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Case Report

Where do those remains come from?

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ABSTRACT

Part of the study of skeletal remains or corpses in advance decay located in the field involves determining their origin. They may be the result of criminal activity, accident, unearthed because of erosion, or they may also have originated from a cemetery. The discovery site, condition of the remains, and the associated artifacts, are factors that could be helpful for the forensic anthropologist to identify the origin of the remains.

In order to contribute to this recognition, an analysis was made of the exhumations of 168 unclaimed human remains from the cemetery of Terrassa (Catalonia, Spain). This investigation presents a description of artifacts and conditions of remains that could indicate that the human remains may have originated from a cemetery.

1. Introduction

The discovery of human skeletal remains and corpses in advance decay in the field, raises many questions that need to be answered. One of these questions refers to the origin of the remains. Occasionally, these may originate from a cemetery. When this type of remains is found, the anthropologist should be able to recognize those characteristic signs that could help to identify their origin.

Remains from a cemetery context can be skeletons and corpses previously legally buried in a cemetery but later removed from their tombs or ossuaries without authorization, as a result of, for example, acts of vandalism [1–5]. When remains are found in or near old cemeteries, it is suggested that they are not of forensic interest.

Occasionally, opposite situations can occur, resulting in illegal burials. For instance, homicide victims can be dumped at a cemetery in an attempt to hide a body. This situation is observed more frequently in countries where the bodies are buried in the ground [6–8]. Therefore, in cases where a tomb is damaged or the number of bodies does not correspond to the known records, the forensic anthropologist has to be able to identify each of the exhumed corpses and make a conclusion about a possible criminal activity. However, the discrepancy in the number of exhumed bodies is not always the result of a crime. Renovation or closure of cemeteries may result in misplacement of human remains. Early recognition of features associated with cemetery remains and collection of related evidence can reduce the time and effort spent on investigations [1]. In this sense, forensic anthropologists should be present during the exhumation process in cemeteries in order to prevent misidentification of exhumed bodies [9].

There are some studies relating to the recognition of remains pertaining to a cemetery context [1,7,10] that offer some guidelines for recognition of cemetery remains. It is of great importance not to forget that funeral customs differ between countries. In some countries it is common to bury human remains in the ground, while in other coffins are placed in special vertical cement constructions called niches (e.g. Spain). In addition, in some areas it is customary to embalm the body before it is buried, while in other places embalming is not a routine procedure [11]. This fact is important due to different environmental conditions that lead to different decomposition processes [12].

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Knowledge of decay characteristics in different environments is very important to understand the origin of remains. However, this kind of information in some specific locations is not always available. One of the current problems that European anthropology and taphonomy has to face is the absence of experimental models or observational studies in this area, which leads to a lack of data that could help to answer the questions of high interest in forensic anthropology. The investigation of human remains decay from a cemetery may offer good training for specialists in forensic science and it can also provide a large amount of information pertaining to human body experimentation.

In addition, forensic anthropologists need to have proper knowledge about funeral customs and thanatopraxy of the local society, including preparation of the body for burial, artifacts accompanying the body, and accouterments associated with the grave, to be able to identify cemetery remains.

Finally, the study present here can be important to differentiate recent cemetery remains from those of historical significance [13], since, as Eliopoulos et al. noted in his article, the remains of historical significance sometimes may be unearthed because of erosion or during a construction project [10]. As a consequence, the characteristics and conditions of human remains from cemeteries need to be known in order to correctly address the investigation. Projects like the one presented here, help to reconstruct and identify the history of archaeological remains, helping to understand how the human remains from an historical context were decomposed.

The aim of this study was to identify and describe the artifacts that may indicate a cemetery origin, studying the unclaimed human remains of exhumations performed in a cemetery from Catalonia, Spain. No observational studies of this type have been conducted in Spain, thus the study presented in here is pioneer in this field.

2. Materials and methods

From March 2012 to May 2013, an investigation was carried out on unclaimed human remains from a cemetery context. The study reports the results of 168 exhumed corpses from the cemetery of Terrassa (Catalonia, Spain). The access to the unclaimed human remains was facilitated by cemetery authorities to the Universitat Autònoma de Barcelona for the observational study. An official agreement of collaboration with cemetery authorities and a health license had been approved.

In this study, remains from different evicted niches within the same cemetery have been analyzed. Decomposition data and artifacts were collected from corpses, clothes, coffins and niches. In all cases, decomposition of human bodies took place in wooden or conglomerate coffins, which simulate an empty space [14]. The evaluation of corpse conservation was performed by categorizing it into one of six different stages: total skeletonization (>80%), skeletonization with wet putrid matter, skeletonization with dry putrid matter, mummification/desiccation, saponification, and corification. Skeletonization with dry putrid matter, as well as mummification, can be defined as dry types of conservation because of the absence of body fluids. Whereas, skeletonization with wet putrid matter or saponification can be defined as wet type of conservation due to the presence of body fluids. The type of conservation may facilitate the incidence and observation of cemetery artifacts. In this study, artifacts refer to any object made by human beings, or which results from anthropogenic treatment of corpses.

Throughout this observational study, four types of artifacts were observed. We distinguish these four types of artifacts by their origin, which can be from: Autopsy practice (autopsy of cranial vault and thorax); Thanatopraxy (sewing of upper and lower jaw together, cotton packing, etc.); Funeral practice (coffin wear, fungal growth or others related to the place and manner of the interment); and finally, forgotten or personal objects.

Photo-documentation was performed throughout the whole research. At the end of the field study, the remains were deposited into ossuaries of the cemetery.

3. Results

The anthropological intervention was carried out between 2012 and 2013 in the cemetery of Terrassa (Catalonia, Spain), with 168 unclaimed corpses exhumed. The observed funeral structures included multiple niches (41) and individual niches (56). The majority of the corpses were adult individuals (164) and just 4 were juveniles. The period of all analyzed interments was between 1937 and 2009.

The decedents were dressed up, some in vestments (105), others shrouded in white burial sheets (36), while in 27 cases it was not possible to observe the type of clothing.

Dry conservation of corpses predominated in the cemetery of Terrassa (114 cases). Skeletonization with dry putrid matter (81) was the most frequently observed decay stage, followed by mummification (29) (totally or partially mummified corpses). Few cases of skeletonization with partial desiccation (2), and skeletonization with dry putrid matter in combination with partial desiccation (2) were observed. Thirty-one cases of total skeletonization were analyzed. The wet conservation was less observed. In few cases, skeletonization with wet putrid matter was presented (24). Saponification was observed only in specific areas of the corpses (small pieces in abdominal area, and between distal parts of legs). No case of whole body saponification was observed. Corification was not observed during this study either.

Table 1 shows the different kind of artifacts found in the 168 individuals observed in Terrassa cemetery.

The artifacts can be divided into 4 types according to treatment/practice performed previously:

1. Autopsy practice/treatment that involves forensic or clinical autopsy (Fig. 1).

Table 1
Observed artifacts throughout exhumations in cemetery of Terrassa (Catalonia, Spain), and their indication of cemetery origin (1–2).

Type of artifacts	Number of cases observed in cemetery of Terrassa	Indication of cemetery origin
Autopsy practice	11	1
Embalming	0	
Aspiration trocar button	1	
Sewing of upper and lower jaw	9	
Cotton packing *buccal*	44	
nostril	40	
buccal + nostril	37	
Eye cup	2	
Cloths posterior cut	64	2
Diapers presence	37	
Waxes rest	0	
Decomposition accelerant product	2	
Coffins wear	23	
Fungal growth within the face or hands	12	
Sawdust from coffin adhering to body	7	
Unpigmented fauna	4	
Hair circular lost in the posterior part of skull	20	
Forgotten objects and associated with funerary, autopsy practice or thanatopraxy	4	

Indication of cemetery origin: highly indicative of cemetery context (1); suggestive of cemetery context (2).

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Fig. 1. Skull autopsy.

2. Thanatopraxy: sewing of upper and lower jaw together (Fig. 2); cotton packing (Fig. 2); embalming of the body, aspiration trocar button (Fig. 3); eye cup (Fig. 4); posterior cut of cloths; remains of cosmetic wax, presence of diapers (Fig. 5), and presence of decomposition acceleration products (an enzyme and micro-organisms pack).
3. Funeral practice: coffin wear, fungal growth (Fig. 6), sawdust from coffin adhering to body (Fig. 7); unpigmented fauna (Fig. 8), and circular hair lost in the posterior part of skull (Fig. 9).
4. Forgotten objects and those associated with funeral customs, autopsy practice or thanatopraxy (Fig. 10).

The most frequent artifact observed was the cotton packing (50%), followed by posterior cut of cloths (38%) and presence of diapers (23%). The coffin wear trait was also frequent (14%). As we mentioned above, the state of conservation conditioned the presence and observation of cemetery artifacts.

Based on the results of this study, and taking into account their origin and frequency, the artifacts found near and/or on the corpses

Fig. 2. Waxed thread rest in upper jaw and cotton packing of mouth and nostrils are observed.

Fig. 3. Presence of trocar button in the anterior part of abdomen.

can be classified into two groups: those highly indicative, and those just suggestive of the cemetery origin of remains. Observations related to medical/forensic or thanatopraxy have been considered as highly indicative of a cemetery context, whereas artifacts of mortuary esthetics, funeral practice, and environmental conditions suggesed a cemetery origin (Table 1).

4. Discussion

Artifacts found near and/or on human remains are closely related to the type of conservation and funeral practice. This study aimed to recognize and evaluate cemetery artifacts that can be used to indicate the origin of the remains. The presence and observation of artifacts is significantly conditioned by the preservation and treatment of the corpse before burial, which differs a lot between countries.

In Spain the customary treatment of the body, once death has been ascertained, includes cleaning, clothing, and placing in a coffin. Typically, the lower and upper jaws are tied together so they are not affected by the development of *rigor mortis* [15]. Embalming of deceased is not performed regularly in Spanish funeral practice, with the exception of the cases when the corpse must be transported to or from another country. In some cases partial treatment of body takes place, and the aspiration of visceral cavities is needed. After the funeral service, the coffin is taken to the cemetery where it is lifted into the niches.

Fig. 4. Presence of plastic eye cups.

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Fig. 5. Diaper presence.

Fig. 7. Sawdust from coffin adhering to skull.

Exhumations occur as a consequence of lack of space in cemeteries. In order to store the bags containing exhumed remains, special buildings within the cemeteries are built, known as ossuaries. According to the Spanish mortuary health laws, the transfer of unclaimed human remains to ossuaries can be carried out only 5 years after the inhumation [16].

The condition of cemetery remains can vary considerably depending on physical, chemical, and biological factors [7]. In the cemetery of Terrassa the overall condition of exhumed unclaimed remains was very good. Generally, predominance of dry body conservation over the wet conservation has been observed. In contrast, the investigation of Ferreira et al. describes predomination of wet condition of exhumed corpses in a Portuguese cemetery [9]. This fact may be related to different environmental conditions and different type of funeral customs (e.g. inhumations in the ground carried out in Portugal).

During our study, four principal types of treatment and related artifacts have been observed. The first one was the results of forensic or clinical autopsy practice. After this process, marks on the human body are observed resulting from different procedures performed during autopsy. During autopsy the cranial cavities are opened. An oscillating saw is used for opening the cranium to enable the examination of the brain [17,18]. The placing of absorbent fabric material (cotton or absorbent paper) within the cranial cavity after the procedure is used to prevent slippage of the skullcap from the cranial base during suturing of the head, and reducing the possibility of fluid leakage during the funeral ceremony. Throughout the autopsy, the thorax and abdominal cavity are also opened. The ribs, sternum and clavicles are sectioned by rib shears for the removal of the breastplate to enable the inspection of the thoracic viscera. In addition, incisions in the skin and subcutaneous tissue, and on the ventral surface of the ribs, in order that the internal organs along the thoracic wall can be observed [19]. Anthropologists should be aware of the location and nature of these cuts, so they are not confused with those produced in cases of intentional dismemberment or other types of sharp force trauma [10]. The presence of cut marks in the bone or mummified skin from autopsy practice is indicative that the body has a cemetery origin. In our study, 11 cases of autopsy practice have been observed. It was possible to observe both cut marks on the skin and cut marks and/or incisions section on the bone. No absorbent material within the cranial cavity was found. This absence could be related to the characteristics of the used absorbent fabric material, which breaks down earlier than the rest of tissues.

The second type of artifact highly indicative of cemetery remains is that related to thanatopraxy treatment, which results in a large number of traits (artifacts). The most notable are those related to embalming process, which has been noted as a key factor in the identification of cemetery remains. Researchers from the

Fig. 6. Fungal growth observed on deceased face.

Fig. 8. Presence of live unpigmented fauna.

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Fig. 9. Circular hair lost in the posterior part of skull.

United States, where embalming frequently occurs, have described a number of attributes encountered in embalmed tissues [1]. According to the funeral industry, embalming involves the injection of chemicals into the vascular system and visceral cavities for disinfection and preservation of a body [1,20]. In Spain, however, embalming is not common, and during our investigation was not observed in any case. Throughout our study, presence of nails, head, facial and body hair was mainly found as a result of natural body conservation. Similarly, dehydrated brain tissue and mummified bodies were found, but the bodies had not been embalmed. Other mummified organs observed during our study were eyes, lungs, heart, diaphragm, entrails and stomach. It may be the result of the warm climate in Catalonia (Spain) and local environmental conditions of the cemetery in Terrassa, as well as the position of the niche within the block of niches and the location of the block of niches in the cemetery.

Partial treatment of the decedent sometimes was performed. In those cases, presence of a trocar button in the anterior part of abdomen was found. A plastic trocar button is used to seal the hole left by the trocar during the aspiration of blood, other body fluids and gases from both the abdominal and thoracic cavity, and injection of fluid in order to disinfect and preserve the remains. The plastic trocar button is screwed into the skin, and may resist for years, helping to define the origin of the remains [1]. We observed one case of trocar button presence during exhumations in the cemetery of Terrassa. The screwed plastic trocar button was placed in the antero-superior part of individual's mummified abdomen.

Fig. 10. Presence of catheter left in the deceased body.

Sewing of upper and lower jaw together is another indicative trait of thanatopraxy. Different types of this procedure are known. A few years ago, injector needles with steel pins were used widely. Injector needles are stainless steel pins with attached wire. One is inserted in each gum line and its function is to keep the mouth closed. Small screws have also been used for this purpose [1]. In the cemetery of Terrassa, this type of sewing was used years ago but we did not find it during exhumations. A simple sewing was used more often. This procedure is easier, cheaper, and more discreet and preserves very well for years. It was possible to observe the rest of thread adhering to the upper or lower jaw in 9 cases.

Cotton packing was the most common artifact observed in the cemetery of Terrassa, frequently put in the mouth and nostrils to prevent from leakage of fluids. Moreover, this method facilitates the shaping of the lips. Some time ago, a mouth former was used for this function. It is a contoured perforated plastic object to fit the teeth, with a smooth inner surface and spiny outer surface [1]. A mouth former, compared to cotton packing, is not universal. This was not observed during these exhumations but, conversely, we could observe the presence of cotton packing. Nostril cotton packing (40 cases) was sometimes observed, due to inferior jaw disarticulation, losing the cotton in the oral cavity. In those cases, *buccal* cotton could be observed out of its position. In cases when *buccal* cotton was preserved *in situ* (44 cases), it could occupy all oral cavity and the superior part of trachea. The presence *in situ* of both, *buccal* and nostril cotton, was observed in 37 cases.

Other artifacts were observed such as, eye cups. Eye cups are thin, plastic, and transparent disks used to shape the eye and keep the eyelid closed. The disk is molded to produce a smooth, concave surface for direct placement over the ocular globe. The convex surface is spiny to facilitate gripping of the inner surface of the eyelid [1]. A cotton bead can be placed under the eye cup. Eye cups with cotton beads were observed in just 2 cases during this study.

To facilitate dressing of decedent during thanatopraxy, the clothes are often cut in its posterior part [1]. Such a posterior longitudinal cut was clearly observed during our examinations. It was observed in 64 cases, when the decedent was clothed in vestment and not in a white funeral sheet. Due to advanced disintegration of cloth tissue, it was not possible to observe either the type of cloth or the posterior longitudinal cut in many cases.

Another characteristic of thanatopraxy or clinical practice is the presence of diapers. Their function is to reduce the possibility of fluid leakage during the funeral ceremony. Diapers resist decomposition and they are frequently observed in remains from cemeteries. There are no other studies that describe this type of artifact. During our observational study, numerous (37) cases of diapers presence could be observed. In some cases it was not possible to identify whether the decedent wore the diapers due to *post mortem* rake out of the remains.

In cases of disfiguring trauma, wax is commonly used for cosmetic restoration of the face, and is resistant to decomposition [1]. Up to this time, any trace of cosmetic restoration or remains of cosmetic wax has not been observed. We found only one known case of trauma, but the cosmetic wax remains were not preserved. The way in which the decedents were wrapped indicates that they were probably not exposed during the funeral ceremony.

In some cases, an enzyme and microorganisms pack (HYGECO, BIOACTRYN®SACOPACK) is deposited into coffin. This biological powder product is a decomposition accelerant that promotes liquefaction and digestion of fats, proteins, starch, and cellulose. Usually, the product is placed into the coffin between thighs, near to pelvis. The powder is packed in a plastic bag, so the perforation is required for the activation of the product by water or body fluids.

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When this does not occur, content of the bag changes from a powder to gel structure. The product does not fulfil its function and may be found later during exhumation process, being indicative of cemetery origin. In this study, two inactive products could be observed. It is known that the application of those products started in 2004 in Terrassa, but there was not a list of cases where this product was used in the inhumation, so the evaluation of its efficiency is not possible. Studies on exhumations performed in North America [1,7,10] did not mention the use of similar products.

The third type of treatment of the dead body is funeral practice. Coffin wear, fungal growth, sawdust from coffin adhering to remains, unpigmented fauna, and circular hair lost in the posterior part of skull, could be included in this category. This group of traits may be a guide to the origin of remains but they are not indicative, at least in the first two groups.

In the study of Eliopoulos et al. [10] the most notable factor was the so-called coffin wear, which has been described in other studies, too [1,21]. Coffin wear refers to the erosion of the bone of pressure points in the supine skeleton, often observed on the occipital bone, scapular spines, humeral heads, spinous processes of the vertebrae, sacrum, innominates, and femora. Moisture or water may be retained in the coffin and accelerate the decay of submerged portions of the body. This decay/erosion may be slight and only affect the superficial layers of the cortical bone, or in some cases, it may extend to the underlying trabecular bone. Differential erosion of bone in contact with the bottom of the coffin may come from electrochemical action of the bone under local effects of temperature and moisture [1,10]. In our study, some cases (23) of this kind of wear were observed, but so far they have not been significant. This could be due to dry conservation in the cemetery of Terrassa, and therefore less moisture or water presence in niches.

Whitish fungal growth over the face and hands was found in 12 cases. Its presence is associated with cosmetic makeup used during the preparation of the body for viewing. Mold or other fungal spores may already be present in the makeup, which provides a medium conductive for growth. The presence of mold on the face and hands is consistent with cemetery remains [1,22]. Moreover, in some cases (2) the presence of fungal growth may be observed over the whole body, which we associated with higher humidity in the niche.

Sawdust from coffin adhering to body could occasionally be seen. Eliopoulos et al. [10] have described that in Greece all coffins had a layer of sawdust in the bottom to absorb decomposition fluids. Thus, in these cases, it is not uncommon to find sawdust adhering to the posterior surface of the bones. In Terrassa, this is not a common practice. The presence of sawdust adhering to bones was observed in those cases when the pillow filled with sawdust was deposited under the head of the decedent (7 cases). The sawdust was released and adhered to the bones due to tearing of the pillow.

We also found unpigmented fauna (spiders, moths, mealy bugs) in four coffins. Due to the lack of similar studies, there is no more information about the presence of this kind of fauna. All the studies mentioned above [6,7,9,10] were performed in the burials in the ground. In Spain, the burial takes place in cement vertical structures—niches that are not underground. They are not hermetic for insects, as are the burials in the ground, where the absence of oxygen makes the presence of insects sporadic and rare [9]. Unpigmented fauna in coffins is good indicator of the absence of sunlight and their presence is a trait to suggest that the body may have a cemetery origin.

Another artifact that can be suggestive of a cemetery origin of the remains is the circular hair loss in the posterior part of skull. This is observed due to the hair being pasted to the pillow. When the skull is removed, this type of defect may be observed. It is important not to confuse this artifact with the loss of natural hair in this part, or some type of *alopecia areata*. In the cases where we could observe this circular hair lost (20 cases), it was possible to the paste of lost hair in the pillow.

The last types of artifacts are the forgotten objects and items associated with the funeral, autopsy practice, or thanatopraxy (4 cases). The most common artifacts are objects placed in the niche as part of the burial process, and include parts of plaques, statues, flowers, photos, jars, toys, etc. Sometimes, the presence of surgical gloves, injections, injector needle, and probes used for body preparation and/or during clinical care are observed.

Not always all the types of artifacts were observed. Sometimes combination of artifacts, or just some of them were found. We must take into account that not all kinds of artifacts have the same value in the determination of a cemetery origin. Berryman et al. [1] describe three types of artifacts as predictors of cemetery origin: the physical characteristics of the remains, coffin/caskets or embalming artifacts recovered in association with the remains, and the presence of embalming tissue. They distinguish between those indicative, and those consistent with, cemetery burial. Our results are in agreement with the Berryman et al. classification, but we introduce other variables to be taken into account. We classify artifacts into four types, and place them into two groups by their weight/value in relation to their origin. Artifacts from autopsy practice, thanatopraxy are considered highly indicative of cemetery origin (Table 1). The artifacts of funerary practice and forgotten objects associated with autopsy, funeral treatment, and thanatopraxy are concluded to be suggestive of a cemetery origin, but they may not exclude human remains of forensic interest (Table 1). However, to identify the correct origin of the remains, a combination of these artifacts is needed.

In summary, the conditions of corpses exhumed in the cemetery of Terrassa and the artifacts indicating a cemetery origin were described in the present paper to help to differentiate them from those of remains of unknown origin. The current study was prompted by similar works based on observations carried out in Greece and United States, where burial customs are very different. The burial customs of Catalonian cemeteries are more similar to those from Greece, where embalming is not widely practiced, but differs in the type of burial. Embalming artifacts are rarely found, because this treatment is not widespread in Catalonia, while it is commonly practiced in the United States. Even so, dry conservation and good preservation of unclaimed human remains was observed. In our study, we found artifacts highly indicative and suggestive of cemetery context. Forensic anthropologists must be familiar with all of them in order to be able to recognize remains that could pertain to a cemetery context.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.forsciint.2014.10.006.

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