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Sharp-Force Trauma Analysis and the Forensic Anthropologist: Techniques Advocated by William R. Maples, Ph.D.

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ABSTRACT: forensic anthropological tenets supported by William R. Maples, Ph.D. provide the bases for a case study from the C.A. Pound Human Identification Laboratory. Using a multidisciplinary team that included police investigators, pathologists, odontologists, entomologists, and anthropologists, a biological profile and trauma analysis was constructed. Our analysis determined that the decedent was a middle-aged Hispanic male, approximately 5′6″–5′7″ in stature, who had died a minimum of three months before the discovery of his remains. Gross and microscopic analysis revealed 11 areas of sharp trauma to the skull and cervical vertebrae. To aid with analysis of the trauma, nonhuman trauma exemplars were created using a Tiger® rear flail mower of the make known to have been used at the scene where the remains were recovered. This use of nonhuman trauma exemplars proved to be essential in the effort to exclude the rear flail mower as the possible trauma agent.

KEYWORDS: forensic science, forensic anthropology, sharp-force trauma, multidisciplinary team, nonhuman trauma exemplars, William R. Maples

A case study from the C.A. Pound Human Identification Laboratory is presented in order to highlight tenets supported by William R. Maples, Ph.D. In agreement with his colleagues, Maples believed that forensic science is characterized and bettered by the close cooperation of many forensic scientists (1,2). His work in physical anthropology helped to establish forensic anthropology as a necessary component in the forensic sciences. I highlight two suggestions advocated by Maples: 1) that the forensic anthropologist provides a valuable scientific service to medical examiners and coroners in cases of identification and trauma analysis where pathological analysis is difficult due to extensive skeletonization or decomposition (1,3,4), and 2) that the creation of nonhuman trauma exemplars aids in the accurate interpretation of sharp-force trauma (4).

Case Report

In March of 1997, a citizen walking his dog through a vacant field in Sanford, Florida discovered the scattered bones of a human skeleton. At the request of the medical examiner, staff from the C.A. Pound Human Identification Laboratory was called upon to help in the recovery and analysis of the remains.

Field Investigation

Before our arrival at the scene, Sanford police and crime scene technicians established a perimeter around the 30 m by 100 m scene, flagging all possible bone and personal effects. Our forensic anthropology team mapped and photographed all skeletal material and personal effects in situ, relative to a permanent datum point and prior to collection. Each of the elements was bagged separately and labeled with a case number, bag number, description of the item, and mapped coordinates. We recovered 66 bones that were mostly fragmentary, one large piece of mummified tissue from the posterior hemi-thorax, and entomological evidence. Personal effects included a Bike® athletic supporter (size Large), one cotton striped Shah Safari® shirt, and one pair of Levi® jeans shorts. At the request of the medical examiner, the C.A. Pound Human Identification Laboratory took custody of and receipted all bone, mummified skin, and entomological evidence for the purposes of identification and trauma analysis.

Our interviews with the crime investigators revealed that as late as six months before the discovery of the remains, the field had been a hub of ellicit activity including prostitution and drug dealing. Local police had made strong efforts over the past months to keep trespassers out of the field. More importantly, the landowner mowed the field periodically with a Tiger® rear-flail mower. This information provided clues to the postmortem interval and nature of the traumatic defects seen on the skeleton.

While in the field, it was evident that at least two areas of sharp-force trauma were present on the skull. The skeleton was very scattered and fragmented. It became the job of our laboratory staff to help assess the sharp trauma and determine whether these defects could have been created by a Tiger® rear flail mower. This would be done through gross and microscopic analysis and comparison of nonhuman trauma samples.

Laboratory Analysis

Time since death was established using both anthropological and entomological analyses. The skeletonized remains were partially sun-bleached and had mummified tissue adhered to the more rugose muscle attachment sites. A large piece of mummified skin from the victim's back was also present. Carpet beetles (*Dermestes maculatus*) and Sap beetles (*Capophilus* sp.) were recovered from the remains and analyzed by a forensic entomologist. The degree of skeletonization seen in these remains, mummified tissue, and ento-

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mological evidence suggested that death occurred a *minimum* of 8–13 weeks before the discovery of the remains.

We created a biological profile including the assessment of individuation, sex, age, race, and stature. The bones were morphologically consistent without abnormal duplication, and thus represented one individual. Morphological features of the pelvis and skull indicated the individual was a male. Because cranial suture fusion is a somewhat unreliable aging technique (1) and the pubic symphyses had been destroyed, we conducted an age assessment using the morphology of right fourth rib (5) and pelvic auricular surfaces (6). This age assessment indicated the individual was in his mid 30's to mid 40's at time of death. Observed morphological traits (7) of the skull, including the presence of a narrow nasal opening, parabolic palate shape, prominent and straight nasal spine, reduced alveolar prognathism and an overall cranial shape of pentagonal to ovoid suggested this individual was white. FORDISC metric analysis (8) classified this unknown individual as Hispanic ($p = .957$). Stature estimate was calculated using Trotter and Gleser's regression formulas (9) for white and black males. Because Trotter and Gleser's original research did not include sufficient samples for Hispanic stature formulas and other formulas for Hispanic stature calculations are not in existence at this time, a best estimate of stature was derived from the white and black formulas. Using the only intact long bone recovered, the left humerus, mean estimate of stature was calculated as 5.7 $\pm$ 3.1 in. for white males and 5.6 $\pm$ 3.5 in. for black males.

Working in conjunction with a forensic odontologist, we created a postmortem dental record using Computer Assisted Postmortem Identification (CAPMI) symbols and dental radiography. The mandible was edentulous, except for tooth number 32. The maxillary teeth exhibited numerous amalgam and composite dental restorations that could be used to establish a positive identification should antemortem records become available.

Trauma Analysis

Gross and microscopic analysis of the remains revealed eleven areas of sharp trauma on the skull and first two cervical vertebrae. There were eight areas of sharp trauma to the skull and three to the cervical vertebrae (two cutmarks on the first cervical vertebra and one cutmark on the second cervical vertebra). When the two cervical vertebrae were articulated with the skull, the eleven areas of sharp trauma suggested a minimum of seven blows with a bladed instrument having a minimum blade length of 83 mm and minimum blade width of 1 mm. Two blows from a sharp blade were present on the right side of the skull (Fig. 1). The posterior aspect of the right mastoid process had been cut at an oblique angle. The flat, smooth surface of this cut had cutmark striae running in a posterio-lateral to anterio-medial direction. The right orbit had a cutmark to its supero-lateral border with associated fracturing of the fronto-sphenoidal suture.

The left side of the skull and two articulated vertebrae exhibited nine areas of sharp trauma (Fig. 2). The left mastoid had been cut off with a blow that may have been associated with the incised mark on the inferior border of the superior facet of C1 and the 6 mm cutmark on the posterior border of the mandibular ascending ramus. The left side of the skull also had a 107 mm cutmark spanning the left temporal, parietal, and occipital. Squamosal portions of the temporal bone were gone, exposing the underlying parietal bone. This type of fracture pattern was possibly caused by the flat surface (side) of the blade. The left mandibular ramus has a 20 mm cutmark with striae that suggest a lateral blow. The left lateral aspect of the occipital has a 46 mm cutmark that may have resulted from the same blow that created the cutmark present on the inner table of the foramen magnum and the cutmark seen on the supero-lateral border of the left transverse process of C1. An 83 mm cutmark, from which the minimum blade width was obtained, was present on the left parietal, crossed the lamboidal suture, and extended onto the occipital (Fig. 3). This cutmark exhibited undermining and fractur-

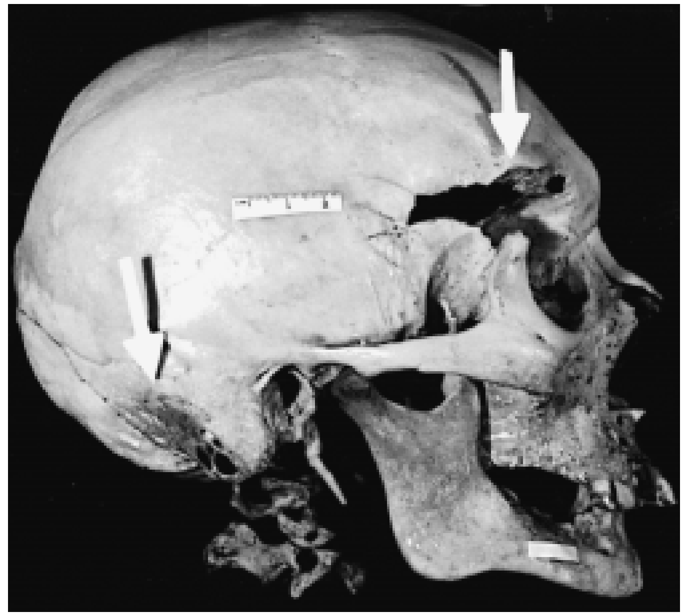

FIG. 1—*Right lateral view of skull. Arrows indicated two cutmarks, one to the orbit and one to the mastoid.*

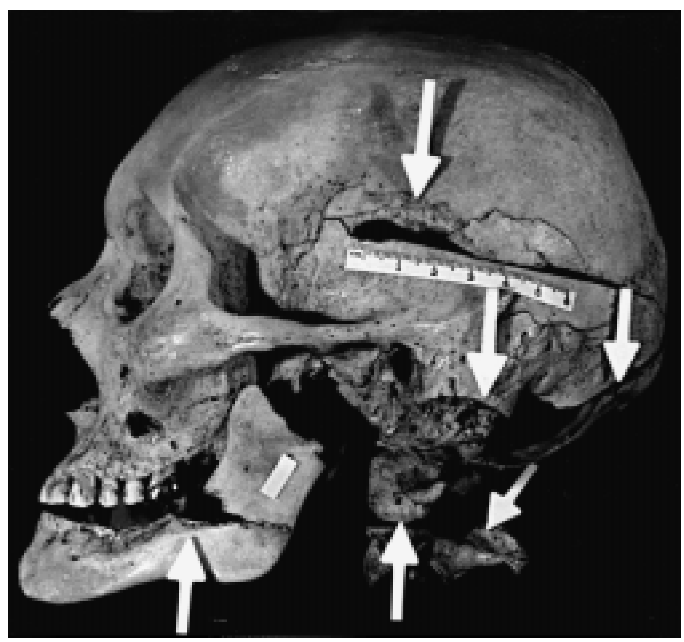

FIG. 2—*Left lateral view of the skull with articulated first and second cervical vertebrae. Arrows point to seven of the nine areas of sharp force trauma. Not indicated by an arrow but still depicted is a cutmark on the posterior border of the mandibular ascending ramus.*

FIG. 3—*Posterior view of the skull with articulated cervical vertebrae. Three cutmarks and extensive cracking are evident.*

FIG. 4—*83 mm cutmark to the left parietal. Undermining and flaking of the outer table is present.*

ing that may have been caused by the flat side of the blade (Fig. 4). The second cervical vertebrae also had a cutmark on the posterior surface of the spinous process.

Small round conical depressions and compression fractures were present on the postcranial skeleton, including the pubic symphysis and the proximal and distal ends of the recovered long bones. The pattern of breakage and splintering of bones seemed to be consistent with carnivore scavenging damage (10–13). However, since spiral fractures from torsion injuries are sometimes confused with compression fractures associated with carnivore scavenging damage (4,11,12,14,16) and animal chewing can produce spiral fractures that may be misinterpreted as those resulting from human activity (12–14,16), the Tiger® rear flail mower had not been ruled out as the possible cause for these defects to the postcranial skeleton.

Experimental Exemplars

In keeping with Maples' suggestions (4), trauma exemplars made of nonhuman bone were created for comparison with the cranial and postcranial trauma defects seen in our case. In particular, both green and dry nonhuman bones were used to create trauma samples with a Tiger® rear flail mower. We expected that the mower flails would *not* produce the discrete sharp defects seen in the skull, C1 and C2. We also predicted that the mower flails might cause some of the spiral/rotational fractures seen on the long bones. Nonhuman specimens (*Sus* sp.) were obtained from a local butcher and consisted of pig heads ($n = 2$), pig legs ($n = 6$), a cow (*Bos* sp.) tibia and cow ribs ($n = 12$). During our two field tests, we simulated mower settings police investigators believed had been used at the scene. The 7 ft-flail mower was set at a 3-in. cutting height and operated at a speed of 5–6 mph at 2000 rpm. We varied the position of the nonhuman material relative to the mower, putting various bones perpendicular and parallel to the mower barrel. The results of this field experiment were consistent with our predictions. The mower flails did not produce bony defects that were in any way similar to the cutmarks seen on the skull and cervical vertebrae from our case. Fracture margins created by the mower were irregular and ragged, with some depressed fractures (Fig. 5). As expected, some of the green long bones did exhibit spiral fractures as a result of the torsional forces created by the spinning mower barrel and flails. Similarity of fracture type, in this case spiral fractures, does not signify the *agent* of fracture (mower v. carnivore) (10–12). Rather, the presence of spiral fracturing indicates that the bone was broken when fresh (green) (11). Identifying the *agent* of bone fracture required the study of multiple bone attributes, notation of missing elements, and the distribution of elements at the scene, as well as fracture type (10–13,15).

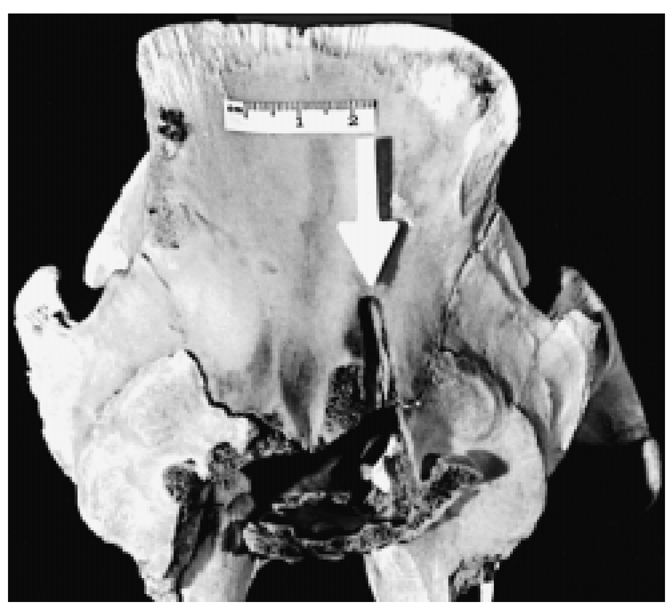

FIG. 5—*Posterior view of a nonhuman exemplar (pig cranium) that was run over by a Tiger® rear flail mower. The cutmarks are irregular and jagged. The arrow indicates a depressed fracture.*

The spiral fractures in the forensic case were in close association with conical depressions and splintering typical of canids and other scavengers (10–15,16). The bone epiphyseal ends and diaphyses had been chewed and gnawed, as represented by tooth mark punctures and some mashing, pitting, and scoring (13,14). The wide dispersal of the recovered elements and the absence of elements, such as the hands, feet, vertebrae, and ribs were consistent with a scavenging pattern (14–16).

Conclusion

The interpretation of skeletal trauma and creation of a biological profile requires a high level of specialized training and knowledge not commonly found in all pathologists and human osteologists. Maples (1–4) was among proponents (17–20) that believe that the forensic anthropologist could provide medical examiners or coroners with very specific information useful in their determination of cause or manner of death and identification. The effectiveness of this approach is exemplified by the success of the C.A. Pound Human Identification Laboratory. During the 21 years of Dr. Maples' tenure as curator, he was referred over 1200 cases (21) from medical examiners seeking his expert knowledge. In this particular case, our forensic anthropology team made a trauma assessment and created a biological profile based upon protocols put forth by Maples. Our biological profile indicated the deceased was a middle-aged male, approximately 5′6″ to 5′57″ in stature who had probably died at least three months before discovery of his remains. He was mostly likely Hispanic, however, because of the well-known inconsistencies between social and biological definitions of racial categories (8,22), this individual may have been self-reported or socially considered white. With this consideration in mind, investigators should include Hispanics and whites in record searches. Our assessment of trauma indicated that this individual had received a minimum of seven blows to the head and neck with a relatively heavy bladed weapon having a blade length of at least 83 mm and blade width of at least 1 mm. Nonhuman trauma exemplars were created in order to rule out a Tiger® rear flail mower as a cause for the skeletal defects seen in the skull and cervical vertebrae. The mower was clearly ruled out as the agent of sharp trauma to the skull and cervical vertebrae. The mower did create spiral fractures on the nonhuman material that were similar to those seen in our forensic case. However, the assessment of the pattern of damage to the skeleton indicates damage to the post cranial skeleton was most consistent with postmortem scavenging damage.

As of time of this writing, no leads on the victim's identity have developed. This case remains unsolved.

Acknowledgments

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