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A Preliminary Investigation of Postmortem Tooth Loss

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ABSTRACT: Forensic anthropologists have found a seemingly increased frequency of dismemberment cases and subsequent scattering of the elements that mandates developing unconventional methods of estimating postmortem interval. The chronological sequence in postmortem tooth loss has been investigated as an indicator for estimation of time since death.

The anterior dentitions of cadavera were observed to discern patterns in "drop time" based on age, periodontal health, seasonality and location of body placement. Individuals deposited in the summer months lost teeth much more rapidly than those deposited in the late fall or winter months. Similarly, individuals exposed to direct sunlight, a micro-environment where rapid decomposition has been noted, lost teeth before individuals in shaded locales. Since tooth loss is dependent on the deterioration of the soft tissues which bind the tooth into the alveolar bone, we found tooth loss to be correlated with general soft tissue decomposition rates as dictated by season and environment.

When utilized as sole indicator, the patterns of postmortem tooth loss can not be used for estimating time since death. However, when used in conjunction with other indicators, tooth loss patterns may provide useful information for more accurate estimation of the postmortem interval.

KEYWORDS: physical anthropology, periodontal ligament, postmortem interval, decomposition

The discovery of skeletal remains poses many questions for the medical investigator. Of critical importance in securing a positive identification is an accurate estimation of the length of time the individual has been deceased. To answer such a query, he/she can employ various methods incorporating the chronology of decomposition and taphonomy. However, the condition of the skeletal remains or the context in which they are recovered occasionally creates obstacles for estimating the postmortem interval. Case studies demonstrate that dismembered remains [*1,2*] and the ever-present scattering of elements by carnivores and rodents [*3–5*] can be problematic for the forensic anthropologist. Whether bones are dispersed through criminal action or scattered due to carnivore/rodent activity, or even complicated by environmental factors such as moving water [*6,7*], the critical need to assess the postmortem interval based on isolated elements clearly exists.

It is generally accepted that the cranium provides a preponderance of evidence about the individual represented. Furthermore, the nature of crania is such that they are often transported and subsequently recovered in isolated situations [*7*]. It seems apparent that techniques for assessing time since death involving crania would provide a wealth of information. In particular, understanding the rates of disarticulation for dental structures could facilitate estimation of time since death on partial remains or isolated skulls and crania. The following study focuses upon tooth loss as a mechanism for estimating the postmortem interval.

Materials and Methods

The Anthropological Research Facility at the University of Tennessee at Knoxville, where donated and unclaimed bodies are exposed to natural environmental factors, provides an ideal arena for decomposition research. Having expanded from a secluded concrete slab in the early 1980s to a semi-wooded setting, this facility allows for first-hand investigation and observation of decay processes on human cadavers.

Human subjects with anterior dentitions (canines and incisors) were chosen for this study. Single-rooted teeth provide the ideal opportunity for studying correlations between tooth loss and time since death as multiple rooted teeth rarely become detached from alveolar bone. Each living tooth is firmly bound to the surrounding alveolar bone by the periodontal ligament, a complex of intertwining collagenous fibers [*8*]. As a soft tissue, the ligament is subject to the normal patterns and rates of decay. When decomposition of the ligament occurs, it leaves a space around the associated root which in turn becomes loose, allowing tooth exfoliation.

The sample consists of 9 male and 2 female Caucasian and African-American cadavera ranging in age from 25 to 82 years. Each research subject was placed in a supine position and age, sex, race, location of body within the facility and the season of deposition were recorded (Table 1).

Tooth loss was investigated at weekly intervals, at which time slight pressure was applied to each tooth in order to detect separation from the alveolar bone. By allowing our fingers to slide along the anterior and posterior surfaces of the tooth from the root to the occlusal surface, we were able to remove already detached

TABLE 1—*Sample subjects with demographics and placement variables*

Subject	Age	Sex	Race	Environment	Season
A	64	Female	White	Open	Spring
B	59	Male	Black	Embalmed	Spring
C	34	Male	White	Wooded	Autumn
D	25	Male	Black	Body bag	Winter
E	54	Male	White	Wooded	Winter
F	53	Male	White	Wooded	Winter
G	64	Male	White	Embalmed	Spring
H	82	Female	White	Embalmed	Summer
I	?	Male	Black	Open	Summer
J	55	Male	White	Aquatic	Autumn
K	69	Male	White	Wooded	Winter

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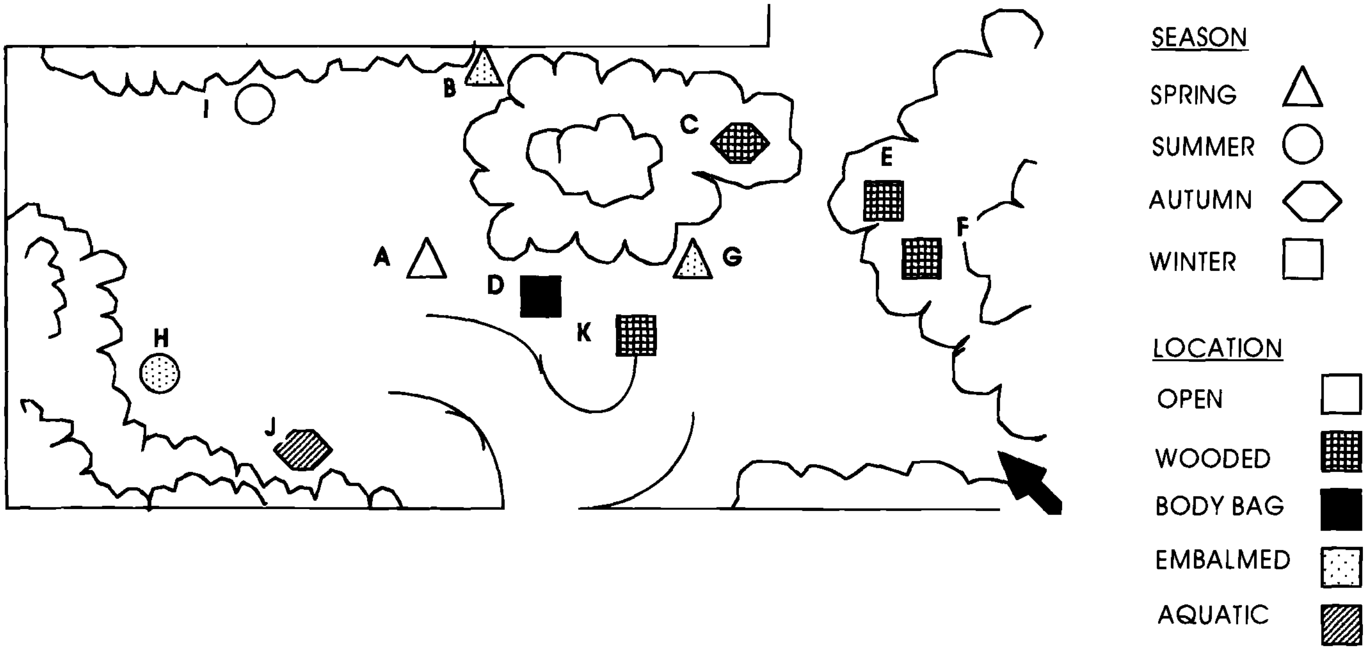

FIG. 1—*Seasonality and location of subject placement within the facility.*

teeth without causing premature loss. The date of tooth loss was recorded and the time that had elapsed between deposition and tooth loss, or drop time, was calculated for comparative purposes.

Many interrelated factors affect the decay rate of soft tissue including temperature, insect activity, humidity, season of deposition and postmortem treatment such as embalming [*4*]. We chose to evaluate differences in immediate environment as variables for rate of decay in the soft tissues. In an attempt to discern differences in the drop rates for subjects across various settings, we categorized the immediate environments in the following manner: open area in direct sunlight, shady/wooded, dark colored plastic "body" bags, embalmed and aquatic. In addition to environment, the initial season in which the individual was exposed to the elements at the facility is a primary variable in the equation for estimating time since death. Both season and location of deposition for each subject are depicted by Fig. 1.

Results

The subjects in each of the various immediate environments showed varying rates of tooth loss. The patterns of tooth loss for each subject were evaluated based on the relationship between micro-environment and season of deposition. As depicted in Fig. 2, the average number of weeks following deposition until tooth loss was calculated for both the maxillary and mandibular dentition of each subject. In certain instances where individuals maintain dentition (indicated by a + sign), the number of weeks reported reflects the number of weeks since deposition. A review of Fig. 2 allows for evaluation of the effects of both season of deposition and immediate environment upon postmortem tooth loss.

Comparisons across micro-environments and season of deposition allow some patterns to be seen. Although both subjects A and I were in the open/direct sunlight, subject I, who was deposited in the summer, lost teeth much more rapidly than subject A who was deposited in the early spring. Subject A, however, lost teeth more rapidly than both subjects B and G, both of whom were embalmed and deposited in the spring. Subject D who was placed inside a body bag and deposited during winter months lost dentition much more rapidly than subjects E and F, both of whom were deposited in the winter but in a wooded environment. Furthermore, subject C, who was deposited in the autumn in a wooded environment, also lost teeth much faster than both subjects E and F. It is also noted that subject J who was placed in an aquatic environment during the autumn lost teeth more rapidly than subject C deposited during the same season in a wooded environment.

ENVIRONMENT

SEASON OF DEPOSITION	OPEN	BODY BAG	WOODED	EMBALMED	AQUATIC
SPRING	A 52 / 52.7			B 65.3 / 68 G ABS / 44+	
SUMMER	I 3.8 / 3.4			H 39+ / 39+	
AUTUMN			C 28.2 / 45		J 22 / 22
WINTER		D 28.5 / 33.2	E 54+ / 54+ F 50.3 / 40.5 K 16+ / 16+		

KEY:

SUBJECT — AVERAGE NUMBER OF WEEKS FOR LOSS OF MAXILLARY TEETH / AVERAGE NUMBER OF WEEKS FOR LOSS OF MANDIBULAR TEETH

FIG. 2—*Average number of weeks for maxillary and mandibular tooth loss.* NOTE—+ denotes individuals who retain detention.

Discussion and Conclusions

Many areas of human and animal decomposition research have been pursued in an effort to elucidate criteria for estimating time since death [4,9–11]. Various aspects of this research indicate that environmental factors such as sun/heat exposure, shaded settings and submersion in water can affect the rate of decomposition. Mann and coworkers [4] report that cool and dry conditions (particularly during winter months) arrest the decay processes and may actually result in mummification of soft tissues. Similarly, research reported by Rodriguez and Bass [11] indicates that decay progresses much more rapidly in the spring and summer months as a result of intensified insect activity during warmer weather. The patterns of tooth loss witnessed during the course of this research are consistent with general soft tissue decomposition with regards to seasonality of deposition and immediate environment.

As illustrated in Fig. 2, when subjects A and I were placed in the same micro-environment, open/direct sunlight, in the spring and summer respectively, subject I lost teeth much faster than subject A. The rate of tooth loss witnessed in Subject I is consistent with decomposition rates of a body exposed to direct sunlight particularly during summer months. The exposure of subject A to cool temperatures in early spring might account for the slower rate of tooth loss as desiccation of soft tissues may hinder the decomposition of soft oral tissues and subsequent tooth loss. Similarly, subjects C, E and F were all placed in a wooded/shaded environment during autumn (C) and winter (E and F). Subject C lost dentition at an accelerated rate in comparison with both subjects E and F. At the conclusion of the initial phase of this study, both subjects E and F are extensively skeletonized, yet most teeth remain intact. This may be due to the initial exposure of these subjects to very cold temperatures during the winter months resulting in decelerated decomposition of soft tissues.

The effect of a micro-environment may be recognized when the rates of tooth loss for subjects D, E and F are compared. While all subjects were deposited during the winter months, subject D was enclosed within a body bag, whereas, subjects E and F were in a wooded/shaded area. The teeth of subject D were exfoliated at a much faster rate than either subject E or F. This may be correlated with the potential of the black body bag for retaining warmth and providing an environment conducive to insect/larvae activity and accelerated decomposition [4]. All embalmed subjects, B, G and H, demonstrate reduced rates of tooth loss regardless of season of deposition. This is consistent with the reduced rate of soft tissue decomposition recognized in embalmed individuals [4,12–14].

In general, we noticed that individuals exposed to the extreme heat and humidity characteristic of the Tennessee summer lose teeth rapidly. Subjects deposited in colder months and exposed to dry conditions, which result in desiccation of tissues, retain dentition for longer periods of time. Regardless of season of deposition, embalmed subjects retain dentition for extended periods of time.

At present our findings do not permit accurate estimation of the time since death based solely on postmortem tooth loss. However, in the overall evaluation of time since death, patterns of tooth loss may be utilized to supplement estimation of the postmortem interval.

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