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Comparison of decomposition rates between autopsied and non-autopsied human remains

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ABSTRACT

Penetrating trauma has been cited as a significant factor in the rate of decomposition. Therefore, penetrating trauma may have an effect on estimations of time-since-death in medicolegal investigations and on research examining decomposition rates and processes when autopsied human bodies are used. The goal of this study was to determine if there are differences in the rate of decomposition between autopsied and non-autopsied human remains in the same environment. The purpose is to shed light on how large incisions, such as those from a thorocoabdominal autopsy, effect time-since-death estimations and research on the rate of decomposition that use both autopsied and non-autopsied human remains.

In this study, 59 non-autopsied and 24 autopsied bodies were studied. The number of accumulated degree days required to reach each decomposition stage was then compared between autopsied and non-autopsied remains. Additionally, both types of bodies were examined for seasonal differences in decomposition rates. As temperature affects the rate of decomposition, this study also compared the internal body temperatures of autopsied and non-autopsied remains to see if differences between the two may be leading to differential decomposition. For this portion of this study, eight non-autopsied and five autopsied bodies were investigated. Internal temperature was collected once a day for two weeks.

The results showed that differences in the decomposition rate between autopsied and non-autopsied remains was not statistically significant, though the average ADD needed to reach each stage of decomposition was slightly lower for autopsied bodies than non-autopsied bodies. There was also no significant difference between autopsied and non-autopsied bodies in the rate of decomposition by season or in internal temperature. Therefore, this study suggests that it is unnecessary to separate autopsied and non-autopsied remains when studying gross stages of human decomposition in Central Texas and that penetrating trauma may not be a significant factor in the overall rate of decomposition.

1. Introduction

Estimating the postmortem interval (PMI) is an issue shared by many forensic science disciplines including anthropology, medicine, entomology, and microbiology, among others. In the past, numerous researchers have examined the rate and process of gross tissue modifications occurring in human remains during the PMI [1–24]. In these studies and others, copious intrinsic (e.g., body mass, cause of death) and extrinsic (e.g., abiotic environment, scavenger access, soil pH, depositional environment) factors have been identified that affect the rate, and sometimes pattern, of decomposition. Penetrating trauma to the body has been cited as one of the factors that significantly affect decomposition rates [2,3,8,24–27]. In this study we compare the rate and pattern of decomposition between autopsied and non-autopsied human remains to investigate the effect of penetrating trauma on decomposition rates. Thorocoabdominal autopsies require a large incision from the neck to the pelvis that penetrates the skin and exposes the chest and abdominal organs. Hence, the comparison of autopsied and non-autopsied bodies allows for the investigation of whether penetrating trauma affects the rate and pattern of decomposition in an outdoor setting. Additionally, it is important to understand how autopsy incisions may affect taphonomic studies utilizing both autopsied and non-autopsied bodies.

The effects of penetrating trauma to the body caused by sharp-force or projectile wounds on the rate of decomposition have been debatable [2,3,8,25–27]. Mann and colleagues [2] first argued that penetrating wounds substantially increased the rate of

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decomposition because of increased fly oviposition. However, more recent studies [28,29] have contradicted the significant effect of penetrating trauma on the rate of decomposition. Cross and Simmons [28] found no significant effects of gunshot trauma on body temperature, total body score, or time required for the body to proceed from fresh to skeletonization. Likewise, Smith [29] found that penetrating trauma caused by sharp-force influenced the pattern of decomposition but not the overall rate of decomposition. Therefore, understanding the effect of penetrating trauma on decomposition rates has practical applications in the forensic sciences.

In addition to the direct application of understanding the role of penetrating trauma on the rate of decomposition, differences in decomposition between autopsied and non-autopsied bodies may also have an effect on taphonomic research. While many of the early studies on decomposition rates relied on animal models [7,15,16] or retrospective analyses of medicolegal cases [1,4,10,13], many recent studies [3,8,11,12,14,17,18,20] utilize donated human remains placed at dedicated decomposition facilities, especially in the United States, to help control for some factors while directly monitoring others. However, most of the decomposition research facilities accept both autopsied and non-autopsied whole body donations. If the autopsied remains differ from non-autopsied bodies in the rate of decomposition, the inclusion of autopsied bodies in taphonomic studies could skew resulting PMI estimations. On the other hand, if there is no difference in the rate of decomposition between autopsied and non-autopsied remains then sample sizes could be increased for many studies. Therefore, it is necessary to investigate the differences, if any, in the processes and rate of decomposition between autopsied and non-autopsied bodies used in studies focused on the estimation of time-since-death.

Because autopsied bodies have large abdominal and chest incisions, insect access as well as internal body temperature may differ between autopsied and non-autopsied remains [2,4–8,10,13,15,16,19,30]. The large incision (penetrating trauma) may result in greater heat loss from the abdomen during decomposition, lowering the overall internal temperature of autopsied remains and reducing the rate of decomposition [2]. However, the incision may also provide a moist area for insect oviposition [2,31,32]. As a result, during the consumption phase (active feeding stage of larvae), there could be a localized increase in temperature [33], which could increase the rate of decomposition. However, Kelly and colleagues [34] found that increased internal temperatures associated with the decomposition of clothed and wrapped pigs resulted in higher rates of maggot death, which could slow the decomposition rate. In addition, autopsied remains generally contain an organ bag sewn inside the abdomen. The fact that the organs are contained in a plastic bag may limit insect access to the organs but also allow for increased temperature. Therefore, due to the incision and organ bag, autopsied bodies may decompose at different rates when compared to non-autopsied bodies, which could affect PMI calculations based on autopsied remains. Since this may have implications in medicolegal death investigations, it is important to determine if the use of autopsied bodies skews regional PMI calculations based on gross modifications of the soft tissues during decomposition.

The goal of this study was to investigate if an autopsy incision affects decomposition rates and internal body temperatures in the subtropic environment of Texas Hill Country. Ultimately, the purpose is to shed light on the effect of penetrating trauma on estimations of time-since-death and to determine whether utilizing both autopsied and non-autopsied human remains in forensic taphonomy studies skews the results of decomposition and resulting PMI estimations. Additionally, this study aims to gain some insight into possible ultimate causes of any differences in decomposition rates between autopsied and non-autopsied bodies.

2. Methods

2.1. Sample

For this study photographs of 83 individuals (59 non-autopsied and 24 autopsied) donated to the Forensic Anthropology Center at Texas State (FACTS) from 2010 to 2013 were examined. The fresh bodies were placed unclothed in a supine position on the ground surface at the Forensic Anthropology Research Facility (FARF) on Freeman Ranch in San Marcos, TX. A donation was considered autopsied if it contained an abdominal autopsy incision, and non-autopsied if they contained no abdominal autopsy incision. Any remains with a cranial autopsy alone were considered non-autopsied, as the incision from the cranial autopsy was much smaller and assumed not to greatly affect the overall rate of decomposition. The sample was analyzed without regard to differences in sex, ancestry, age, cause of death, or body size.

2.2. Decomposition stages

Photographs and notes recorded for each of the 83 bodies were examined to determine the day a donation reached each stage of decomposition (i.e., early, advanced, and mummification) following the criteria outlined by Galloway and colleagues [1] (Table 1, Fig. 1). Since the stages of skeletonization and extreme decomposition are seldom reached at FARF these stages were omitted [20]. Notes and photographs were recorded daily (on weekdays) for two weeks after placement and then every other weekday until the bodies mummified.

2.3. Accumulated degree days

The relationship between the beginning of each decomposition stage and the accumulated degree days (ADD) was examined. Accumulated degree days take into account the thermal energy units available for decomposition. Therefore, the use of ADD rather than calendar days accounts for temperature differences due to time of year [10].

To calculate ADD, ambient temperature data (°C) was obtained from the Texas A&M Forest Weather Station. To ensure the Texas A&M station provided an accurate representation of the ambient temperature at FARF, daily temperature data was collected at FARF for one month using a thermocouple data logger and compared to the forest site data. A *t*-test reviled no significant differences in temperature between FARF and the forest site (*t*-score = 0.6327, CV = 2.042).

After acquiring the temperature data, ADD was calculated from the date of placement at FARF to the day each body reached early, advanced, and mummified stages and between decomposition stages (i.e., early to advanced, early to mummification, advanced to

Table 1
Stages of decomposition used in the current study.

Stage	Description
Fresh	No discoloration, no insect activity
Early	Skin slippage, green discoloration, bloat
Advanced	Sagging of the flesh following post-bloat, caving in at the abdominal cavity, high maggot activity,
Mummification	Complete drying out of soft tissue, retention of skin in leathery, tattered state.

Adapted from Galloway and colleagues [1].