BRIEF COMMUNICATION

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Post-cremation Taphonomy and Artifact Preservation*

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ABSTRACT: Contemporary commercial cremation is a reductive taphonomic process that represents one of the most extreme examples of postmortem human alteration of bone. The thorough reduction and fragmentation of cremated human remains often leaves little biological evidence of diagnostic value. Instead, non-osseous artifacts often provide the best evidence of the origin of the cremated remains, the identity of the decedent, and commingling of the remains of more than one individual. Once human remains have been cremated they are most commonly placed into a processor and reduced into small fragments and fine ash suitable for inurnment or scattering. The type of processor determines the size and utility of the particulates and artifacts available for analysis. The newest type of processors have changed the manner and degree of postmortem bone modification and altered the preservation of diagnostic bone fragments and cremation artifacts. This paper addresses the impact of the newest cremation procedures on forensic analysis of cremated remains.

KEYWORDS: forensic science, forensic anthropology, cremation, cremation artifacts

Introduction

The number of people choosing cremation over burial has been increasing and will continue to increase over the next decade. At present, over 25% of deaths in the United States result in cremation. The Cremation Association of North America projects that by 2010 this number will increase to greater than 35% (1). As more people choose to be cremated we can expect a concomitant increase in the number of cases that forensic anthropologists are asked to examine. Litigation and subsequent forensic examination of cremations usually involves inappropriate disposal of human remains, questions about the identity of the decedent, and commingling of the remains of one individual with those of another. A small number of case histories and methodological papers, most presented at professional meetings, have addressed many of these issues (2–8) and provided forensic investigators with excellent descriptions of the commercial cremation process (9,10). This brief communication addresses relatively recent changes in cremation practice and their impact on the analysis of cremated remains.

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Three sources of information are used to identify cremated human remains: a) bone and tooth fragments, b) weights and volumes, and c) artifacts.

Bone and tooth fragments can be used to determine if the cremated remains are those of a human; establish whether or not the decedent had dentition; reveal the developmental stage of the dentition and, therefore, the age of the individual; and finally, help detect the presence of various age-related pathologies.

Cremation weights, and to a lesser extent volumes, can provide limited baseline information. Weights exceeding the ranges established by researchers may suggest the presence of more than one individual. Weights less than expected may point to remains that are either incomplete (i.e., some portion of the remains have been removed prior to examination), or the cremated remains of a juvenile or nonhuman. All things considered, the weight of the cremated remains should correspond with published values for the sex and general skeletal robusticity of the decedent (11,12). Occasionally, calcined atherosclerotic blood vessels can be found among the cremated remains. Since atherosclerosis is an age-related pathology, the presence of these calcined vessels provides a clue that the decedent was most likely a mature adult (13).

Cremation artifacts provide contextual clues that may be as important as the biological clues. We have assembled a reference collection of artifacts collected after cremation, but prior to processing, from over 100 individuals. The collection is used to aid in the identification of artifacts recovered in subsequent cases and also to provide reference hardware for cases involving severely burned or decomposed bodies. As outlined by Ubelaker, this hardware can be exceedingly useful for the purpose of establishing identity (14).

For purposes of classification, we divide artifacts into five categories: medical, dental, mortuary, personal, and miscellaneous.

The largest, most obvious medical and/or dental artifacts are removed prior to processing. However, many medical artifacts are not removed and may be discovered among cremated remains. Most are relatively small in size and are manufactured from nonferrous surgical alloys. Examples of these types of artifacts include surgical staples used for skin closure and vascular clips used to ligate blood vessels during surgery. We also commonly see fragments from sternotomy sutures as well as pacemakers leads. Occasionally, pacemaker components are recovered even though it is recommended that the pacemaker be removed prior to cremation (14).

Similarly, several types of dental artifacts are recovered in processed remains including fragments from metallic crowns, posts, bridgework, and porcelain crowns and caps.

Two mortuary artifacts are almost invariably found in cremated remains. These are the injector needles that are inserted into the maxilla and mandible to "set the features" and prevent the mouth from opening during visitation, and various staples that are used to construct the wood and cardboard cremation caskets in which the cremations take place. We have recovered complete staples from wooden cremation caskets. However, we generally do not recover complete staples from cardboard caskets, but rather staple fragments, which are readily identifiable.

We refer to remnants of jewelry, clothing, and other personal effects as personal artifacts. For example, we commonly recover zipper fragments, bra clasps, and jewelry chain fragments. In addition, it is also relatively common to recover artifacts that were added to the cremated remains after they are processed. Examples we have seen include a small silver metallic cross, the ignition key of a decedent's boat, and a wedding band. Miscellaneous artifacts are fragments that are not readily identifiable. Most of the metallic artifacts that are recovered fall into this category. Non-diagnostic wire fragments are common and may be due to any number of sources, including sternotomy sutures, flower arrangements that are added prior to cremation, or wood and cardboard casket staples.

Processor Types

After the cremated remains are removed from the retort there are many large diagnostic fragments. Once the remains have cooled, the cremationist removes large medical and dental prosthetics and runs a magnet over the remains to remove ferrous metallic objects. The cremated remains are then reduced by means of a processor, or pulverizer, to decrease their volume for inurnment and/or scattering. The type of processor determines the size of bone and tooth fragments and the survival of cremation artifacts.

We have analyzed cremated remains that have been processed by three different methods: hand processing, ball/hammer mill processing, and rotary blade processing. Hand processing is used in Europe and other areas. In the United States, cremated remains from neonates and infants are often hand processed to preserve sufficient volume for memorialization. We have observed the use of a cremation magnet or some other blunt object such as a piece of wood to pulverize cremated remains. This processing method produces relatively large fragments.

Ball or Hammer Mill processors are an older type of mechanical processor. Cremated remains are placed in a perforated steel drum in which contains a number of metal balls or cylinders. The drum rotates causing the hammers to crush the remains into smaller and smaller fragments until they are small enough to fall through the perforations into a collection bin at the bottom of the machine. The cycle is over after all of the cremated remains have passed through the perforations. The circular perforations are approximately 4 mm in diameter. Although fragments can be no longer than 4 mm along one axis, they can be longer than 4 mm along another axis. This reducing method results in diagnostic tooth and bone fragments, and often complete ear ossicles that identify the remains as human. There can also be excellent survivability of small cremation artifacts.

These older types of processors are not time dependent (i.e., longer processing times do not affect the degree of pulverization). Fragments produced by this type of processor are therefore fairly consistent in size—most slightly less than 4 mm in one plane. In addition, commingling could also be introduced if fragments got caught in the perforations and were not removed prior to processing another set of cremated remains. A large quantity of metallic fragments can be recovered after ball mill processing.

Larger fragments result in a larger volume of cremated remains because the fragments pack less efficiently. Cremationists will occasionally have difficulty in reducing the remains to a small enough volume to place in a standardized size urn. The purpose of processing the remains into smaller fragments is to facilitate inurnment. A recurring problem in the industry was the occasional situation in which the volume of the remains exceeded the capacity of the industry standard-sized urn. We have been told by a number of cremationists that families did not receive the portion of the cremated remains that did not fit in the urn. In 1987, an industrial engineering firm in Florida introduced the newest type of processor (personal communication, Kenneth Robinson). The manufacturer refers it as an electric cremains processor. The majority of crematories in the United States and Canada now use similar rotary-blade type processors. When cremated remains are placed into the processor the top pan rests on the pot. The cremated remains are placed in the pan and brushed into the pot. The pan is lifted and placed in the present position and the lid is placed over the pot. There is a 60 s timer on the machine. The inside of the pot, which looks like a food processor, has blades that are hinged on both sides with ends angled upward to help facilitate mixing of the remains.

The rotary blade processor is capable of reducing cremated remains to minute non-diagnostic bone fragments and ash. Due to the efficiency of these new processors, it may be difficult, or impossible in some cases, to determine if the processed remains are human based on the osseous material alone.

The manufacturer asserts that they were trying to produce a processor that would consistently reduce human remains to a volume of less than 200 cubic in.—the size of the industry standard urn. A secondary benefit is that the processor reduces osseous elements to non-diagnostic fragments. Forensic anthropologists may be understandably skeptical about the purpose of the new processor. In his recent chapter on the forensic implications of the growing popularity of cremation, Murhad states that "it is believed that such a reduction will hinder an anthropological/morphological analysis of cremated remains and thus limit an investigator's ability to determine completeness or commingling. Simply, many in the cremation industry are taking steps to curb the frequency and the success of future litigation" (10). Whatever the reason for the development of the newer processor, it has resulted in a more challenging examination for the forensic investigator.

We have observed that the condition of the blade, and not the length of the processing cycle, has the greatest effect on the size of the osseous fragments. As the blade decreases in length with use, it becomes less efficient in reducing the cremated remains to a small enough quantity to fit in a standard sized urn (Fig. 1). As a result, worn blades may produce diagnostic osseous fragments that are larger than those generated by the older type processors.

One of the services offered by the manufacturer is replacement of the blades. The manufacturer asserts that a 30 s cycle is all the time needed to reduce cremated remains to fit in a standardized urn. The original processors did not have a timer and as a result, the blades were prematurely wearing too quickly because cremationists were processing remains for a longer time period than was recommended. The timer was later added by the manufacturer to decrease the cremation time and increase blade life.

During a consultation with a funeral director, we were asked to observe their cremation procedure and to make recommendations for improvements. We also analyzed cremations to understand more about the differential survival of fragments produced by time cycles of varying lengths using rotary blade processors. We allowed the operator to perform her normal routine, which consisted of processing the remains for two 30 s cycles. The blade on the processor was in good shape and the two cycles were more than enough time to reduce the cremated remains to fit in a standard sized urn. This particular cremationist felt that two 30 s cycles were more efficient than one 60 s cycle. There were no recognizable osseous fragments present in this cremation, however, there was unbelievable preservation of cremation artifacts. Figure 2 displays the artifacts, which include a complete sternotomy suture, large sternotomy suture fragments, complete dental crowns, pacemaker components, and surgical gown snaps. We asked the cremationist to increase the length of the processing cycle on the ensuing cremations. The operator ran a 1 min cycle followed by an additional 30 s cycle. Even after the increased length of the cycle, we were still able to recover identifiable cremation artifacts.

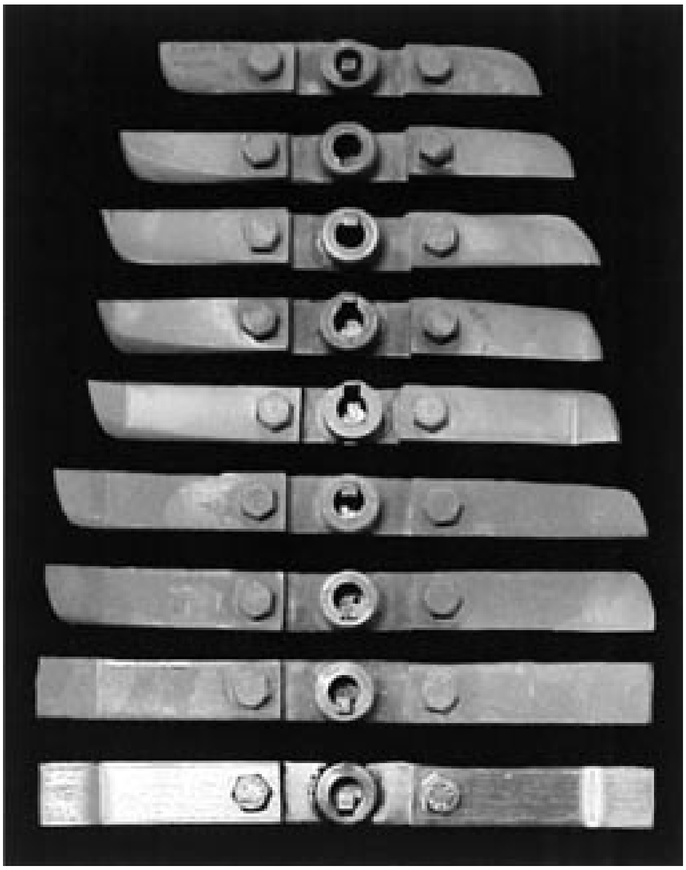

FIG. 1—*Processor blades seriated from unused at bottom to extensively worn at top. Note the lifts at the distal ends of the new blade at bottom.*

Conclusions

Rotary hinge blade processors have made forensic analysis of cremated remains a more challenging task. Blades with minimal or absence of wear will produce non-diagnostic osseous fragments that may not be recognizable as human. In addition, there may be excellent survivability of cremation artifacts with only minimal wear on the processor blade. However, the condition of the blade is directly related to the survivability of osseous fragments. The size of the fragments appears to increase as the wear on the blade increases and it becomes shorter in length (losing lift). In other words, in certain instances, there may be better presentation of osseous fragments and cremation artifacts in the newest processors since fragment size is not restricted by the aperture size of the filtering perforations in the older ball mill type of processors. Obviously, the more osseous material and artifacts available for analysis, the more likely the investigator will find evidence of the identity of the deceased.

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FIG. 1—*Artifacts recovered from a cremation processed with a rotary-blade processor. Note Pacemaker lead wires at left; metallic tooth crowns upper right; and sternotomy wire at center.*

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