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Recognition of Cemetery Remains in the Forensic Setting

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ABSTRACT: Cemetery remains exposed through vandalism or natural phenomena are frequently brought to the attention of law enforcement agents or medical examiners. Although it is often difficult to distinguish cemetery remains from those of medicolegal significance, clues to their origin may exist. Characteristics consistent with cemetery remains include physical characteristics associated with the embalming process. Characteristics indicative of cemetery remains include functional or ornamental artifacts associated with the coffin, devices used in embalming the body, and elevated levels of embalming chemicals in the soft tissue.

KEYWORDS: physical anthropology, pathology and biology, musculoskeletal system, embalming, decomposition, skeletal remains, graves

From 1985 to 1989, 258 of the 3386 forensic science cases (7.62%) examined in the United States by anthropology diplomates were of historic origin [*1*]. Increasingly, graves are exposed by construction, vandalism, and nature, despite state laws to protect them. As a result, bones or bodies from historic cemeteries find their way into the realm of forensic science investigation. Early recognition of characteristics associated with cemetery remains can reduce the time and effort spent on investigation. Recognition is enhanced by an understanding of the basic funerary customs of our culture, including preparation of the body for burial, artifacts accompanying the body, and accoutrements associated with the grave.

Embalming is perhaps the least understood of our funerary customs. According to the funeral industry, embalming, which involves the injection of chemicals into the vascular system and visceral cavity, is practiced for the disinfection and preservation of a body [*2*]. The embalming fluid preserves, dehydrates, and hardens the tissue by preventing bacterial growth and coagulating protein. Although this tradition has existed for centuries, the practice has evolved considerably as a result of technical innovation and in answer to recognized needs.

Commonly used 19th century embalming chemicals included aluminum sulfate, potassium carbonate, copper sulfate, zinc chloride, arsenic, and bichloride of mercury [*2–4*]. Early embalming was frequently performed in the home of the deceased and usually

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involved the simple injection of the thoracic and abdominal cavities using a trocar and a rubber bulb syringe. A cloth moistened with the preservative chemical was often placed over the face. In addition, the cranium was injected through the foramen magnum, the corner of the eye, or the nostril [2]. Only the more sophisticated embalmers performed arterial injection, usually through the right brachial artery, using gravity flow or a bulb syringe and often requiring manual massage to disseminate the chemicals. Such early techniques were fraught with problems, as exemplified in the 1872 embalming of Cardinal Donnet:

> On his death, . . . an outstanding surgeon was dispatched to Bordeaux to perform the embalming. . . The fluid in this case was allowed to flow in by force of gravity, following drainage removal of the blood, and then it was further dispersed through the arterial tree and body by kneading and massage. . . . By the time this squeezing. . . manipulative process had been applied from stem to stern, one intercrural strategic part had become quite turgid and assumed a grossly erectile character. The organ proved so refractory on further manipulation that it had to be slit altitudinally in order to release the pent-up fluid under pressure [3].

Modern embalming using motorized injection has eliminated many of the earlier mechanical problems involved with injection. The right carotid artery is the most common injection site for arterial embalming, and the jugular vein is the site at which the blood is drained. The femoral arteries may be used to infuse the legs by directing the fluid downward, or the fluid may be directed upward to inject the abdomen. If trauma or disease obstructs the circulatory system, a combination of injection sites may be used. To embalm the body cavity, a trocar 18 in. (46 cm) long and ½ in. (12.7 mm) in diameter is inserted in the abdomen to aspirate the upper chest and viscera, which are then injected with 16 to 32 oz (0.47 to 0.95 L) of cavity fluid. The cranial cavity is commonly embalmed through the carotid artery.

As a result of the embalming process and funerary rites, cemetery remains possess characteristics that can be used to identify their origin. The recognition of such predictors is derived from the authors' experiences and observations with numerous forensic science cases and in the excavation of cemeteries in various parts of the country [5–8]. Predictors of cemetery origin include (1) the physical characteristics of the remains, (2) a coffin or embalming artifacts recovered in association with the remains, and (3) the presence of embalmed tissue. Each of these predictors may involve characteristics that are either consistent with or indicative of a cemetery burial. The term *consistent* means that the trait cannot be used to exclude other sources of origin for the remains, while the term *indicative* implies an exceedingly high probability that the remains originated from a cemetery to the exclusion of other potential sources.

Physical Characteristics of the Remains

The differences in decomposition rates between embalmed and nonembalmed bodies have been reported by Bass et al. [9] and Meadows et al. [10]. According to their research, embalming does not affect the sequence of events in the decomposition process, but it does retard the rate and alter the areas of the body affected. Thus, the first evidence of cemetery origin may be seen in an examination of the physical appearance of the remains. These physical characteristics include fungal growth, the presence of head and facial hair, cracking and flaking of the skin, fabric impressions in the skin, decomposition at pressure points, flaking of cortical bone, differential decomposition, brain preservation, and cribriform plate fracture.

Whitish fungal growth over the face and hands is associated with cosmetic makeup used by the embalmer during the preparation of the body for viewing. Mold or other fungal spores may already be in the makeup, which provides a medium conducive to growth. The presence of mold on the face and hands is consistent with cemetery remains.

Head and facial hair (such as eyebrows and eyelashes) may adhere to the skin of embalmed cemetery remains (Fig. 1), whereas skin slippage normally occurs in nonembalmed, unprotected bodies during the first 24 hours in a warm, moist environment. The presence of hair on forensic remains is consistent with a cemetery burial or with a body that has been protected from the elements to the extent that the skin can dehydrate.

In time, cracks will develop in the skin because of continual or extreme shrinkage, and the skin takes on an appearance resembling old paint (Fig. 2). Embalming fluid serves to preserve the skin until it can dehydrate. The rate of skin shrinkage is affected by the extent to which the coffin protects the body. The peeling characteristic of the skin, with its old-paint appearance, results from the continued shrinkage of the skin, which decreases the surface area and elevates the margins. If the skin is still intact, the body was probably somewhat protected. Embalming fluid prevents the skin slippage that naturally occurs during decomposition. The presence of skin resembling old paint is consistent with cemetery remains.

Fabric impressions may occasionally be seen in the skin of the face. The pleated fabric in the lid of the coffin may settle across the face. As a result, furrows may form in the skin, and occasionally the warp and woof impression of the weave may remain.

In coffin remains, contact or pressure points of the body decompose first to expose the more superficial bony projections, such as the posterior aspect of the occipital bone, spinous processes of the vertebrae, and the spine of the scapula. Moisture or water may collect in the bottom of the coffin or vault and speed the decay of submerged portions of the body. In addition, these bony projections may exhibit excessive erosion relative to other parts of the skeleton. Differential erosion of bone in contact with the coffin

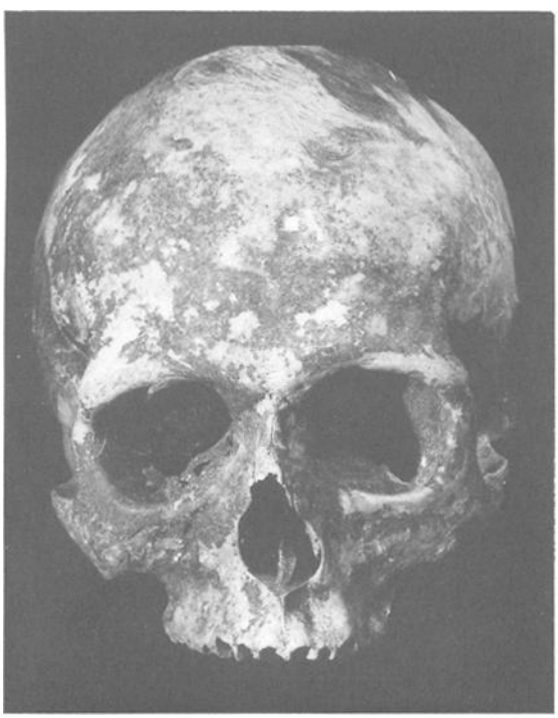

FIG. 1—*Cranium from an embalmed body with adherent head hair and eyebrows.*

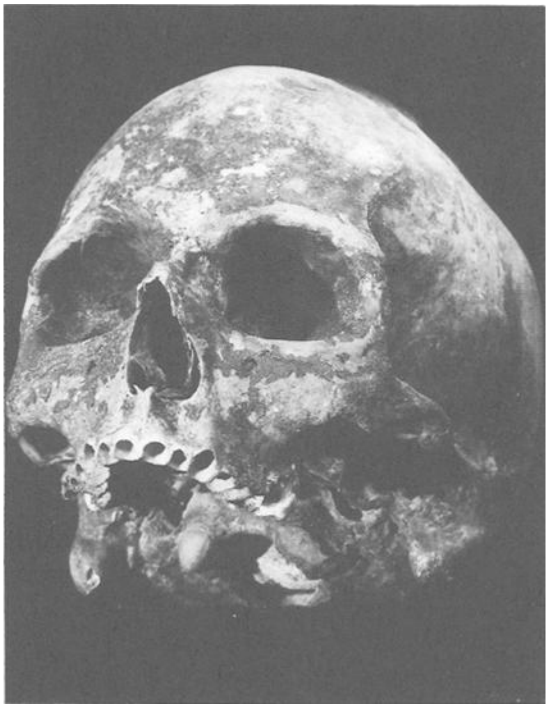

FIG. 2—*Cranium from an embalmed body with adherent dried skin.*

floor may result from the electrochemical action of the bone under local effects of temperature and moisture.

Cortical bone may flake and peel from the periodic wet and dry periods to which the bones are subjected. Superficial cortical bone becomes wet before deeper cortical bone, and, during dry periods, the cortical surface dries first. This differential expansion and contraction produces flaking. Cortical flaking is prevalent in long bones, where the circumferential lamellar bone provides natural lines of cleavage. Also, mold on bony specimens is further suggestive of a dark, moist environment consistent with a coffin.

The upper body or trunk may be more thoroughly embalmed and better preserved than the appendages, especially the legs. Collateral circulation near the site of injection acts as a shunt, to direct the embalming fluid along the path of least resistance and circumvent the more remote parts of the circulatory system. In natural decomposition, the upper body tends to decompose before the appendages. Bass et al. [9] found that the legs and groin of an embalmed body demonstrated active decay relative to the trunk. The pattern of decomposition reflects the dispersal of the embalming chemicals through the body tissues. The gravity-flow method used for arterial embalming in earlier times was less effective in infusing the legs and removing gravitated blood than the mechanical pump commonly used today. However, it is still more difficult to embalm appendages than the head and thorax.

The brain may be preserved as a dry, hard mass in the cranial vault (Fig. 3). During embalming, the brain is infused through the common carotid artery. The chemical preservation of the brain, in conjunction with the protection of the grave, provides the time and dry environment necessary for it to dehydrate and form a solid, spheroid mass.

If trauma or disease obstructs cranial circulation, fluid may be injected via the nostril

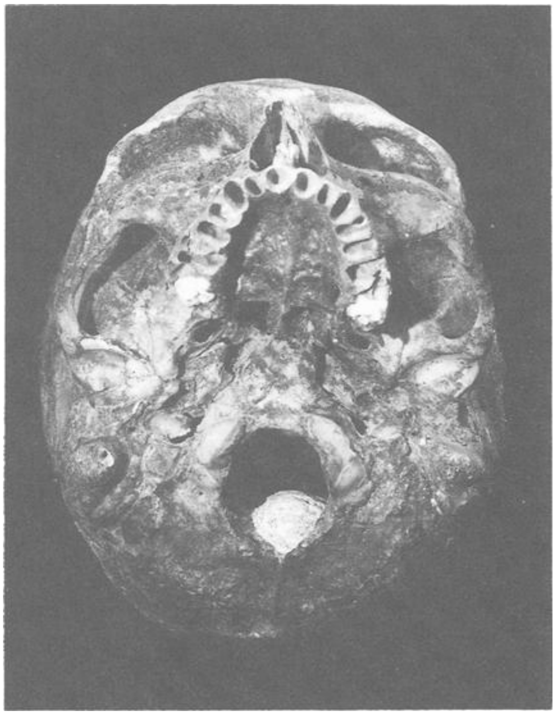

FIG. 3—*Cranium from an embalmed body with the dried brain visible through the foramen magnum.*

into the cranial vault through the cribriform plate of the ethmoid bone. A trocar is used to aspirate the cranium and inject the fluid. Although injection through the nostril is not a common practice, the presence of a perforation in the cribriform plate is indicative of embalming. Care must be taken not to confuse gunshot or stab trauma to the cribriform plate with a trocar hole.

Artifacts Associated with the Remains

With unmarked graves or cemeteries, artifacts associated with the coffin or the actual embalming process provide some of the most reliable evidence of cemetery remains. Among the more recognizable of these artifacts are coffin handles, hinges, nails, and screws. Ornamental coffin trim may include cap lifters, cap plates, and decorative thumb screws.

Paraphernalia introduced into the body by the embalmer provide some of the most indicative evidence of cemetery remains. These artifacts include eye caps, mouth formers, injector needles, trocar buttons, sutures, cotton packing, molding wax, and specific articles of clothing.

Eye caps are thin, plastic disks used to shape the eye and keep the eyelid closed (Fig. 4). The disk is molded to produce a smooth, concave surface for direct placement over the globe of the eye. The convex surface is spiny to facilitate gripping of the inner surface of the eyelid. Not all embalmers use eye caps; some elect to use glue alone to seal the lids.

The mouth former is similar in form and function to the eye cap (Fig. 4). Made of

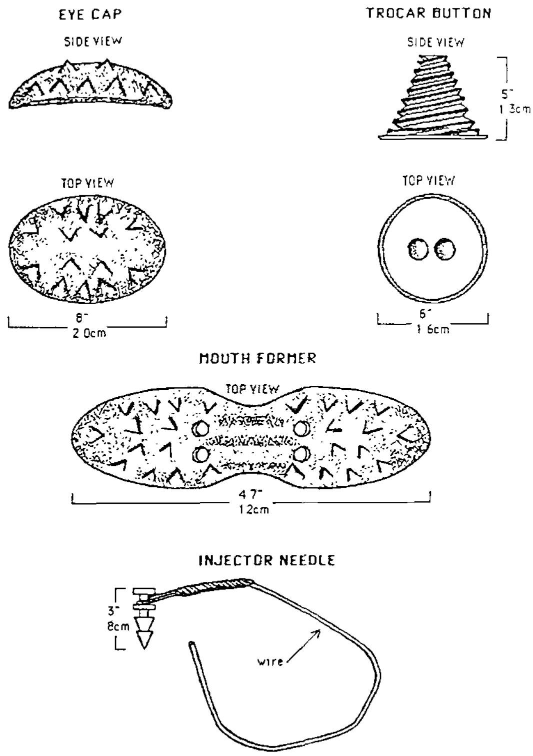

FIG. 4—*Artifacts associated with the embalming process.*

perforated plastic, it is contoured to fit the teeth, with a smooth inner surface and a spiny outer surface. It facilitates the shaping of the lips and prevents them from opening. As with eye caps, use of the mouth former is not universal but is indicative of cemetery origin.

Injector needles are stainless steel pins with attached wire (Fig. 4). One is inserted in each gum line and they function to keep the mouth closed. Small screws have also been used for this purpose.

A plastic trocar button is used to seal the hole left by the trocar in the abdomen after aspiration and injection of the cavity. The button is threaded and is screwed into the trocar hole left in the skin (Fig. 4).

All injection sites are sutured, usually with waxed thread. The location of suture material at sites commonly used for injection is indicative of cemetery remains.

Cotton packing can be used in all orifices of the body. Some embalmers use cotton to pack the nostrils, while others use it only when a trocar has been passed through the nostrils to inject the brain. Thus, cotton may be found in conjunction with a perforated cribriform plate.

In cases of disfiguring trauma, wax is commonly used for cosmetic restoration of the face. Wax resists decomposition and its presence is indicative of cemetery origin.

The presence of specific articles used to clothe a body for burial is another source of evidence. Although practices may vary according to custom and region, men tend to be buried in suits, or at least a coat and tie. Women may be buried in either street clothes, which may include gloves, or a gown. Underclothes are commonly placed on the body, but shoes seldom are. Also, the clothes may be cut dorsally to facilitate dressing the embalmed body.

The presence of utilitarian associations may suggest that the remains are not from a cemetery. For example, money, keys, a lighter, and similar articles are associated with the living, not the dead. However, care must be exercised since the deceased may occasionally be supplied certain utilitarian items felt by the living to be important in the "second life."

Evidence of a previous autopsy may indicate that the death has been investigated. This evidence consists of a sutured Y-shaped incision used to close the chest and abdomen, and the sutured transverse incision of the scalp. The scalp incision is usually placed posterior to the ears and extends over the apex of the vault. The skull cap is cut free from the cranium to allow removal of the brain.

Presence of Embalmed Tissue

The identification of chemicals used in the early days of embalming (aluminum sulfate, zinc chloride, copper sulfate, arsenic, and bichloride of mercury) is less problematic than more recent alcohol- or aldehyde-based preservatives. Since alcohol is produced during decomposition, its presence alone is not evidence of embalming. An embalmed body will have alcohol concentrations exceeding those produced through normal fermentation; thus, the alcohol concentration and overall condition of the remains must be considered. Samples of muscle, organ, or bone tissue can be obtained for toxicological analysis. As much tissue as possible should be taken to ensure a sufficient amount for chemical analysis.

Conclusions

Postmortem tissue changes provide subtle clues to the cemetery origins of remains, and, when associated with more specific indicators, they can be used to corroborate such origins. However, it is the presence of artifacts specifically associated with a coffin or with an embalmed body that provide the most conclusive evidence of cemetery origin.

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