CASE REPORT

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Differentiation of Perimortem and Postmortem Trauma Using Taphonomic Indicators

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ABSTRACT: Skeletal remains discovered at a construction site in Georgia display classic "butterfly" fractures on several long bones. Although this fracture pattern is usually associated with perimortem trauma, in this case taphonomic indicators demonstrate that they can also occur on dry defleshed bone. Variations in bone color at the fracture sites indicate recent postmortem trauma. Analysis of the directions of force and points of impact indicates that the bones were most likely disarticulated when the trauma occurred.

KEYWORDS: physical anthropology, peri/postmortem trauma, taphonomy, butterfly fracture, forensic anthropology

Usually skeletal evidence for perimortem trauma is quite clear and can easily be distinguished from that reflecting postmortem alteration. Much of the evidence involved in making such distinctions is derived from an assessment of the morphological characteristics of classic perimortem trauma (sharp force trauma, gunshot wounds, blunt force trauma, etc.) and postmortem alterations (carnivore tooth marks, surface erosion, sun bleaching, etc.) [*1*]. A further distinction between perimortem and postmortem trauma is determined not only by observations concerning the factors that produce each type, but also by the condition of the bone and its ability to respond to the trauma. This latter point reflects the difference between a "green bone" response and that of "dry bone."

"Butterfly" fractures are well known in the anthropology, pathology, and radiology literature [*2*]. They result from blunt force trauma or gunshot wounds when the external force produces angulation fractures. In such cases, the force causes the bone to bend, creating a concave surface at the site of impact and a convex surface on the opposite side. The tension stresses on the convex surface lead to a linear fracture, while the compression stresses on the concave surface lead to either splintering or multiple fractures. Frequently, two fractures form on the concave surface that connect to the single fracture on the convex surface, separating a triangular shaped section of bone (Fig. 1). Such a break is termed a "butterfly" fracture due to its distinctive shape, and in the absence of any bony remodeling usually indicates perimortem trauma. The following case study indicates that "butterfly" fractures are *not* limited to perimortem trauma, but can also be produced postmortem.

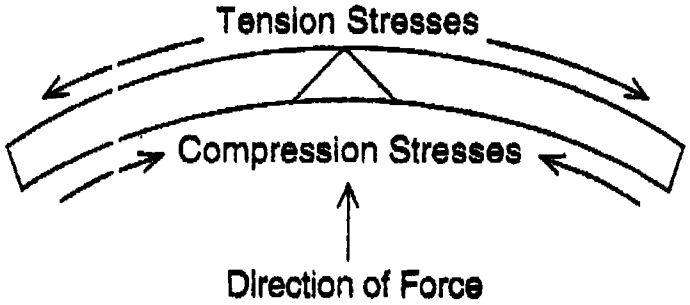

FIG. 1—*Compression and tension stresses that produce a "butterfly" fracture (modified from Harkess, 1975* [2]).

Case Report

In June 1993, a construction worker clearing underbrush and small trees for a new subdivision in a suburban area in Marietta, Cobb County, Georgia found skeletonized human remains. When authorities responded, they found that the cranium had been discovered about 15 feet from the majority of the bones. Apparently, the skeleton had been scattered by the machinery operating in the area, and none of the bones were observed in their original locations. All materials were carefully recovered by police investigators and the surrounding soil was sifted to search for small bones and artifacts.

Following examination by police specialists and the medical examiner, the remains were submitted to the FBI laboratories for evaluation. Photographs of missing persons that might be represented by the remains were included as well. Following routine procedures, all materials were presented to the Department of Anthropology, National Museum of Natural History, Smithsonian Institution in Washington, D.C. for evaluation.

Our examination revealed a relatively complete human skeleton showing evidence of a previous postmortem examination (that is, autopsy section of the upper cranial vault, teeth glued in place, and broken bone fragments glued together). The right side of the cranium was stained dark brown while, in contrast, the left side was more white in color, with adherent green algae and/or moss. This suggests that between death and discovery the cranium had been resting on its right side with its left side exposed to the sun. No soft tissue, arthropods, or significant odor were present.

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Furthermore, the extent of sun bleaching, surface erosion, and cracking on all remains suggested time since death was likely more than one year. The post-cranial remains were darker in color than the left side of the cranium suggesting they may have been at least partially covered with organic debris. Like the cranium, the post-cranial bones lacked odor and grease and exhibited taphonomic alterations similar to those of the cranium.

Standard measurements and observations indicated the skeleton was that of a female, likely between 25 and 35 years of age, approximately five feet seven inches tall, and of probable European ancestry. Identifying characteristics included a very prominent chin and generally large lower jaw, prominent rounded supraorbital ridges, some unusual arthritic changes in the lumbar vertebrae, numerous dental restorations, and a very large, bony protuberance (inion hook) on the external occipital in the midline.

Many areas of the skeleton revealed damaged or altered bone. Clear evidence of rodent gnawing was apparent only in the occipital condyle area. Because of the lengthy postmortem interval, many of the bones displayed damaged surfaces, eroded areas, and general evidence of bone fragmentation. This was especially apparent on the ribs and on the ends of most long bones. The exposed surfaces of these fragmented and eroded areas were stained dark, indicating that the alterations were not recent (Figs. 2 and 3). No evidence of perimortem trauma was visible on the remains, but more than one episode of postmortem damage is apparent.

Of particular interest for this case report are several diaphyseal fractures located on the midshafts of both humeri and the left tibia and fibula. The bone coloration associated with these breaks is lighter than the previously mentioned fragmented areas. Because of earlier damage to the proximal and distal ends of these bones, measurements documenting the locations of the diaphyseal fractures were taken from nonstandard landmarks when necessary.

Recent fractures on the right humerus are of the "butterfly" type, producing three segments of the humeral diaphysis: a triangular shaped bone fragment and the superior and inferior segments (Fig. 4). The triangular fragment measures 35.1 mm in length and 20.8 mm in width. The two fractures that produced the triangular fragment measure 22.9 mm on the inferior margin and 24.6 mm on the superior margin. The base of the triangle (site of compression and impact of force) is on the lateral surface. The apex of the triangle is on the medial surface, 116.8 mm superior to the inferior extremity. This fracture pattern indicates that the force travelled from the lateral to medial surface, with the point of impact on the bone's lateral surface.

An additional "butterfly" fracture is present on the left tibia, producing three segments of the tibial diaphysis: a triangular fragment and superior and inferior segments (Fig. 5). The triangular fragment measures 22.7 mm (longitudinal) by 26.5 mm (horizontal)

FIG. 2—*Dark stained fractured surface of right mandible.*

FIG. 4—*Butterfly fracture of right humerus diaphysis.*

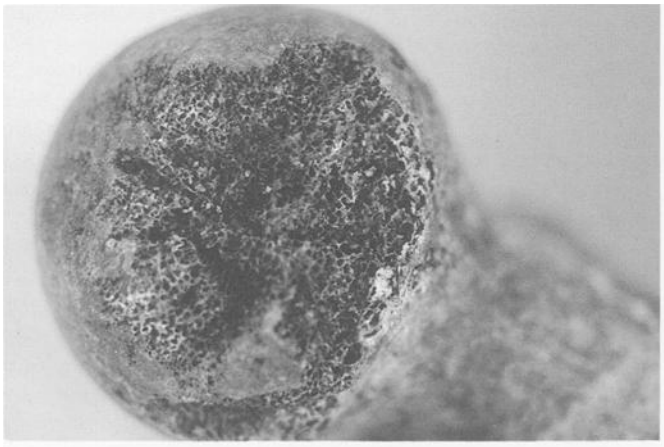

FIG. 3—*Dark stained fractured surface of left femoral head.*

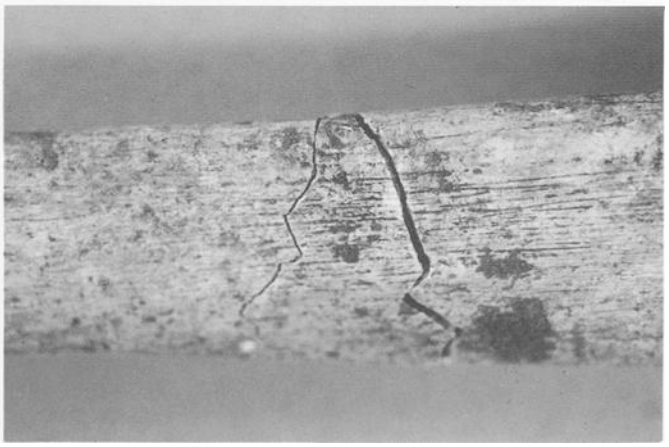

FIG. 5—*Butterfly fracture of left tibia diaphysis.*

and primarily involves the anterior and medial portions of the bone. The base of the triangle (site of compression and impact of force) is on the medial/anterior aspect of the diaphysis. The apex is on the lateral surface approximately 246 mm from the lateral condyle of the superior articular surface of the tibia. The force creating the fracture travelled from the medial to lateral surface, with the point of impact on the bone's medial surface.

A third "butterfly" fracture is located on the diaphysis of the left fibula, producing three segments: a roughly rectangular fragment and the superior and inferior segments (Fig. 6). The rectangular fragment measures about 10.9 mm (longitudinal) by 11.9 mm (horizontal) and involves the lateral and posterior aspect of the diaphysis: The center of the fragment is located approximately 137 mm superior from the most inferior point of the fibula (lateral malleolus) and is the site of compression and point of impact. The force creating the fracture travelled from the lateral to medial surface.

Recent fractures are also present on the left humerus, but these are not of the "butterfly" type. They are described in this report because they most likely occurred at the same time as the previously mentioned "butterfly" fractures. All of the recent trauma is concentrated within a 95 mm area of the midshaft. A horizontally oriented linear fracture is located about 66 mm superior to the superior border of the olecranon fossa. This fracture separates the humerus into superior and inferior segments. Additional longitudinally oriented irregular fractures are located on the superior segment and on all sides. These longitudinal fractures resulted in some splitting of the bone, but did not produce additional fragments.

Discussion

Although these "butterfly" fractures display characteristics normally associated with perimortem trauma, taphonomic features indicate they all reflect recent postmortem events. In particular, each of the fractured surfaces displays light coloration that contrasts with the dark staining present on those surfaces which have been exposed for much or all of the postmortem interval. This contrast is revealed by comparing the "butterfly" fractured surfaces with the external bone surfaces in general. It can also be seen by comparing the "butterfly" fractured surfaces with the adjacent unfractured endosteal and periosteal cortical bone surfaces (Fig. 7). If the "butterfly" fractures were perimortem (sustained at or near the time of death), a more uniform, dark coloration pattern would be expected on the fractured surfaces. Clearly, the "butterfly" fractures represent recent trauma, likely sustained shortly before discovery.

FIG. 6—*Butterfly fracture of left fibula diaphysis.*

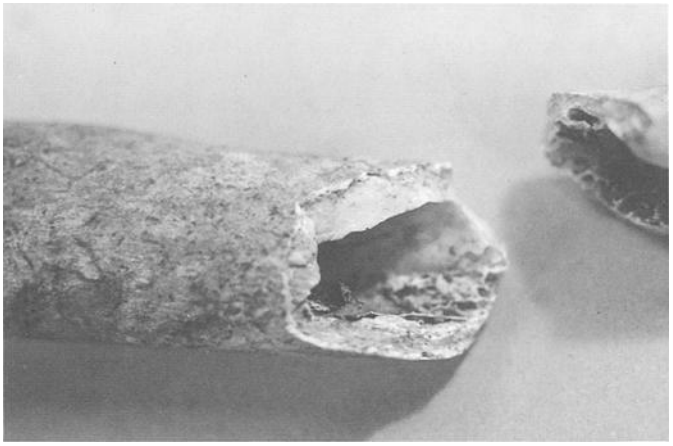

FIG. 7—*Fractured surfaces of right humerus showing coloration contrasts.*

Additional evidence suggesting a recent postmortem origin of these fractures involves interpretation of the direction of causative forces operating on the bones. As discussed, an analysis of the morphology of the "butterfly" fractures, with particular consideration of the compression and tension stresses that were operating, reveals force direction. The recent fractures on the left humerus were not of the "butterfly" variety and direction could not be established. However, on the right humerus, direction clearly was from the lateral side (point of impact on the lateral surface). Similar observations on the left tibia suggest the direction was from the medial surface (point of impact on the medial surface). In contrast, direction of force on the left fibula was from the lateral/posterior area.

Although the locations of the fractures on the left tibia and fibula are in the approximate same location on the diaphysis, they display fracture patterns which suggest the forces that produced them travelled from different, in fact, nearly opposite, directions. If this trauma occurred perimortem, with the bones still in anatomical order (soft tissue present), the pattern would only be possible from two separate traumatic events originating from opposite directions, but involving the same area of the lower leg. Considering the additional taphonomic observations discussed above, it appears that this trauma was sustained postmortem, shortly before discovery. In the absence of the soft tissue, the left tibia and fibula may have slightly shifted position so that the tibia was resting on its lateral surface and the fibula on its anterior/medial surface, exposing their opposite surfaces to crushing forces sustained from above.

According to documents associated with the case, the remains were discovered by the operator of a front end loader clearing brush at the scene. The heavy power equipment seems a likely source of the trauma to the long bones discussed above. Curiously, the affected bones reveal no recent scratch marks on the external bone surfaces in association with the fractures, as might be expected if equipment was involved. Leaves or debris covering the remains and protecting the bone surface represents a possible explanation, but this interpretation cannot be verified.

Summary

This case offers an example of how taphonomic observations are needed to accurately interpret traumatic evidence. In this

instance, both coloration differences, as well as the directions of force and points of impact were important factors distinguishing postmortem from perimortem trauma. In addition, it is apparent that a pattern of fracture ("butterfly") normally associated with perimortem trauma can also be produced postmortem.

References

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