (0.3 acre) section of the adjacent property, had been divided into a grid of 22 rectangular sectors of varying size (Fig. 1). The sectors included a small pond, a wooded area, and an elevation (Dahmer referred to it as a cliff) from which Dahmer said he had thrown bones.

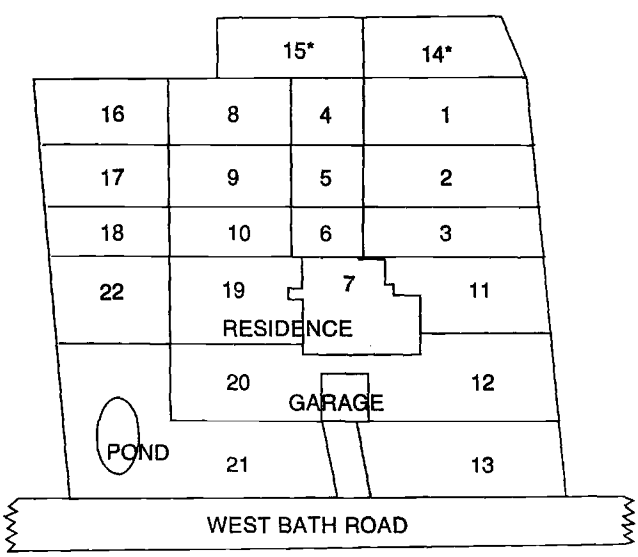

FIG. 1—*Diagram of the crime scene showing grid pattern used in the site survey. (Not to scale.)*
* Grid placement on adjacent property.

The two-acre site was raked and searched with metal detectors, then debris was collected by hand from each sector. From two to six inches of top soil were next turned over and sifted, and the grid location of each element found was recorded. These elements consisted of both human and nonhuman bone fragments, as well as a variety of artifacts (for example, plastic bag, bits of cloth and metal, coins, a plastic fork, a glove, and a shoehorn).

Smithsonian Analyses

Plastic bags containing material from each grid were delivered to the Smithsonian. The first step was to inventory the contents of each bag and sort them into the following categories: human bone, human teeth, nonhuman bone/teeth, and material evidence (other items of metal, plastic, and cloth). The human remains were inventoried according to side of the body and type of bone (cranial fragment, sternum, etc.). Bone fragments that could be matched were reconstructed with glue, with any long bone fragments (arm, leg) being counted and measured prior to reconstruction. An effort was made to sequence rib and vertebral fragments. The bones were examined for evidence of perimortem trauma, dismemberment (for example, cuts), postmortem breakage (for example, smashing), and animal activity (for example, rodent gnawing).

E. Moore, a biological archaeologist at the Smithsonian's Museum Support Center, undertook the inventory and species identification of the nonhuman bones. She prepared a list for each grid block of the types of species represented, the type of bone and side from which it came, and any evidence of taphonomic processes.

Findings

Nonhuman Bone Inventory

The identifiable nonhuman bones and bone fragments ($N = 85$) found at this semirural site represented a variety of species, as indicated in Table 1, which shows the distribution of animal bones by area and species. There is no element duplication in the chicken

TABLE 1—*Distribution of animal bones by grid location and species.*

	Grid Location													
Species (Total)	1	2	4	5	6	8	9	10	11	12	14	15	18	21
Bos taurus (cow) (16)	1	2	2	1	1	2	1		1	1			1	3
Ovis anes (sheep) (1)								1						
Sus scrofa (pig) (4)			2			1						1		
Gallus (chicken) (9)			9											
Canis familiaris (dog) (22)	4	1	13								3		1	
Sylvilagus (rabbit) (1)	1													
Felis sylvestris (cat) (4)										4				
Didelphis marsupialis (opossum) (4)			3	1										
Marmota monax (woodchuck) (6)		1	2	3										

remains, so it is likely that they represent one fowl. Grid location 4, which was a wooded area adjacent to the property line and farthest from the road, yielded the most nonhuman bone fragments. Most of these were cow, dog, and chicken bones, though woodchuck, opossum, pig, cat, rabbit, and sheep bones were also present. At least three dogs were represented, two large ones and a smaller breed. In addition, there were five unidentified bird bones and 20 bone fragments from unidentified mammals of various sizes, from large (cow size) to medium (sheep or pig) to small (including a possible skunk, a rodent, and an otter or weasel). Most of these unidentified mammals were represented by vertebrae, though there were also fragments of two crania, a mandible, three long bones, a rib, and a pelvis.

Evidence of taphonomic processes was characteristic of this sample of animal bone fragments. The most frequent example was rodent gnawing, which was evident on 14.5% (16 of 110) of the animal bones. Almost all (88%) of the fragments of chicken and bird bone showed evidence of burning, as did many of the unidentified mammal bones. Eighteen of the cow, sheep, and pig bones displayed evidence of sawing. Generally, these bones were portions of the shafts of long bones (such as, femora and tibiae), with one or both ends sawed off. Such sections represent typical cuts of meat found at a market and made by a butcher.

The most unusual find was the left femur of a large dog with a spike/nail driven into the distal end of the shaft (Fig. 2). The bone was nearly complete and displayed no

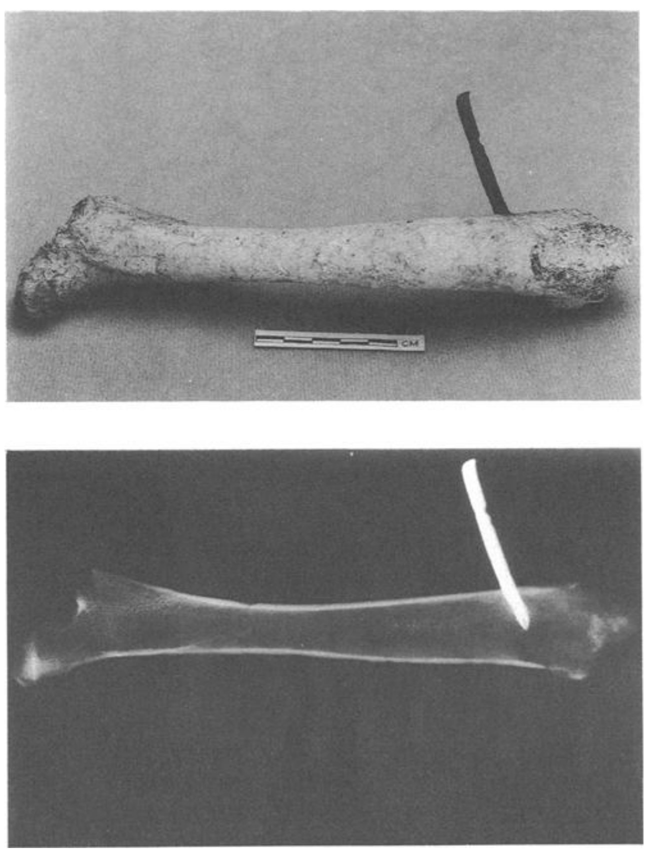

FIG. 2—*Left femur of a dog with a spike driven into the distal end and the corresponding X-ray.*

apparent evidence of bone growth around the spike, suggesting that this modification was made at about the time of death or thereafter. (The Akron investigators who surveyed the site reported finding a dog skull mounted on a wood stake, but this was not included in the material submitted to the Smithsonian.)

Other than the dog femur, the assortment of bones is characteristic of a semirural community and includes three basic categories of animals: (a) those butchered for consumption in typical marketable cuts; (b) domestic animals kept as pets; and (c) wild species frequently found in rural, wooded areas.

There is no evidence to link Dahmer with any of the modifications of animal bone found at the site; however, his subsequent emphasis on dissection of his victims and in some cases preservation of skulls, hands, and other parts of the anatomy is of interest in this context.

Human Osteological Analysis

The human bones found at the site were not only extremely fragmented but dry and weathered, indicating that they had been exposed for many years. None of the bones was intact or complete. The bones of the arms and legs were broken into many slender, elongated fragments (Figs. 3 and 4). Lengths of the fragments were measured to document the degree of fragmentation (Table 2). Average lengths of long bone fragments varied from 4.9 to 7.0 cm. The longest piece recovered was a fragment of a fibula measuring 12.4 cm. The extreme degree of bone splintering, warping, bending, and spiral breakage was unusual. Although it is not unusual for bones that are exposed to the elements and animal chewing to be fragmentary, to find every long bone shaft broken into numerous slender fragments is rare. Long bone shafts are thick and sturdy, thus substantial force would be necessary to cause such breakage. Further, when the breakage occurred, the bones were not desiccated but "green" or "fresh" [*1*]. The ribs were not only broken into fragments but these pieces were warped, bent, and distorted.

Table 2 presents the distribution of human bone fragments among the grids into which the site was divided. The largest concentration was in grid 2, which was a wooded area containing the elevation ("cliff") from which Dahmer indicated that he had thrown and scattered bones. Grid 5, with the next highest number of human bone fragments, was also a wooded section and adjacent to the sector in which the greatest concentration of animal bones occurred. The majority of the skeleton was not recovered. In all, 266 fragments of human bone were found at the site.

Examination of the bone fragments and reconstitution of bone elements when possible revealed no duplication; that is, the remains represented only one individual. The diagram in Fig. 5 shows the bone fragments identified according to side and specific location. In

FIG. 3—*Fragments of femora including reconstructed sections.*

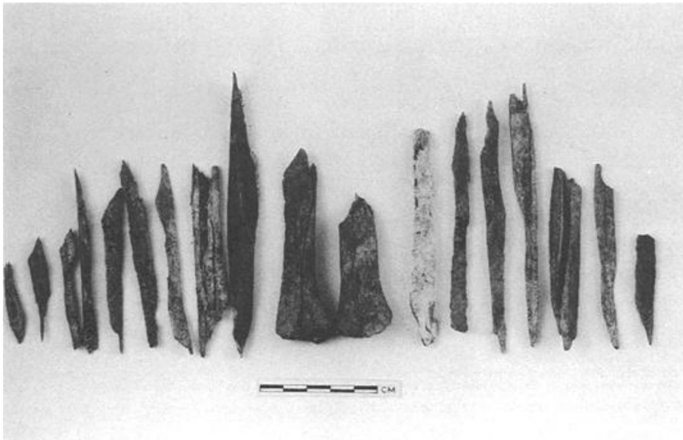

FIG. 4—*Splintered pieces and spiral fractures of the fibulae.*

TABLE 2—*Number of human bone fragments and distribution by area.*

Bone	Grid Location 2	5	6	10	Total
Cranium	1	3	1	1	6
Mandible			1		1
Clavicle	2				2
Scapula	11	2			13
Sternum	1				1
Ribs	39	8	3		50
Cervical		1			1
Thoracic	11	1			12
Lumbar	6	1			7
Sacrum	5				5
Os coxae	17	6			23
Humerus	3	2			5
Radius	2	1			3
Ulna	9	3			12
Femur	16	9	1		26
Tibia	11	3			14
Fibula	15	4			19
Unidentified long bone	39	22	1		62
Total	188	66	7	1	262

spite of the extreme fragmentation, it was possible to determine that the individual was male. The large size of the left proximal ulna, left ischium, and right scapula were consistent with male, as were the shape and size of the pubic bones.

It was not possible to establish race, the cranial bones being too few and too fragmented and not those containing racial indicators. An accurate determination of stature was not feasible because of the extremely fragmentary condition of the long bones, which prevented exact measurements on which to base an estimation of height.

Some long bone epiphyses were in the process of uniting, with lines still visible on the distal ulnae. Epiphyseal lines were also visible on the thoracic centrum rings, sacral ala, iliac crest, and inferior scapular body. Cranial vault sutures were open, and the symphysis

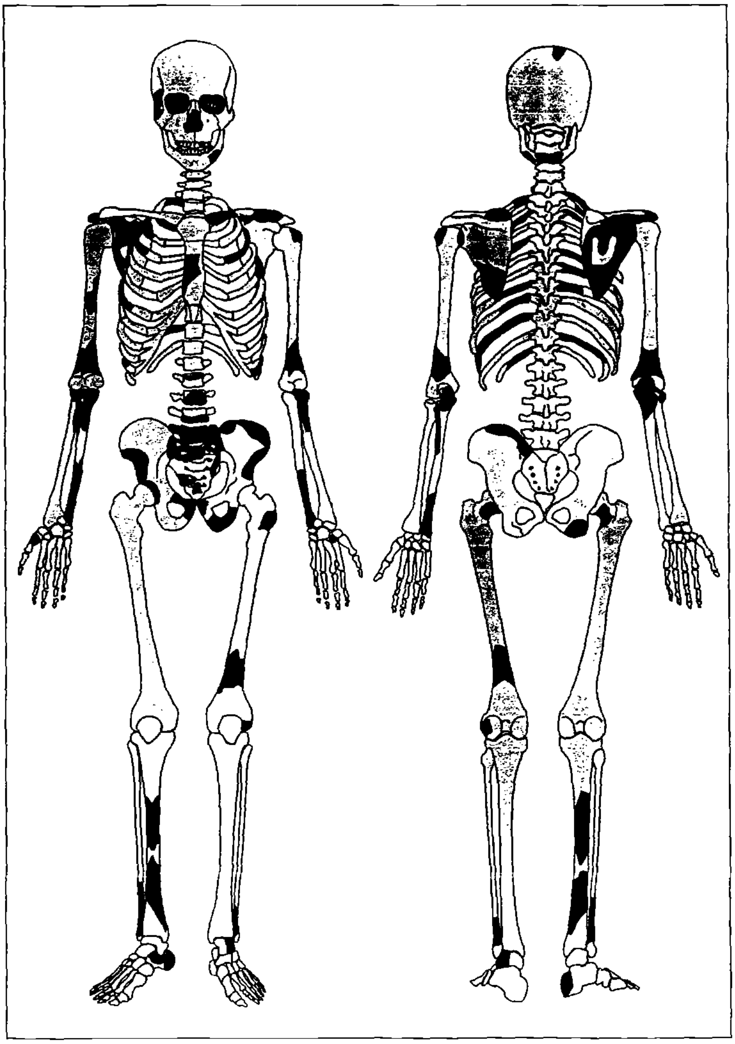

FIG. 5—*Diagram showing bone fragments by side and anatomical location.*

pubis was billowy. In addition, roots of a third molar were at least three fourths developed. All these findings were consistent with an age between 17 and 20 years at the time of death.

In regard to elapsed time since death, the degree of drying and weathering and the substantial amount of rodent gnawing suggest that the bones were exposed for a period of years.

Definite evidence of trauma leading to the victim's death was absent; however, cuts were apparent on a number of the bone fragments (Fig. 6). Those on the third and seventh right ribs near the spine, on the fourth cervical vertebra, on the body of the sternum, and on the inferior surface of the left clavicle had been inflicted when the bone was flexible, that is, around the time of death, but it was not possible to determine whether the cuts were made shortly before death or soon thereafter. The size and characteristics of those cuts on the ribs and clavicle were consistent with cuts made with a

FIG. 6—*Two intersecting cuts on the inferior border of the right third rib, 3.7 cm from the vertebral end.*

bladed implement such as a knife rather than with a larger, heavier hatchet or machete. The sternum had been both cut and snapped. A nearly horizontal cut had originated on the ventral surface of the chest. The ventral margin of the cut was beveled.

The ribs on which cuts were present were on the right side and in the upper portion of the back. The location of the cuts suggested that they were inflicted while the ribs were still articulated with the spine.

The cut on the left dorsal surface of the fourth cervical vertebra was half-moon shaped and measured 4 mm across. It had been made to the back of the neck from below to above with a bladed implement.

The bones displayed no evidence of osteoarthritis, disc problems, or any other osteological disease or abnormality.

The results of the osteological analysis were consistent with data indicating that the victim was a white male, born 11 June 1959, thus 18 years old at the time of death. He was five feet, eleven inches tall, and weighed 160 lbs. He had no deformities or fractures. Though the findings of the osteological analysis generally supported or were not inconsistent with this description, they were not sufficient to establish positive identification. Consequently, additional analyses were undertaken using the one nearly complete bone, the fourth cervical vertebra, and the root fragments of the left and right mandibular second molars.

Establishing Positive Identification

Radiographic Methodology

Seven antemortem radiographs of the presumed victim were provided. These consisted of one lateral view of the head and cervical vertebrae and six periapical dental films. Most of the bones and teeth depicted in the X-ray films were not represented among the fragmentary, incomplete remains recovered from the site; however, one cervical vertebra and three tooth fragments were present and provided a possible basis for comparison.

The antemortem radiographs were taken when the victim was 13.7 years of age, and his disappearance and presumed death occurred when he was 18. This period is one of accelerated growth, and as a result, comparison of antemortem and postmortem films for purposes of identification presents problems. In addition, the antemortem radiographs were nearly 20 years old and had become cloudy and discolored. They were submitted to the Special Photographic Unit of the FBI Laboratory for enhancement to improve clarity and detail. Both film and contact prints were provided. As contact prints require a thinner emulsion, they admit more light and yield greater clarity of detail. Further, masks (light-color reversals) were prepared with an X-ray copy machine so that original postmortem pictures of the corresponding recovered bone and teeth could be superimposed for precise comparison.

To obtain radiographs of the recovered bone of a size consistent with the antemortem film required certain assumptions. First, it was assumed that the standard distance used for taking lateral, cervical spine X-rays (72 inches) was the distance used for the antemortem film. At this distance, the rays in the X-ray beam are parallel and produce a nonmagnified, nondistorted image. As the antemortem film did not include the seventh cervical vertebra, it was also assumed that the cassette holding the film was resting on the patient's shoulder. An estimation of the distance from the fourth cervical vertebra (the specimen from the site) to the film was made, and the vertebra was taped to a radiolucent sponge at that distance, with the exposure made at 72 inches. The resulting image was then reversed to produce a mask that was superimposed on the original radiograph.

In regard to the tooth fragments to be used for comparison, the films were taken with the teeth placed directly on the film cassette, thus approximating the distance of the teeth to the film of the original radiographs, and the images obtained were comparable in size. Focal film distance was considered but not deemed relevant in this particular instance. The image was reversed, and the resulting mask was superimposed on the original.

Comparisons Using the Fourth Cervical Vertebra

Comparison of the X-rays of the fourth cervical vertebra with the enhanced antemortem lateral, cervical spine radiograph showed congruence in the shape of the vertebral arch and, especially, that of the spinous process, and exact radiographic correspondence in detailed structural features of the internal cancellous bone of the neural spine. There is a difference in vertebral body size of the dry-bone specimen vertebra when compared to the antemortem radiograph, but this difference can be attributed to the normal increase that would accompany increasing age—that is, the difference in size between 13.7 and 18 years of age.

As a check on the findings, a control sample of 15 fourth cervical vertebrae from young, adult, white males drawn from the Terry Skeletal Collection at the Smithsonian was X-rayed and compared with the antemortem enhanced radiograph. None of these comparisons revealed the correspondence of radiographic features found in the comparison of the fourth cervical vertebra from the site with the antemortem X-ray of the presumed victim.

Dental Comparisons

The left and right mandibular second molar root fragments provided the only basis for comparison with the antemortem periapical X-rays showing the left second mandibular molar and the mesial root and bifurcation point of the right mandibular second molar root. (The poor quality of the original antemortem image prevented a hoped for comparison of a maxillary premolar fragment.) The results were as follows:

1. The second mandibular molars showed correspondence in the size of the roots, as measured with needlepoint dial calipers, including root thickness and estimated root length.

2. The mesial root of the right molar was moderately curved; that of the left showed less curvature.

3. The mesial roots had well-defined distal surface grooves, visible in both the X-rays and the specimens.

4. The spacing between the right mandibular mesial and distal second molar roots corresponded.

5. Superimposition of the right mandibular molar root fragment on the antemortem X-ray using a subtraction procedure (mask made from a reversal) produced a good fit in size and shape. (Because the left mandibular second molar mesial and distal tooth roots were separate fragments, making correct positioning much more difficult, correspondence between antemortem and postmortem radiographs for this tooth, though present, was less clear.)

To check further the closeness of the fit indicated in item 5, a morphometric analysis was next performed. Tracings from the X-rays were digitized using a Summagraphics digitizing pad (1000 lpi resolution). A single landmark, the bifurcation point between the mesial and distal roots, and all available tooth margins were included. The line representing the mesial side of the mesial root was divided into roughly 100 evenly spaced points. A point approximately opposite the landmark was chosen on the antemortem tooth, and the coordinates of all points were recalculated using the length between the landmark and this point as a unit value. The same procedure was followed for the postmortem tooth X-ray, varying the point used on the mesial side of the mesial root until the best fit was obtained. This technique eliminated size differences between the tracings and provided a baseline for superimposing the two. A similar comparison for the distal root was not feasible because of the fuzziness of the X-rays and the consequent difficulty in establishing clear root margins.

The superimposition showed an excellent fit between the two mesial root depictions, despite difficulties resulting from the quality of the X-rays and the availability of only a single landmark point. That the two tracings represented the same tooth was likely, but additional analyses of other right mandibular second molars from a sample of 15 adult, white males drawn from the Huntington collection were undertaken to ascertain the variability, or uniqueness, of second molar mesial root morphology.

The sample teeth were X-rayed and the X-rays digitized. In addition, visual comparisons of the 15 samples with the antemortem X-ray were made, with particular attention to mesial root length, maximum width of the mesial root at the midpoint, width of the mesial root at the level of bifurcation, maximum distance between the mesial and distal roots, and mesial root curvature. A morphometric analysis was run comparing the shapes of the second molar roots of the victim (recovered from the site), the presumed victim (based on antemortem X-rays), and the specimens taken from the Huntington collection.

As a result of the comparative analyses, it was concluded that: (a) there is substantial variation among individuals in molar root morphology (as noted in other studies; see, for example, [*2*,*3*]) and (b) the best fit between the antemortem X ray for the presumed victim and the postmortem X-rays of the 15 controls and of the right second molar recovered at the site was the tooth found at the site. The degree of fit was extremely good. In addition, the comparison of mesial root morphology between the recovered tooth and the 15 control teeth revealed two control teeth that were somewhat similar in shape, suggesting that rough approximations in root morphology would probably occur in about 10 to 13 percent of the individual cases in a given sample.[4]

[4]Because the judge deemed Dahmer's confession, together with the osteological evidence related to the fourth cervical vertebra, to be sufficient evidence, it was not necessary to introduce the data on tooth root approximations in court.

Summary

Bone fragments from a site indicated in the confession of Jeffrey Dahmer as the scene of his first murder were sent by the Office of the Coroner, Akron, Ohio, to physical anthropologists at the Smithsonian Institution to be examined. The objective was to determine whether the human bone fragments found at this site were those of the alleged victim, an 18-year-old, white male. The material submitted to the Smithsonian included both human and nonhuman bone and teeth, as well as other material from the site that was listed but not analyzed.

The initial, routine osteological analysis of 266 human bone fragments and seven tooth fragments from the site provided supporting, but not conclusive, evidence that the fragmentary remains were those of one individual, who could be the alleged victim.

Subsequent analyses employed antemortem X-rays of the presumed victim, which were enhanced to improve their clarity, and subtraction procedures to compare these with postmortem X-rays of the only virtually complete bone from the murder site, a fourth cervical vertebra. Tracings from the enhanced antemortem X-ray and from the postmortem X-rays of the dry-bone specimen revealed an exact radiographic correspondence in several osseous features. No such correspondence was found when a control sample of cervical vertebrae from 15 young adult, white, male specimens in the Terry Collection was compared with the antemortem X-ray.

In addition to the striking match revealed by the osteological comparison, the visual comparisons and morphometric digital analysis of the mesial roots of the left and right mandibular second molars provided corroborating evidence. Again, the resulting correspondence between antemortem X-rays and specimens from the site was checked by analysis of a control sample. None of the control specimens produced a comparable match but demonstrated instead considerable variation in root morphology among individuals in the comparative sample.

What this case illustrates chiefly is the possibility of establishing a positive identification even when there has been extreme, intentionally inflicted fragmentation resulting in no completely intact bone or tooth.

In addition, analysis of the species represented by the nonhuman bone fragments found at the site provided useful information about taphonomic processes and the types of animals, wild and domestic, likely to be encountered when systematically surveying a semirural residential community for skeletal remains. In the context of the Dahmer case, the animal bones from the site that showed intentional modification—sawing and burning and, especially, the dog femur containing a metal spike—were also of interest.

Acknowledgments

Joseph Orlando, Chief Investigator of the Office of the Coroner, Summit County, Ohio, provided helpful background information. The crime scene diagram was provided by the Bath Township Police. Harry Mincer, D.D.S., Professor of Oral Pathology, University of Tennessee, assisted with comparison of the antemortem and postmortem dental records. Fran Albrecht, RT, took X-rays of the skeletal remains and of control specimens and suggested the subtraction procedure as a means of facilitating radiographic comparison. Gerald Richards, Special Agent, and Richard Swing, Special Photographic Unit, FBI Laboratory, enhanced the premortem X-rays of head and cervical vertebrae through photographic and electronic image processing. Malcolm Richardson maintained the computer database and provided summary statistics. The photographs were taken by Chip Clark. Bertita Compton offered invaluable editorial guidance.

References

[1] Morlan, R. E., "Spiral Fractures on Limb Bones: Which Ones Are Artificial?," G. E. LeMoine and A. S. MacEachern, Eds., *Carnivores, Human Scavengers & Predators: A Question of Bone Technology*, Proceedings of the Fifteenth Annual Conference, The Archaeological Association of the University of Calgary, Calgary, Alberta, 1982, pp. 241–269.
[2] Kovacs, I., "A Systematic Description of Dental Roots," Dahlberg, A. A. *Dental Morphology and Evolution*, University of Chicago Press, Chicago, 1971, pp. 211–256.
[3] Taylor, R. M. S., *Variation in Morphology of Teeth. Anthropologic and Forensic Aspects*, Charles C Thomas, Springfield, IL, 1978.

Address requests for reprints or additional information to
Douglas W. Owsley
Department of Anthropology, MS 112
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560