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# PERIMORTEM AND POSTMORTEM MODIFICATION OF HUMAN BONE. LESSONS FROM FORENSIC ANTHROPOLOGY

*ABSTRACT: Interpretations of taphonomic and/or cultural modifications of ancient human remains are enhanced with data gleaned from modern forensic cases. Examples of perimortem and postmortem changes from documented modern cases are reviewed.*

*KEY WORDS: Bone modifications — Perimortem/postmortem alterations — Forensic anthropology.*

Modern forensic cases offer not only an opportunity to apply our methods of physical anthropology to contemporary problems of identification and detection of criminal behavior, but also offer data on perimortem and postmortem changes. These data augment our understanding of taphonomic and cultural factors that may have affected ancient remains. For the last 15 years, I have served as consultant in forensic anthropology to the Federal Bureau of Investigation in Washington D.C. Complementing the efforts of colleagues at state and regional offices, I work to identify the largely skeletonized human remains that are submitted to the FBI.

Although many of the over 400 cases that I have studied turn out to be archeological in origin, many represent recently deceased individuals with known details of manner of death and postmortem treatment. Most evidence for criminal behavior found in human skeletal remains represents alterations made perimortem (at or about the time of death). On skeletal evidence alone, forensic anthropologists rarely can determine or reliably estimate the cause of death. However, observations on the nature and location of alterations on bones can provide relevant information which can contribute to the determination of cause and manner of death.

A general rule in forensic anthropology is that alterations in bone approximately reflect the size and shape of the instruments or objects that made them. However one must remember that a single object or instrument can produce a variety of alterations depending upon the direction, angle, and force of the blow or insertion. Also it is sometimes difficult to distinguish perimortem trauma associated with foul play from postmortem injury.

In April of 1980, human remains were recovered from rocky terrain in Yosemite Valley of Yosemite National Park, California that were positively identified as belonging to a young woman missing since September of 1979. The remains were found directly below the outlet of a ventilation side tunnel connecting to the main tunnel on a highway. The recovered remains showed evidence of postmortem gnawing by a large carnivore. In addition the right femur was fractured just above the mid-line and much of the right parietal and temporal was fractured and missing (*Figure 1*). In this case, it was not possible to determine if the trauma resulted from the lengthy fall to the rocky terrain below or from trauma sustained to the body through criminal behavior prior to the fall.

A cranium showing very similar fracture patterns was submitted in 1984 from South Dakota. This cranium and associated skeleton belonged to a 30 year old American Indian who according to testimony died after being struck in the head with a heavy tire jack. The resulting fracture was massive but virtually indistinguishable from postmortem trauma (*Figure 2*).

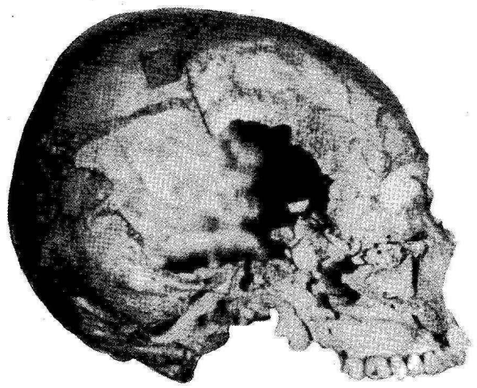

FIGURE 1. *Cranium of young female from California with perimortem fracture.*

FIGURE 2. *Cranium of 30 year old American Indian male showing perimortem fracture resulting from blunt force trauma.*

The best evidence for perimortem trauma consists of what has been called "green bone response" (Maples 1986). In some situations, living bone will respond to trauma by bending or twisting in a manner that is not possible after the organic components have deteriorated after death. Such a response was observed in the cranium from a 20 year old Tennessee male (*Figure 3*) who had been killed by being struck with a large rock. In this 1981 case, the left parietal and temporal displayed a compressed fracture that was oblong in shape measuring 70 mm by 40 mm. Some aspects of the border of the fracture were bent inward, documenting both the impact of the large blunt object and the elastic bone response.

In 1983, I examined the remains of a 42 year old white female who initially was reported dead by her husband who indicated she had been kicked in the head by a horse on the family ranch. The woman was buried

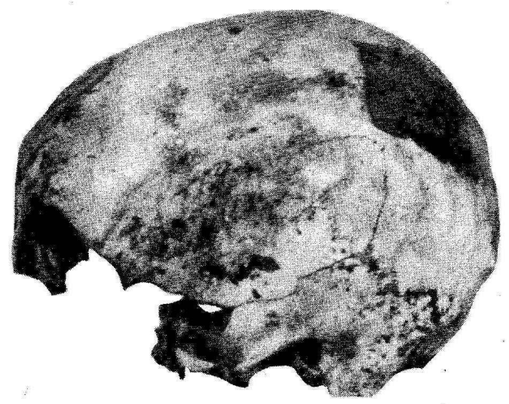

FIGURE 3. *Cranium of young male from Tennessee showing perimortem depressed fracture.*

following a partial autopsy. Several years later, another woman reported that the husband had told her that he had killed his wife by striking her in the head with a hammer and furthermore that he had placed the body in the horse's pen to make it look like an accident. Exhumation of the body and examination of the cranium revealed massive fracture of the left lower vault that most experts agreed could have been produced either by the kick of a horse or by a blow to the head with a hammer. Examination of the other side of the cranium however revealed similar trauma to the right temporal region and a clear-cut ovoid perforation in the frontal that could not have resulted from the horse's kick, but represents the signature alteration of a blow from a hammer like object. The angle of the blow produced a sharp upper margin and a platform on the lower margin.

Stabbings typically produce a slight incision where the edge or point of the knife strike bone. These are usually very slight alterations that are easily missed without careful cleaning and examination. An alteration caused by a knife inserted at or about the time of death will have very distinct borders and lack any evidence of healing or long term bony response. This condition contrasts with the bony response usually seen when at least several months have elapsed between death and the formation of the initial bony alteration.

It is important to remember that many knife insertions will penetrate the soft tissue without striking bone. A recent case illustrates this point well. The shirt recovered from the crime scene showed evidence of ten cut marks on the left front area and four additional cut marks on the back right side of the shirt. Bony alterations were confined to the ninth thoracic vertebral arch and spinous process, the vertebral arch of the 8th thoracic vertebra, and the superior border of the left 4th rib. Thus of the 14 apparent insertions, only about three struck bone.

In some circumstances the green bone or bending effect also may be seen with knife incisions. Usually evidence takes the form of bone pushed in along the edges of the incision. If the incision is located near the margin of a thin flat bone like a scapula or rib (*Figure 4*),



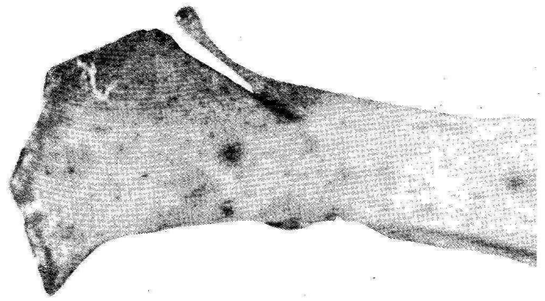

FIGURE 4. *Human rib showing "green bone" response to perimortem incision.*

a slice of bone may be bent outward in a characteristic manner.

A single knife or similar weapon can produce a variety of incisions on a single skeleton depending upon the instrument surface used, force, angle, twisting motion etc. In a 1985 New England case, a single knife was used to produce 28 different incisions in the skeleton of a 16 year old Massachusetts woman. The cranium displayed a deep alteration on the left frontal just above the orbit made by the point of the knife. It also showed long shallow incisions extending across the lower margin of the left orbit made by the blade of the knife. The longest of these incisions culminated below the orbit in blunt force trauma, probably produced by a blow with the handle of the knife. Other alterations produced by the same weapon were located on the back of the cranium, femur, scapula, fibula, ribs, vertebrae, tip of the coccyx, ischium and even the lateral margin of the pubis. Since this case involved an adolescent, care was required to distinguish cut marks from lines of partially united epiphyses.

Note that perimortem cut marks can be difficult to distinguish from those made immediately after death. The latter result from postmortem dismemberment or in archeological recovered specimens from cultural funerary practices. In prehistoric ossuaries from the mid-Atlantic area of the United States, cut marks have been found on long bones resulting from the removal of flesh from the deceased to disarticulate body parts in preparation for burial.

Modern forensic cases also offer data and interesting documented cases of post-mortem changes in bone. Bones exposed to fire or extreme heat while the flesh was still present show twisting of the bone contour and an ovoid, irregular fracture pattern. In contrast bones burned after flesh had decomposed generally lack the twisting and display vertical fracture lines.

Skeletons burned with flesh attached also show greater variability in the effects of burning than do those burned as dry bone. A recent case from the New England area represented a young child burned in an open fire soon after death. Some of the bones were completely calcined, others were only charred, and still others were unaffected.

A cranium found on a Pacific island in 1981 had been subjected to very intense heat soon after death. The protection of the soft tissue confined the bony alteration to a particular area, with a sharp line separating the affected from the unaffected area. A similar line of separation was found on the cranium of a Nebraska woman who had been killed and then disfigured by the application of lye or some other toxic chemical to the head and face at the time of death (Ubelaker and Sperber 1988).

Our experience in forensic anthropology indicates that foraging birds and animals contribute greatly to the rapid postmortem loss of soft tissue and to the disarticulation and dispersal of skeletal parts. Many animals not only consume the soft tissue but leave marks on bones as well (Morse 1983). Skeletons exposed on the ground surface may show characteristic gnaw marks of small rodents, especially on the orbits, and bone ridges. Carnivores such as coyotes, dogs and wolves tend to chew on the nose and male genitalia (if exposed) of recently deceased individuals. After soft tissue decomposition, they chew on the ends of long bones and will transport them considerable distances in the process (Haglund et. al. 1988). These carnivores will leave behind a characteristic pattern of gnaw marks as well as diagnostic individual tooth impressions. Pigs and to some extent bears tend to break the shafts of the bones more than do the carnivores mentionned above (Morse 1983; Murad and Boddy 1987). Again, diagnostic tooth impressions frequently are left behind. The proximal portion of a human tibia recovered from the stomach of a great white shark off the coast of South Carolina shows the characteristic chisel-like alterations.

Forensic experience also testifies to the role of root penetration in bone fragmentation. Plant roots frequently will penetrate bony orifices and eventually follow the medullary cavity of a long bone. As the plant grows the root will increase in diameter until it pushes the bone apart.

Prolonged exposure to the sun will produce slow loss of the organic component and calcination. This process typically gives the "bleached" white appearance to the affected bones. Forensic experience suggests that exposure to salt water can give a similar effect.

Unusual patterns of post-mortem change are sometimes produced by forensic circumstances that document how difficult it becomes to predict human behavior. A case in point involves a 19 year old female murder victim from Nebraska. After putting a caustic substance on her face to thwart identification, the assailant placed the body in an unused cistern where it remained undetected for several years. After the skeleton was located and identified as that of the missing woman, we noticed several white spots on top of the cranium. In contrast to alterations on the facial bones produced by contact with the caustic substance, the spots showed no loss of bone, only a circular well defined whitening. It seems the cranium was located directly below a metal covering to the cistern which contained a number of perforations. For a brief period each sunny day, sunlight would stream through the perforations and strike the top of the cranium. After a number of years, the periodic beams of light eventually produced the white spots that we observed (Ubelaker and Sperber 1988).

In summary, details from modern forensic cases indicate the diversity of perimortem and postmortem factors which can affect bone. Consideration of these factors should improve interpretation of similar alterations on ancient human remains.

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