CASE REPORT

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Bone Fragments a Body Can Make

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ABSTRACT: Data obtained from various analytical techniques applied to a number of small bone fragments recovered from a crime scene were used to provide evidence for the occurrence of a fatality. Microscopic and histomorphometric analyses confirmed that the fragments were from a human skull. X-ray microanalysis of darkened areas on the bone fragments revealed a chemical signature that matched the chemical signature of a shotgun pellet recovered at the scene of the crime. The above findings supported the deoxyribonucleic acid (DNA) fingerprint evidence which, along with other evidence, was used to convict a man for the murder of his wife, even though her body was never recovered.

KEYWORDS: physical anthropology, criminalistics, bone fragments, homicide

In June of 1986 a woman was reported missing by her mother. Her disappearance remained a mystery until March of 1988, when the woman's red 1985 Ford Escort was discovered in a locked storage garage in a neighboring town. A rental agreement, dated the day of her disappearance and signed by her husband, was found.

Examination of the interior of the car revealed a large amount of debris, which included what appeared to be tissue fragments, shotgun pellets, dried blood, and bone fragments. Deoxyribonucleic acid (DNA) fingerprinting of the blood and histomorphological analysis of the bone fragments, along with other evidence, led to the conviction of the husband for murder [*1*].[3] This paper will discuss the histomorphological analysis of the bone fragments, which provided crucial evidence that a fatal injury had occurred in the car.

In March of 1988, author Stout received several matchboxes containing debris from the missing woman's car. Thirty-one possible bone fragments were identified among the debris (Fig. 1). The largest of the fragments measured approximately 27 mm^3, and the total weight of the fragments was 700 mg.

Because of the small size of the fragments, the first question that had to be addressed was whether they were bone. Two of the fragments were embedded in plastic and sectioned for microscopic examination. The observation of a lamellar pattern typical of bone and the presence of Haversian systems (osteons) provided conclusive evidence that the

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[3]The details of this case are reported in the paper by Dix et al. immediately preceeding this paper.

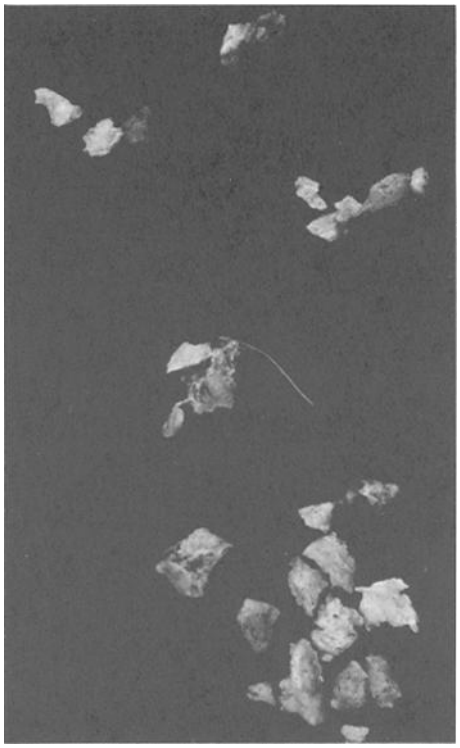

FIG. 1—*Bone fragments recovered from the crime scene. The largest fragment measures approximately 27 mm², and the total weight of the fragments was 700 mg.*

fragments were indeed bone (Fig. 2). This observation was later confirmed independently when the chemical composition (calcium phosphate) was determined by X-ray microanalysis.

The next question was whether these fragments of bone were of human origin. The presence of Haversian systems eliminates several species, such as birds and small mammals, from consideration since they do not exhibit Haversian bone remodeling. The size of Haversian systems increases as the body size of the species increases, up to the size of a human. The measured cross-sectional area of several of the osteons produced a mean osteonal cross-section area of 0.049 ± 0.011 mm². Statistically, this value falls outside two standard deviations of the mean osteonal cross-section size of 0.019 ± 0.01 mm² for the dog, reported by Jowsey [*2*]. It falls well within the size range of 0.045 ± 0.007 to 0.033 ± 0.007 mm² reported by Pirok et al. [*3*] for humans. The cortical thickness of the bone fragments and the lack of evidence of plexiform bone eliminates the bone of large animals, such the cow, from consideration.

When the bone sections were examined using fluorescent microscopy, tetracycline-like banding was observed (Fig. 3). The fact that all the bands were located on bone surfaces, rather than embedded within the bone, showed that the antibiotic must have been administered relatively recently. Since "sigma," the time required for human bone remodeling units to be completed, is approximately three months [*4*], the antibiotic was probably administered within three months prior to death. The missing woman's medical records revealed that she had been prescribed tetracycline within this time period.

The next question was from what part of the body did the bone fragments come. In

FIG. 2—*Photomicrograph of an undecalcified thin section of one of the bone fragments. Note the lamellar pattern and the presence of osteons (Haversian systems), (×2.5 magnification, polarized light).*

order to shed light on this, core samples were removed from a known human skeleton, and histological sections were prepared for comparison with the fragments recovered from the car. The cortical thickness and histomorphology of the bone in question clearly match those of skull bone, rather than those of a long bone. In addition, one of the fragments closely resembled a bone from the orbital region, such as the lacrimal bone (Fig. 4). Another fragment exhibited multiple foramena and a surface curvature that is only observed in bones of the skull.

Several bone fragments exhibited dark areas on their surfaces. Two such fragments, along with a shotgun pellet and a piece of glass from the car, were selected for micro-characterization. A scanning electron microscope (SEM) equipped with an energy-dispersive X-ray spectrometer (EDS) was utilized to determine the chemical composition of these samples. As mentioned earlier, the fragments were confirmed to be bone, giving a typical calcium and phosphorus signature. The elemental composition of the dark smudges on the bone produced a prominent lead peak and a small antimony peak (~99% lead and 1% antimony). The shotgun pellet gave an elemental signature similar to that of the darkened areas on the bone. Neither lead nor antimony were detected in the piece of glass or the clean area of the bone.

It was concluded from the histomorphological and SEM-EDS data that the fragments recovered from the missing woman's car were from the skull of a human who had taken a tetracycline-like antibiotic within approximately three months of death. Further, the skull fragments had been impacted with lead similar to that from shotgun pellets also recovered from the car. This information, coupled with the results of DNA fingerprinting, was crucial to the verdict of this case, in which no body was recovered nor was there an eyewitness to the death. The woman's husband was found guilty of her murder.

FIG. 3—*Photomicrograph of an undecalcified thin section of one of the bone fragments. Note the tetracycline-like labeling of the osteon in the center of the field (×10 magnification, fluorescent light).*

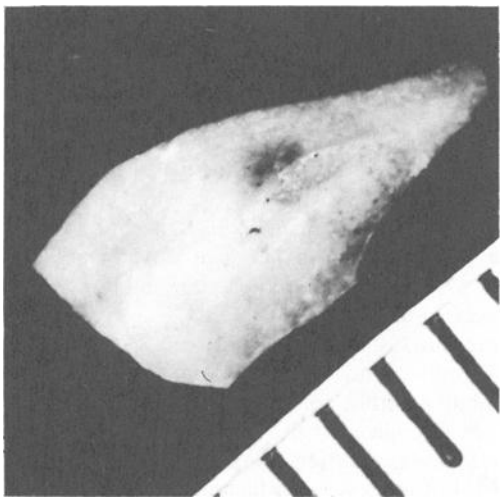

FIG. 4—*A fragment morphologically similar to the lacrimal bone of the skull.*

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