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The Role of Forensic Anthropology in the Recovery and Analysis of Branch Davidian Compound Victims: Techniques of Analysis

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ABSTRACT: The recovery and analysis of human remains from the Branch Davidian Compound, Mount Carmel, Texas, was a multidisciplinary team effort. This presentation deals with one aspect of the forensic anthropological contribution to this collaborative endeavor—the examination and inventory of human skeletal remains and the interpretation of these osteological data. Briefly described first are the content and format of the skeletal inventory and the examination procedures used for data collection. Two subsequent sections illustrate the use of these data to determine (a) age, sex, ancestry, stature, and other distinguishing characteristics, and (b) the presence and nature of any premortem, perimortem, and postmortem trauma. The next section shows how these findings assist in establishing positive identification through, for example, comparison with medical, dental, and other background records, especially comparison of premortem and postmortem radiographs of bones or dentition. In this context, we consider also the sorting of commingled remains, which includes preliminary assessment of rapidly decomposing remains prior to autopsy to preserve information crucial to identification.

KEYWORDS: physical anthropology, human identification, mass disaster, Branch Davidians, commingled remains, trauma

The multidisciplinary team of experts assembled to deal with the April 19, 1993, mass disaster at the Branch Davidian Compound, Mount Carmel, Texas, included forensic anthropologists. Their contributions were of two principal types: (a) locating and recovering human remains, and (b) examining often fragmentary and sometimes commingled skeletons, recording and interpreting these osteological data, and helping to establish positive identification. In such analyses, anthropologists worked closely with medical examiners, odontologists, criminologists, and others taking part in the investigation. Continuous interaction among representatives of the various participating disciplines enhanced the effectiveness of the investigation, as well as increasing each participant's appreciation of the contributions of the others and the value of close cooperation.

The responsibilities of the forensic anthropologists included: osteological examination and inventory, determination of age, sex, ancestry, and other physical characteristics, identification of trauma and the time at which it occurred (that is, premortem, perimortem, postmortem), assistance in establishing positive identification, and the conduct of brief, preliminary assessments of rapidly deteriorating remains prior to autopsy.

Inventory

The skeletal inventories and the cranial and postcranial measurements that were recorded when possible are those provided by the National Forensic Anthropology Data Bank (at the University of Tennessee, Knoxville) [*1*]. The inventory encompasses the entire skeleton, and bones are scored in terms of their presence/absence and condition (for example, state of preservation, completeness). Additional notes document, for example, damage from fire and other causes and the type, severity, extent, and location of any pathological changes.

The inventory and description of each set of remains provided the taphonomic information needed to document the extent of skeletal preservation and recovery, particularly as affected by burning. The inventories also facilitated the process of sorting commingled remains by highlighting the duplication or absence of specific elements, particularly arm and leg bones. Morphological attributes and measurements were used to determine sex, age, ancestry, and stature. For children, the long bone diaphyseal lengths and dental calcification scores provided developmental criteria for seriating individuals from youngest to oldest.

Compatibility with the coding format and procedures of the Forensic Anthropology Data Bank permits entry of these data into the computerized national repository. This data bank is a major resource for applied forensic work and long-term basic osteological research on a variety of topics, such as historical and regional trends in cranial and postcranial measurements.

Assessment of Physical Characteristics

Assessments of physical characteristics are based on a number of criteria; for example, ages of adults are derived mainly from

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features of the pubic symphysis, the auricular surface of the innominate, morphology of the sternal ends of ribs, arthritic changes, and cranial suture closure [*2–4*]. Subadult ages are based on long bone length [*5*], stage of epiphyseal closure, and dental development [*6,7*]. Characteristics of the pelvis and the cranium provide the principal indicators of sex, together with size of long bones and overall skeletal robusticity [*8–10*]. Among the main skeletal characteristics considered in determining ancestry are interorbital distance, nasal width, presence/absence of a well-defined nasal sill, shape of the orbits, zygomaxillary suture pattern and shape of palate, presence/absence of alveolar prognathism, and dentition [*11*].

Data on age, sex, and ancestry can narrow the range of possibilities when attempting to identify human remains. As an example, the forensic anthropological examination of Case MC 3 indicated an older (that is, past middle age) black male. Among the traits indicating that MC 3 was male were large malar bones, a large mandible with a wide ascending ramus, a well-developed occipital protuberance, and large mastoid processes. The wide nasal aperture, well-developed nasal sulcus, pronounced maxillary alveolar prognathism, and U-shaped palate and mandible suggested that he was black. The presence of large osteophytes on the right anterior side of the lower thoracic vertebral bodies, moderate osteophyte development on the centrum of the fifth lumbar vertebra, and anterior osteophytic lipping on the auricular surface, which was also somewhat irregular, were indicators of advancing age. With the sex, ancestry, and an approximate age range of the individual known, a likely match was soon discovered, and a forensic odontologist confirmed the identification. The actual age of the man was 61 years.

Assessment of Trauma

The types of trauma encountered in this investigation included injuries resulting from blunt force, gunshots, shrapnel, and fire. In many instances, trauma consisted only, or mainly, of postmortem fire damage, as shown by discoloration (brown scorching to charring and blackening), cracking, calcination, and missing elements from a body displaying heat damage (Fig. 1).

Because of the fragmentation and fire damage to many of the remains, it was sometimes necessary for the forensic anthropologist to reconstruct shattered bones to distinguish the type of trauma, for example, whether a penetrating wound was inflicted by a gunshot or shrapnel. Case MC 8 (David Koresh) provides an example. The skull was broken into several large pieces, with many small pieces missing or warped by fire (Fig. 2). Reconstruction was possible, even though large sections of the frontal and left parietal, the squamosal portion of the left temporal, and small sections of the posterior right parietal were not recovered. Following reconstruction of the cranium (Fig. 3), it was apparent that a bullet had entered the mid-frontal and exited through the occipital below and to the right of the external occipital protuberance. The inferior half of the entrance wound was present and showed no evidence of charring, but the exit wound in the right occipital was charred around the left, superior, and right margins (Figs. 4*a* and 4*b*). The charring on the superior and left margins included burning of the diploe, although overall fire damage to the occipital was not extensive. The depth of burning exhibited on the outer surface would not have been sufficient to cause the amount of charring present in the exposed diploe if the outer table had been intact at the time it was burned. Therefore, the gunshot wound, which caused exfoliation and beveling of the outer table and exposed the diploe, had to have occurred prior to burning.

The entrance wound in the frontal, slightly to the right of the mid-sagittal line, was circular (only the lower half was present) and showed the characteristic internal beveling. Fracture lines extended laterally from the defect.

Extending from the exit wound, also circular but larger than the entrance wound, were four radiating fractures. One of these terminated in the superior fracture line originating in the frontal,

FIG. 1—*Fragmentation and calcination of the skull of an adult black male (MC 5) as a result of extensive burning.*

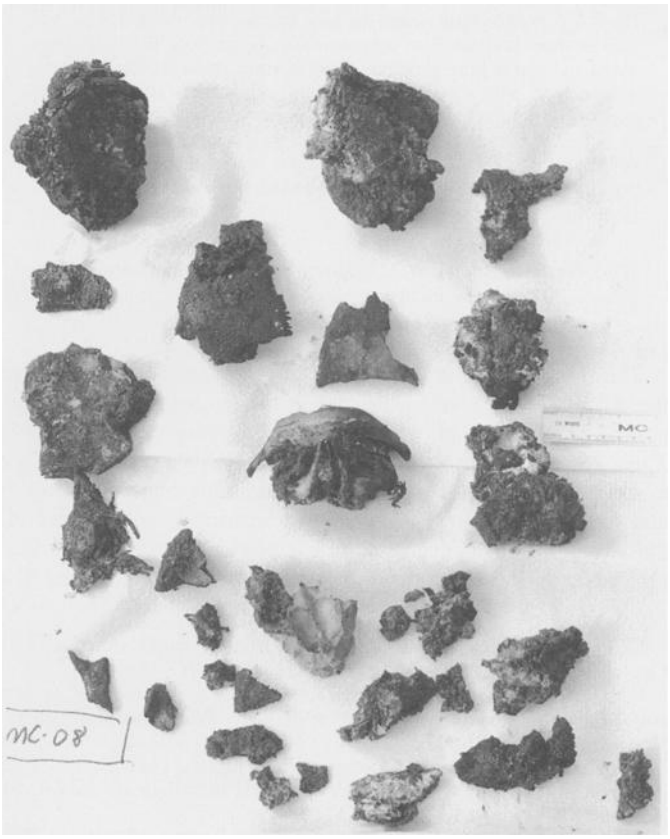


FIG. 2—*The fragmented cranium of an adult white male (MC 8) prior to reconstruction.*

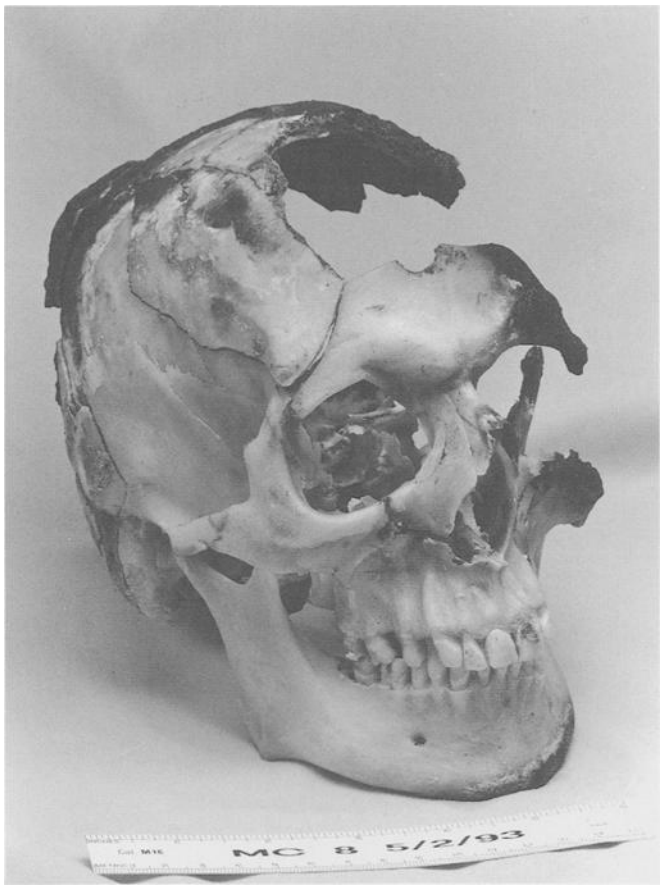
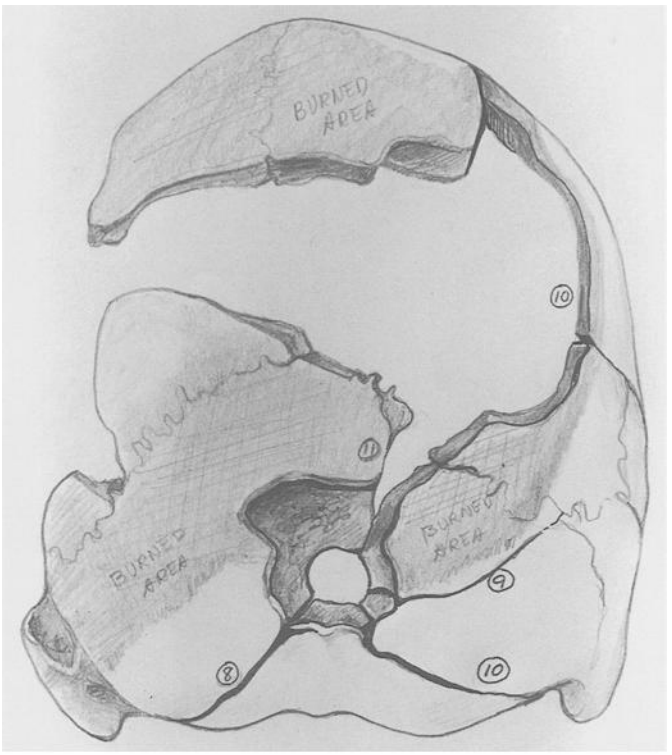
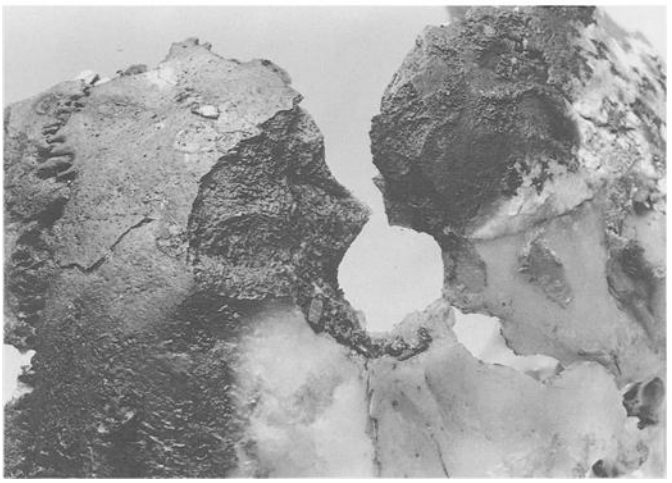


FIG. 3—*Reassembled skull of MC 8 showing the lower half of a gunshot entrance wound in the middle of the forehead.*





FIGS. 4*a* and 4*b*—*The exit wound in the occipital bone of MC 8 has four radiating fractures and external beveling. Note the pattern of charring. Illustrations produced at the time of examination helped to clarify and document injury patterns.*

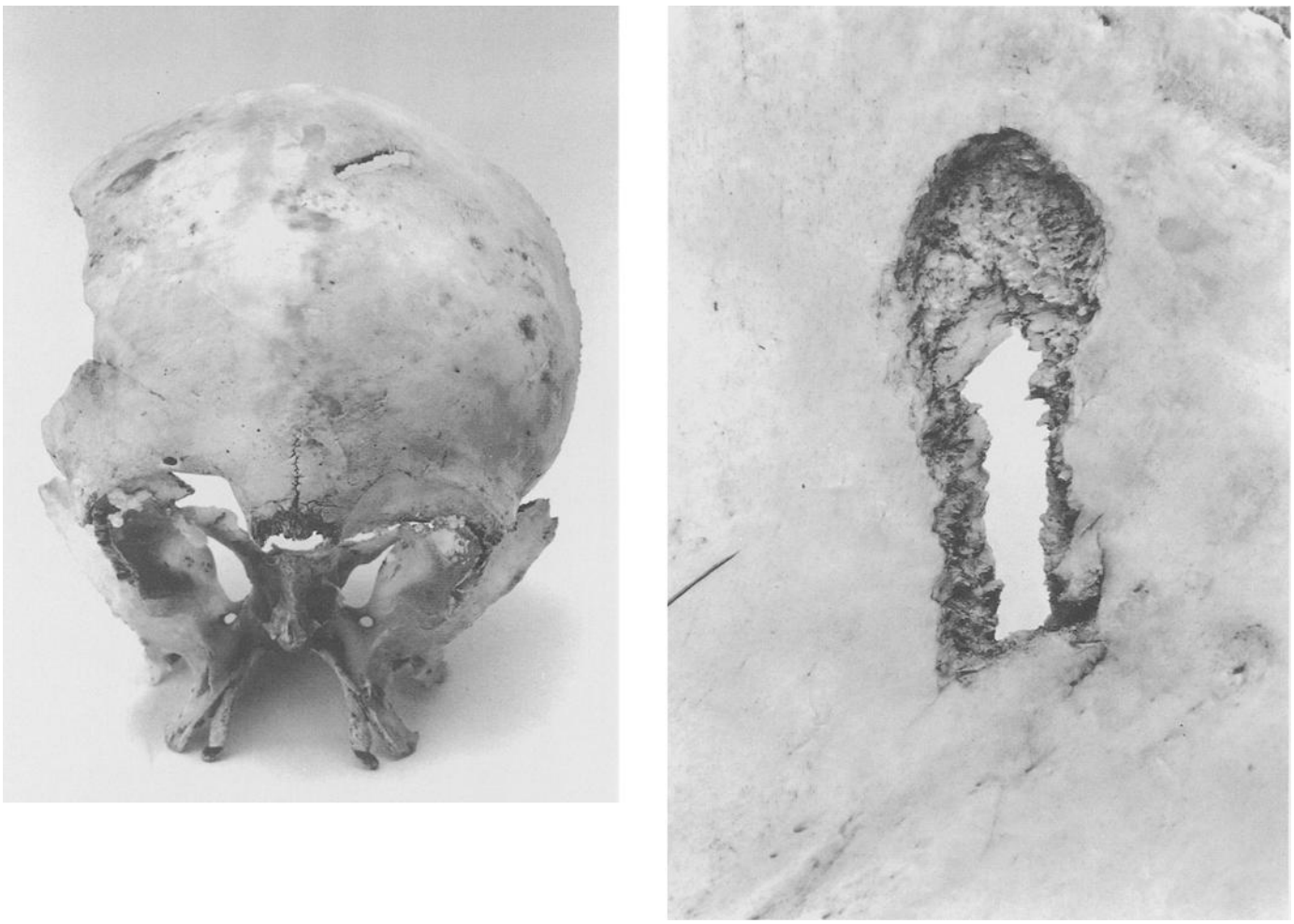
thus indicating that the frontal bone fractures occurred first in the sequence.

In addition to this perimortem gunshot wound that was the probable cause of death, MC 8 had suffered a nonfatal gunshot wound to the anterior one third of the ilium during the February 28 assault on the compound. The projectile had entered the external surface of the ilium and traveled posteriorly, causing internal exfoliation of the cortex, then exited from the posterior lateral side of the lower back. The projectile had removed a large (43 mm) fragment of bone.

Large quantities of munitions were stored in the compound, and the fire caused ammunition to explode. A number of individuals recovered in and around the arsenal (that is, the bunker) displayed shrapnel injuries. These injuries to bones varied considerably in size, shape, distribution, and force of impact. Some metallic fragments were embedded in bone, others produced only indentations, and still others resulted in punctures with irregular fracture margins.

The cranium of Case MC 65,D2, a very young, female child displayed a perimortem shrapnel wound. The skull was fragmented, but the frontal was present. In it was a defect with the distinctive internal beveling that is characteristic of forceful penetration by shrapnel (Figs. 5*a* and 5*b*).

One of the clearest examples of postmortem shrapnel injuries was Case MC 69, an approximately one year old child. Present were the nearly complete skull and mandible, with deciduous teeth, the upper body, and the left radius and ulna. On the lateral portion of the right parietal were two defects (Figs. 6*a* and 6*b*), one of which was 11 mm in diameter. The outer table was compressed and the inner table partially punctured. The second defect was a puncture of both the inner and outer tables, with compression on the surface. Some inner table blow-out was apparent. On the medial posterior portion of the right parietal was a discolored area 8 mm in diameter, but there was no puncture of the cranial bone. What appeared to be charred flesh adhered to the area. In the zygomatic process of the right temporal anterior to the external auditory meatus was a fourth defect, another compression puncture (Fig. 6*c*). In addition to trauma associated with the cranium, there was a puncture (3.5 mm in diameter) on the distal right humerus, with fracture lines traveling from it for a length of 22 mm superiorly



FIGS. 5*a* and 5*b*—*A shrapnel wound to the frontal bone of a small female (MC 65 D2). Figure* 5b *shows the endocranial surface of the wound.*

and 17 mm inferiorly (Fig. 7). All of these defects were consistent with shrapnel wounds.

Identification

Identification of the human remains from the Branch Davidian Compound was a principal objective of the investigation, requiring the complementary efforts of medical examiners, forensic odontologists, criminologists (for example, fingerprint specialists), molecular biologists, anthropologists, and others. The forensic anthropological examination was a basic part of this collaborative effort, for with information on distinguishing physical characteristics, the range of possible matches is narrowed. Comparison of premortem and postmortem medical and dental records of these possible matches then results in establishing, or rejecting, a positive identification. Case MC 27, a female, possibly black, between 50 and 60 years of age provides an example. Premortem (December 1988) and postmortem lateral and anterior-posterior radiographic views of the torso (Figs. 8*a* and 8*b*) and pelvis of an individual who might be MC 27 were compared. The anterior-posterior views revealed the following points of correspondence:

1. The morphology of the transverse processes of thoracic vertebrae was identical.

2. The contours of the sternal ends of left ribs 10 and 11 matched, rib 10 being elliptical, and rib 11 also elliptical but somewhat more rounded.

3. An asymmetrical difference in the left and right sides of the transverse process on the first lumbar vertebra was present in both views.

4. The contour of the left iliac crest matched, including the presence of a protuberance in the posterior third of the crest.

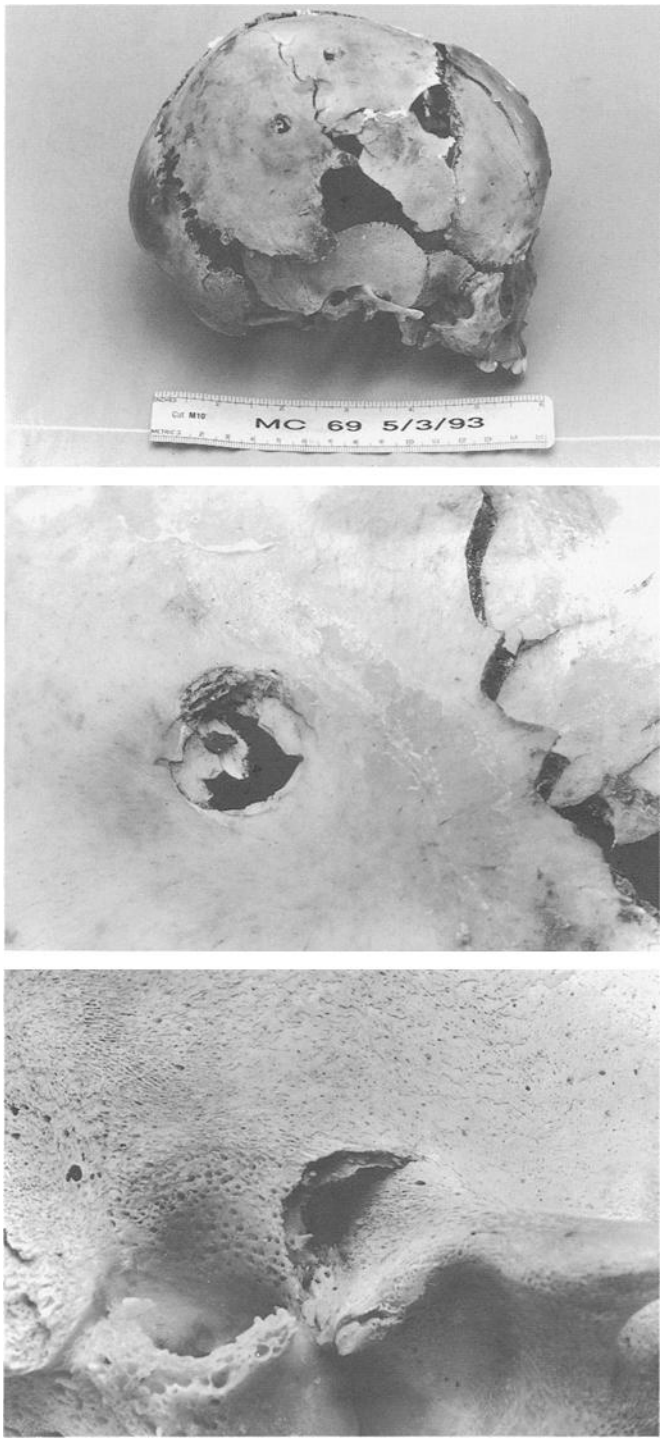
5. The morphology and kidney-shaped contour of the left lateral transverse process of the fifth lumbar vertebra were the same.

6. The right border of the third lumbar vertebra showed a pronounced curvature and so-called "Christmas tree" contour.

7. The appearance and overall contour of the sacral alae and promontory matched, as did the morphology of the attachment site of the left and right sacroiliac joints.

8. The superior neural spine on the posterior sacrum displayed an oblique orientation to the left in both films.

The left lateral view showed osteophytes on the ventral surfaces of the inferior and superior end plates of the fourth lumbar vertebra. The one on the superior surface was slightly more pronounced in the postmortem than the premortem film. The curvature of the ventral surface of the third lumbar vertebra was the same in premor-



FIGS. 6*a*, 6*b*, and 6*c*—*Shrapnel injuries in the right parietal and temporal bones of a one-year-old child (MC 69). Figure* 6b *shows a close-up view of the puncture wound in the middle of the parietal. Figure* 6c *shows a semicircular depression fracture in the temporal bone anterior to the external auditory meatus.*

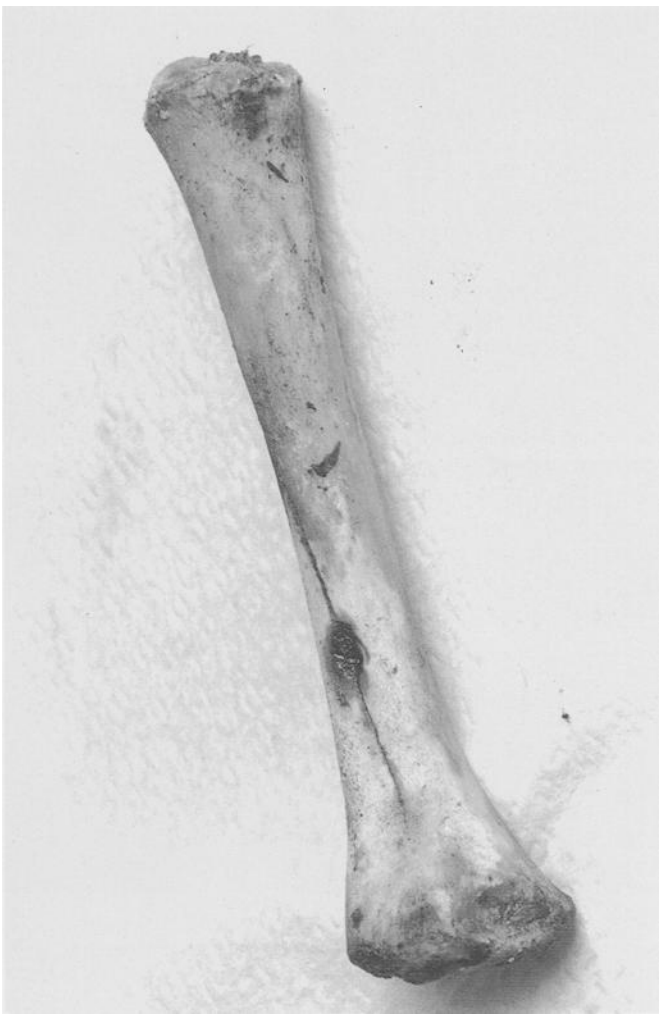


FIG. 7—*Shrapnel puncture in the ventral surface of the distal humerus of MC 69.*

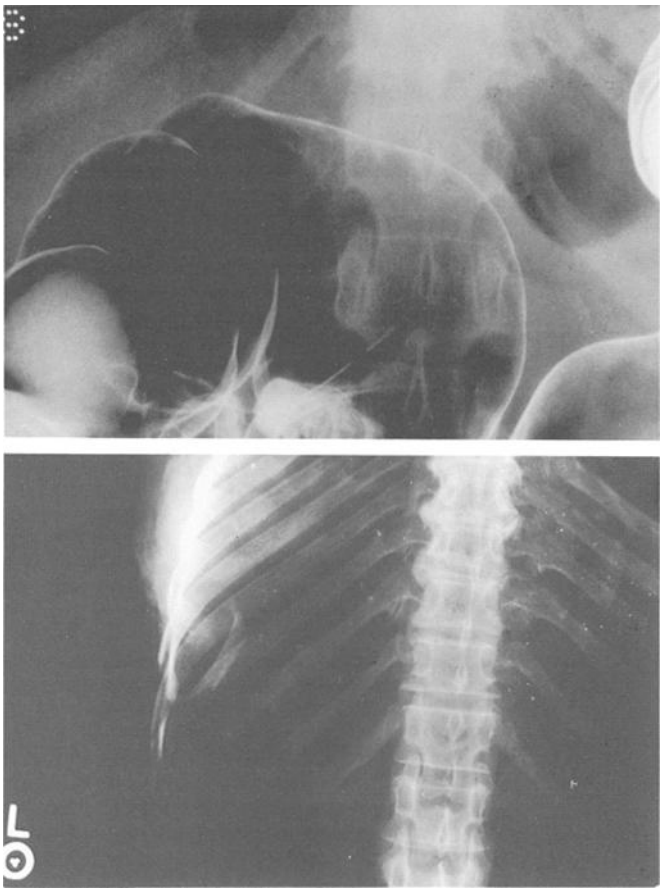
tem and postmortem films, and no osteophytes were present on this vertebra.

The many points of correspondence between the premortem and postmortem radiographic records permitted a positive identification of MC 27.

One of the principal contributions of a forensic anthropologist to identification, particularly in cases of mass disaster, is the sorting of commingled remains. It is necessary to sort and match, and thereby to determine the minimum number of individuals represented, before any meaningful attempt at identification can take place. Critical in matching dissociated elements are assessment of long bone robusticity, diaphyseal lengths, and joint surface articulations; identification of bones by side; matching of broken ends of fractured bones; noting correspondence in anthroposcopic features such as color of body hair and skin color (for example, color and distribution of hair on the legs); and determination of elements missing from assemblies of associated bones. Any associated remnants of clothing, especially shoes and socks, are also useful.

Most of the commingled remains were those retrieved from the bunker of the Branch Davidian Compound. The bodies recovered from this building were extensively damaged, in advanced stages of decomposition, and thoroughly intermixed. It was impractical to attempt to separate the remains at the site; therefore, closely associated body elements and clothing were placed in body bags for subsequent sorting at the morgue. The objectives of the forensic anthropological examination and assessment of these commingled remains were briefly as follows:

1. To separate the remains, matching dissociated skeletal elements and determining the minimum number of individuals present



FIGS. 8*a* and 8*b*—*Antemortem and postmortem radiographs of the lower torso of MC 27 showing correspondence in the outlines of the vertebral bodies, including the neural spines (for example, T11-L1) and the transverse processes of L1.*

prior to autopsy and medical, dental, and other anthropological analyses.

2. To provide assessments of age, sex, and ancestry, noting especially the features that were undergoing rapid decomposition (for example, skin color, external genitalia).

3. To indicate associated remains from which fingerprints or footprints could be obtained (FBI specialists worked closely with the forensic anthropologists).

4. To provide preliminary descriptions of biological features, traumatic injuries, and clothing and other objects associated with the remains prior to cleaning and detailed examination. (These preliminary assessments were necessary because of the lengthy interval required for systematic autopsy of such a large number of remains and the ongoing decomposition that would result in the loss of vital information.)

Cases MC 47, 47B, and 47C provide examples of the analysis of commingled remains. In this instance, it was not difficult to distinguish among the remains and to determine the number of individuals present. Case MC 47 was a white female about 22 to 28 years of age (subsequently positively identified as a 24-year-old female). Found in association with her were a young child and a fetus in about the fourth month (16–18 weeks) of development (based on measurement of the long bone diaphyses; see [*12*]). The fragmented skull of the adult female was present, with the partial mandible, left maxilla, and a few molars in place. Root development of the maxillary third molar was complete and the tooth was almost fully erupted (not quite in the occlusal plane). Ribs, pelvis, and partial long bones, most being burned and blackened, were also present. Associated with these remains were the left forearm and hand of a child (MC 47B), with the long, brown hair of the woman twisted about the fingers. Measurement of the radius and ulna [*3*] suggested that the age of the child was approximately 3.5 years. The fetal remains (MC 47C) included the frontal, right humerus, radius, and ulna, left and right innominates, left and right femora, and left tibia. The ilia of the innominates had ossified, but the ischia and pubes were largely cartilaginous (Fig. 9).

The hair on the left side of the adult female's head was matted with blood, in which two lead particles were found, and a forensic pathologist subsequently removed lead fragments from the brain. Entrance and exit wounds could not be determined without reconstruction of the very fragmented cranium. Radiographs of the partial long bones showed no perimortem breakage, but radiopaque particles were present in the tissues of the left femur, tibia, and fibula. Perimortem trauma appeared to be the likely cause of death, with postmortem fire and possible shrapnel damage.

A more difficult problem was the sorting of the four body bags containing the commingled remains of 12 individuals that were

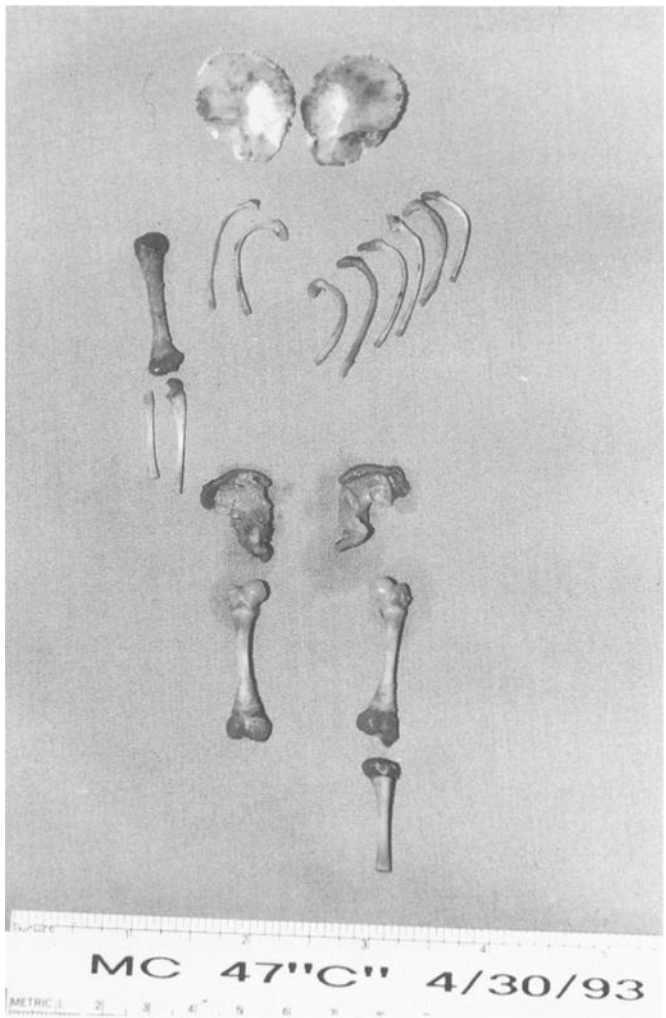


FIG. 9—*Partial skeleton of a fetus (MC 47C) aged 16–18 weeks. The photograph shows the ununited halves of the frontal bone, the right humerus, ulna, and radius, the innominates, the femora, and the left tibia.*

recovered from one location in the bunker of the Compound (Fig. 10). The first bag (A) contained the partial remains of several children. With one exception—an infant between 1.0 and 1.5 years old—the bones and soft tissues of the children were subsequently matched with remains from Bags B, C, and D.

Bag B included an adult female and three children. Based on long bone measurements, upper leg elements and a pelvis and torso from Bag A were associated with a five to six year old child in Bag B. Two femora and a trunk from Bag A were matched with a second child, about a year old. Body elements from both Bags A and C were associated with those of a third child in Bag B, a 7.5–8.5 year old, white and probably male.

The remains of the adult in Bag B were lying face down when initially examined. Present were the left mandibular ramus, left maxilla, and left mandibular and maxillary dentition. The left humerus and upper vertebral column were present. The left ulna and radius were broken and separated at mid-shaft, and the clenched right hand held the dissociated hand of the one-year-old child. A right ulna and radius from Bag A were matched with this individual on the basis of the articulation of these bones with the left humerus.

Bag C contained commingled bones, shell casings, unfired bullets, a gas mask, a baby blanket, fragments of a blue bandanna, and stained gauze bandages. Represented among the bones were a 2.5-year-old child and an adolescent female, about 14 to 18 years of age.

FIG. 10—*Initial inventory and sorting of commingled remains in Bag C.*

Bag D, like C, contained shell casings and unfired ammunition as well as the commingled bones of three individuals, an adult female some 30 to 50 years old, and two small children, an infant, and a toddler. Also present were a stained, perforated blanket, a lady's watch (still running), a terry cloth hair tie, and a metal tag with a string attached.

Because of the commingling, case numbers were not assigned to some bodies until after the remains were sorted in the morgue and the exact number of individuals known. These identification codes were essential for maintaining accurate records during the examination and analysis of remains. Whenever possible, dismembered fingers, hands, and feet, key means of identification (such as prints), were associated with bodies and assigned the same case number. Often, as a result of such linkages, an assembly of bones representing one individual could be identified rather than only an isolated, dissociated body part such as a hand. The sorting and association of these commingled skeletal remains provided a foundation for the subsequent detailed analyses needed to document the events that occurred in this mass disaster and to identify those involved in it.

Conclusion

Participation in this multidisciplinary investigation provided an opportunity for forensic anthropologists to demonstrate some of the ways that they can assist and complement the efforts of medical, dental, biochemical, and other forensic experts in dealing with the recovery, osteological analysis, and identification of victims of a mass disaster. The close cooperation and interaction that occurred among the representatives of the many disciplines taking part made the experience especially rewarding.

Acknowledgments

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