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The Analysis of Cremains: A Case Study Involving the Inappropriate Disposal of Mortuary Remains

REFERENCE: Murray, K. A. and Rose, J. C., **"The Analysis of Cremains: A Case Study Involving the Inappropriate Disposal of Mortuary Remains,"** *Journal of Forensic Sciences*, JFSCA, Vol. 38, No. 1, January 1993, pp. 98–103.

ABSTRACT: Cremation as a method of body disposition has increased over the last two decades. Mishandling of the remains is bringing the analysis of cremains to the attention of forensic anthropologists. The destruction of skeletal components by heat, and mechanical reduction, make the analysis of cremains difficult.

Three years after receiving cremains believed to be that of their mother, a family received a second set of cremains that were also purported to be those of their mother. Questioning whether which, if either, set of remains were the decedent, the family initiated an anthropological analysis of both sets of remains.

The investigation focused on both osseous and nonosseous characteristics of each set. Total weight of the material and differences in both the osseous and nonosseous characteristics indicate that the cremains represent two individuals. These differences include the degree of color change due to heat, the amount of bone fragments vs. ash, and the lead and calcium content remaining in the fragments from each set. Differences in the nonosseous components of each set are related to coffin hardware, and medical and dental artifacts.

KEYWORDS: physical anthropology, cremation, cremains, analysis, inappropriate disposal

Frequently, forensic anthropologists are called upon to examine skeletal material that has been altered by fire. Burned remains from both archeological and criminal investigations are not infrequent, and often can be assessed by gross examination. However, the intense heat and mechanical reduction of the skeletal material produced by commercial cremation make this type of assessment more difficult.

Cremation of the dead is a custom dating to antiquity and has been practiced by societies as diverse as the Chinese, Asian Indian, and Native American. Yet, until recently the most common method of disposal in the modern United States was earth burial of the cadaver. Changes in American funerary practices over the last two decades have resulted in the increasing use of cremation as a method of body disposition [*1*].

Generally, cremations performed in the United States proceed in the following manner. The body is placed in a receptacle such as a wooden casket or a heavy cardboard container. Temperatures of 1500 to 1600°F are created by air jets blowing into the oven chamber. After the cremation is complete and the material has cooled, a magnet may be used to remove any metal objects remaining in the material. The material then may be mechanically pulverized reducing the space the fragments would otherwise require. These elements are then placed in an urn or some other container suitable for transport [*2,3*].

Inappropriate handling of cremains has produced a corresponding increase in civil

Received for publication 14 April 1992; revised manuscript received 27 June, 1992; accepted for publication 3 July 1992.

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litigations [4]. Inadvertent or deliberate commingling of the remains, the return of the remains to the wrong family, or illegal disposal of cremains have increasingly been brought to the attention of the forensic anthropologist [5–7].

The destruction of many recognizable skeletal components by the process of commercial cremation make the analysis of cremains a particular challenge for the anthropologist. In these cases both osseous and nonosseous findings are crucial to the investigation.

Case Report

Upon the death of their mother in 1987, a family requested cremation of the body and shortly afterward received the remains enclosed in a brass urn. At about the same time a second set of cremains purported to be the mother were unintentionally delivered to the warehouse of the local public school system. The subsequent investigation failed to reveal just how this happened since no shipping and/or receiving documentation was uncovered. Nevertheless, these cremains, encased in a plastic bag and stored in a black plastic box, were inadvertently placed on a shelf and forgotten. Three years later, a decision was made to clean the warehouse, for, as one official put it, "the place is such a mess, you probably couldn't find a body in there." The cremains were discovered and promptly returned to the crematorium. The crematorium then forwarded the remains to the family and assured them that the material in both the urn and the black box were the remains of their mother. Somewhat skeptical, the family initiated an investigation into the possibility that the crematorium had given them the remains of an unknown individual.

The family's attorney asked the authors two questions: Were the cremains in both receptacles those of the same person? And if not, was either one their mother?

Case Investigation

Both the urn and the black box enclosed burnt human bone, ash, and nonosseous material. Based upon the Eckert et al. classification system [6], all skeletal material was identified as a #2 cremation, consisting of bone pieces and ash. The material had been mechanically reduced after cremation. Variations in temperature and length of exposure time produced color ranges within the material, which are discussed below.

Each set of cremains was examined separately and labeled as from the urn or the black box. All material was examined with the aid of incandescent light and a magnifier. Nonosseous items discovered within the contents of bone and ash were removed and examined with a microscope. The burnt bone and ash were divided into small units, placed in plastic bags, and weighed. Using a ⅛" sieve, the bone/ash content of each set of cremains was determined. Radiographs of each bag were taken and nonosseous radiopaque items discovered during this process were removed. Five samples of bone from each container were randomly coded from one to ten for chemical analysis. They were analyzed for calcium, mercury, copper, iron, zinc, and lead; however, only lead and calcium were found to be above detectable limits.

Findings

The contents of the urn and the black box are summarized in Table 1.

Brass Urn

The material consists of burnt human bone (68% by weight) and ash (32% by weight). The mean calcium content of the bone is 7.31%, and the mean lead content is 66.6 ppm.

TABLE 1—*Contents of the urn and black box.*

	Urn	Black Box
Bone	68%	60%
Ash	32%	40%
Mean Calcium content	7.31%	5.94%
Mean Lead content	66.6 ppm	55.7 ppm
Max/ Fragment size	7.5 × 3.5 mm	5.0 × 3.0 mm
Color	gray/white/yellow	gray/some white
Weight	2343.8 gr	2640.2 gr
Nonosseous Material	pacemaker liga clips	gold dental bridge coffin hardware straw fragments

The bone has been mechanically reduced and the fragments are no larger than 7.5 by 3.5 mm. The color of the material ranges from gray to white to yellow. The gray to white coloration represents varying exposure to heat, both in time and temperature, while the yellow is unburnt trabecular bone. The total weight of the osseous material is 2343.8 g. Except for one tooth root, individual bone fragments could not be identified as belonging to specific anatomical categories, although the fragments were identified as flat bone or long bone.

The nonosseous material consists of 38 wood fragments ranging from slightly burned to charred and 14 small globules of unidentified gray material containing fibers. In addition, 22 fragments of coiled wire, one fragment of insulated copper wire, two diodes and four surgical staples were discovered.

The coiled wires have been identified as ventricular leads, and, along with the copper wire and diode, are identified as material belonging to a pacemaker. The surgical staples are of a type known as Liga clips and are consistent with the surgical implantation of a pacemaker.

Black Box

The material consists of burnt human bone (60% by weight) and ash (40% by weight). The mean calcium content of the bone is 5.94%, and the mean lead content is 55.7 ppm. The bone has been mechanically reduced and most of the fragments are no larger than 3 by 5 mm. A few fragments are somewhat larger. The color of the material is gray with some white. The total weight of the osseous material is 2640.2 g. Two tooth roots were identified, all other fragments were categorized as flat bone or long bone.

Nonosseous material consists of 17 charred wood fragments, 2 #3 ring shank nails, two Hex head self drilling screws, 17 straw fragments (unburned) such as the type associated with a broom or whisk broom, four U-shaped carpenter staples, six portions of gold alloy, two metal screws. These gold alloy pieces form a contiguous unit, which was identified as a dental bridge. The two end portions of the dental bridge fit over the two metal screws.

Discussion

Several points of comparison were noted, which led to the conclusion that the cremains from the urn and the cremains from the black box represented two different individuals and two different cremation events.

The most obvious differences during the visual examination of the material from the urn and the black box was the difference in color (Fig. 1). These findings appear to be

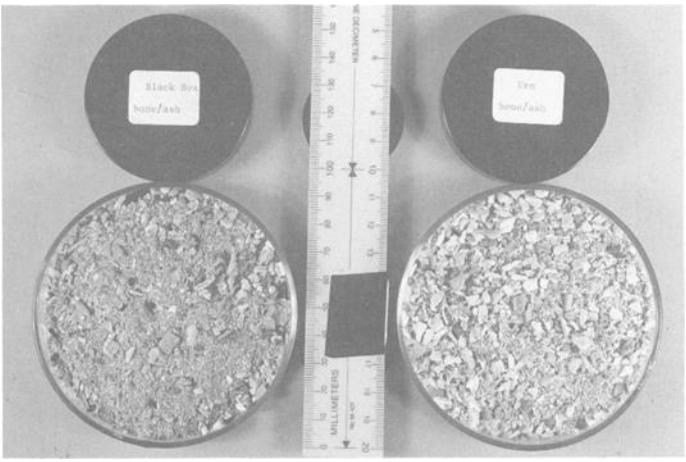

FIG. 1—*Cremain samples from both the urn and the black box showing visual differences in both color and bone/ash content.*

related to intensity and duration of heat. The cortical bone from the urn is generally more calcined than that from the black box, yet much of the trabecular bone from the urn is unburnt, while most of the trabecular bone from the black box is calcined. The material from the urn was exposed to higher temperatures but of shorter duration than the material from the black box, thus indicating two separate cremation events.

The dissimilarity of the proportion of bone to ash in the urn and the black box is also related to duration of the heat. In addition, the amount of mechanical reduction and possibly different shipping experiences would affect bone/ash proportions. Again, this finding indicates two distinct cremation and handling events.

The presence of tooth roots, flat bone, and long bone fragments in the urn and the black box indicate both cranial and postcranial remains are contained in each receptacle. Thus, each contains material representing these two identifiable components of a human body.

The nonosseous contents of the urn and the black box are distinct in their nature and function. Within the black box, gold alloy pieces and two small dental attachment screws were found, which represent the remains of a dental bridge. The hex screws, ring shank nails, carpenter staples and pieces of burnt wood may represent the remains of a coffin/casket. The pieces of straw are unburned thereby indicating commingling with the remains occurred after cremation. Their presence may be a result of removing the remains from the crematorium, or sweeping them up after spilling. Within the urn, most of the nonosseous contents are the remains of a pacemaker. The pieces of burned and partially burned wood fragments may be the remains of a coffin/casket.

There is no commingling of these materials. No dental bridge or coffin-associated material (other than wood fragments) was found in the urn, and no pacemaker-related material was found in the black box. The burned and partially burned fragments of wood from the urn are either round or triangular in shape, while those from the black box are rectangular in shape. Each container produced distinctive end-products. This distinct distribution of the nonosseous material demonstrated that the box and urn contain two different individuals.

A pamphlet produced by the Cremation Association of North America [7] states that the skeletal material remaining after cremation will weigh between three and nine pounds,

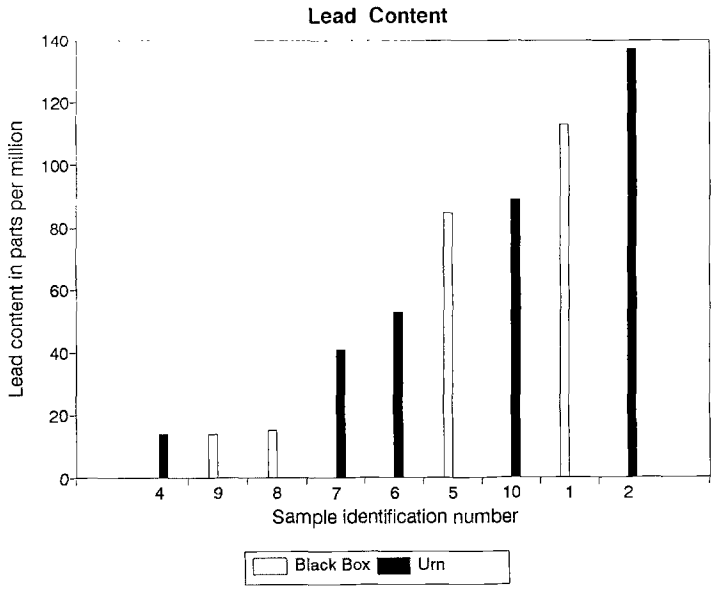

FIG. 2—*Distribution of the lead content of the bone from both the black box and the urn.*

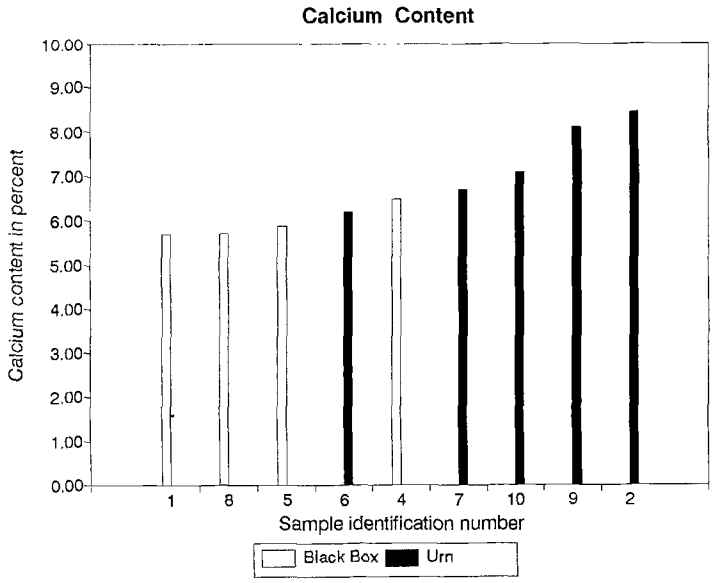

FIG. 3—*Distribution of the calcium content of the bone from both the black box and the urn.*

while a recent study of ten commercially cremated individuals produced an average weight of 3375 g (7.4 lbs.) for males (n = 6), and 2625 g (5.8 lbs.) for females (n = 4) [8]. Maples and Birkby (personal communication) have said that in their experiences with cremains, the material generally ranges from 2000 to 2500 g (4.4 to 5.5 lbs.). The total weight of the bone and ash from both the urn and the black box is 4984 g, which is slightly over eleven pounds of material. Because this is nearly twice the weight expected

from a single cremation of an adult individual, it was concluded that at least two individuals were represented.

The distribution of the lead content (Fig. 2) from each bone sample reveals considerable overlap that can be explained by the contamination of the material from coffin hardware. The calcium distribution (Fig. 3) shows considerable separation of the distributions. The results of the calcium analysis indicate that the samples from the black box and those of the urn represent two different people.

The question that remained was—were the cremains in either receptacle those of the decedent? Examination of the medical records of the decedent indicated that she had expired of coronary heart disease, however, her medical history did not produce any evidence that she had worn a pacemaker. Since the remains in the urn indicate the presence of a pacemaker, it appears the remains in the urn belong to an unknown individual. Although one member of the family stated her mother had "some gold fillings," complete dental records were not found, and consequently identification of the cremains contained in the black box could not be positively established.

The family initiated legal proceedings against the crematorium that led to an out-of-court settlement. Feeling the cremains originally placed in the black box were the remains of their mother, they requested those remains returned to them, while the remains originally in the urn were returned to the crematorium.

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