Gaps in Information: What Missing Teeth Mean in Bioarchaeology

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Keywords: Postmortem tooth loss, Dental pathology, Dental disease

ABSTRACT Previous bioarchaeological analysis of postmortem tooth loss (PMTL) has failed to recognize the potential influence of diseased dental tissue on tooth retention after death. Because tooth loss from a traditional taphonomy prospective is treated simply as missing data, demographic studies are potentially influenced by underestimations of disease prevalence. To investigate the association of tooth loss and dental disease, data on the pathological conditions observed in the tissues were collected on a sample of teeth from 771 individuals. By analyzing the evidence of disease in the bone and dental tissues immediately surrounding empty alveolar sockets suggestive of PMTL, trends in the presence of diseased tissue and retention of a tooth emerged. When compared to teeth retained after death, PMTL sockets were 15.3% less likely to retain neighboring teeth and 21.5% less likely to have neighboring teeth that showed no signs of carious or periapical lesions. The results suggest that the traditional explanation of susceptibility to loss due to the exposure and morphology of single-rooted, anterior teeth does not sufficiently explain the causes of PMTL in many cases. Rather, it would be more accurate to consider PMTL, in part, as an advanced symptom of dental disease when interpreting missing teeth in the bioarchaeological record.

Tooth enamel is the densest, most resilient tissue in the human body (Hillson, 1996). As a result, human teeth typically can survive a wide range of environments, making them a rich source of information for bioarchaeologists gathering data on human behavior. Indeed, the importance of the dentition in bioarchaeology relates to the fact that it informs on human evolution, diet, growth and development, migration, identity, and disease (Scott and Turner, 1988; Hillson, 1996). Since the oral cavity has direct contact with both the external and internal environment, examination of oral disease in the dentition enhances our understanding of the differences in foodways between and within cultures. Dental disease provides significant information concerning ancient diet and cultural practices, as well as the influence of diet on pathological conditions of the dentition (Konig, 2000; Moynihan, 2005). Dental disease is sometimes used as a proxy for understanding oral health, but the inconsistency in defining the term *health* has led researchers to move away from the umbrella term that includes unknowable factors (e.g., psychosocial aspects) and instead focus on *dental disease* as indicated by specific conditions (e.g., dental caries; Pilloud and Fancher, 2019).

Although teeth are valuable indicators of disease and life history, as well as a source of demographic and cultural data, several studies highlight the prevalence of sample bias arising from antemortem and postmortem teeth loss (e.g., Lukacs, 1995; Erdal and Duyar, 1999). Loose or missing teeth are extremely common in bioarchaeological samples, and a review of the literature has shown inconsistent methods in dealing with the consequent bias during data collection and analysis. The study of dental pathology is further complicated by the varying preservation rates of the multiple

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This paper was the recipient of the Albert A. Dahlberg prize awarded by the Dental Anthropology Association in 2021.

tissues that make up the dentition. Teeth are enclosed in some of the most fragile bone, the alveolar sockets of the maxilla and mandible. That brittle enclosure is susceptible to much more damage in archaeological contexts than the teeth themselves, and results in significant tooth loss after death.

This article explores the potential influence of missing teeth on the analysis of skeletal samples utilizing a statistical examination of patterns in dental pathology to infer what information may have been lost from teeth missing postmortem. We will focus on patterns found in various samples that exhibit missing teeth to potentially correct the underrepresentation of oral disease prevalence and will propose steps to correct possible biases from data loss.

Taphonomy of Tooth Loss

Tooth loss after death can occur through tissue loss during natural processes of decomposition. The conical shape of roots, especially of anterior teeth, makes teeth susceptible to coming loose from their sockets (Oliveira, Melani, Antunes, Freitas, and Galvão, 2000). The burial environment also affects decomposition of the soft and hard tissues and influences postmortem tooth loss (PMTL). In addition to tissue shrinkage and decomposition during skeletonization, handling of the remains during excavation, examination, transport, and storage can contribute to the dislodging and loss of teeth (Đurić, Rakočević, and Tuller, 2004; Oliveira et al., 2000). A common storage method for crania, for example, is to rest them on their mandibles for stability, which may damage maxillary teeth (Oliveira et al., 2000).

The postmortem interval, root morphology and number, and excavation methods all influence the rate of PMTL (Tibbett and Carter, 2008). Recent bioarchaeological literature emphasizes the need for careful excavation to ensure the complete recovery of the dentition. Because skulls are often recovered with teeth missing, it is important to maximize tooth recovery through careful excavation methods. Loose teeth that are outside of expected anatomical position may not be recognized during excavation, especially if burial context is not carefully examined (Đurić et al., 2004). The lack of standard excavation methods has affected the way human remains are analyzed in both bioarchaeological and forensic contexts (Evis, Hanson, and Cheetham, 2016; Haglund, 1997). Recent research suggests that a stratigraphic excavation method results in more evidence recovery than an arbitrary level method, especially in small element recovery rates and with fewer bones categorized as unassociated (Evis et al., 2016, Tuller and Đurić, 2006). The recovery of disarticulated material, such as dental remains, is crucial for constructing biological profiles and paleoepidemiology research (Tuller and Đurić, 2006).

Pathology of Tooth Loss

Although PMTL in bioarchaeological contexts is often due to carelessness during excavation, the amount of effective soft tissue holding a tooth in its anatomical position also is an important factor to consider (Đurić et al., 2004). Periodontal disease influences the integrity of the periodontal ligament that helps anchors the cementum to the alveolar bone and the gingiva, and therefore contributes to the potential for teeth to be easily dislodged postmortem (Đurić et al., 2004; Meller, Urzua, Moncada, and von Ohle, 2009).

Oral disease can be introduced through several different pathways and can affect both the soft and hard tissues of the oral cavity. Teeth are at risk for loss through infection of the adjacent tissues or due to trauma to the enamel structure. The three main pathological conditions of interest are dental caries (carious lesions in the tooth), periapical lesions (lytic lesions in the alveolar bone), or occlusal tooth wear (loss of tooth enamel). These pathological conditions threaten the integrity of the tissues involved, therefore compromising the tooth as a unit. The most significant outcome, no matter the pathogenesis, is loss of the overall tooth.

Once a tooth is lost, both the soft tissue and the surrounding alveolar bone begin to heal. Within eight weeks of tooth loss, most of the socket is filled with remodeled bone (Larjava, 2012). This remodeling reaches the alveolar crest within three to four months (Shiroma, Terrado-Naguinlin and Zuerlein, 2019), and continues for around six months, with variation based on the location and presence of neighboring teeth (Larjava, 2012). But the successful healing of a single tooth socket does not spare the rest of the oral cavity from a similar fate. Typically, the interaction of the environment and the tissues of the mouth are not confined to one tooth alone; oral pathological conditions often have multiple causes, and more than one tooth may be affected by the same disease process. As the dental tissues respond and react at different rates, moving beyond an individual tooth and considering the implications of oral pathology creates a better sense of the physical indications of an individual's overall health. From there, population level analysis provides perspective on overall disease prevalence in a past community.

Although rarely recorded beyond an inventory, tooth loss is often included in the larger interpretations of prehistoric dentitions (Costa, 1980; Lukacs, 2007). The loss of data from absent teeth is one of the most prevalent concerns in the bioarchaeology dental disease literature (Cucina and Tiesler, 2003). Potential underestimation of dental caries rates has been acknowledged in calculations of disease prevalence in samples with high rates of missing teeth (Lukacs, 1995; Littleton and Frolich, 1993). Analyzing when tooth loss took place (e.g., antemortem or postmortem), and the underlying factors that led to loss of that tooth, can be difficult to determine. Establishing when tooth loss occurred depends on the remaining alveolar bone and the degree to which it has remodeled.

Antemortem tooth loss (AMTL) of the permanent dentition is associated with advanced stages of dental disease. Antemortem tooth loss has several potential causes: caries, pulpitis, or periodontitis resulting from infection of the tooth and the surrounding tissues, or trauma (Costa, 1980; Hillson, 1996; Indriati and Buikstra, 2001; Larsen, 1995). The bias in data collection that results from AMTL has long been acknowledged, primarily in the context of studying rates of dental caries, but only a few researchers have attempted to correct for this loss in data (Hardwick, 1960; Brothwell, 1963; Powell, 1985; Kelley, Levesque, and Weidl, 1991; Lukacs, 1995; Gagnon and Wiesen, 2013). Most successfully, Lukacs proposed the "Caries Correction Factor," which derives from the prevalence of pulp exposure due to carious lesions versus attrition observed in the sample. By creating a sample- or population-specific equation for calibrating caries rates, the correction factor considers the relationship between carious lesions and AMTL (Lukacs, 1995). This focus on the effects and interpretations of AMTL has led to increased incorporation of tooth loss data in dental inventories and oral disease assessments (Nelson, Lukacs, and Yule, 1999; Cucina and Tiesler, 2003).

Postmortem tooth loss, on the other hand, has been much more ignored in the bioarchaeological literature and often treated as missing data. Although it is commonly acknowledged as a data collection bias, it is rarely addressed outside of the need for careful excavation when exhuming human remains (Tuller et al., 2004).

As discussed below, a tooth lost either antemortem or postmortem is often an indication of the subtle changes in the surrounding tissues, and consequently the disease of the overall oral cavity, rather than solely an unfortunate consequence of taphonomic processes. This study examines samples that exhibit different patterns of PMTL and explores how these patterns influence the underrepresentation of oral disease prevalence and how to correct for this bias.

Materials and Methods

The dentition of 771 individuals was inventoried and each tooth or empty tooth socket was assessed for wear and pathological conditions. The methods follow Bartelink's (2006) modification of the scoring system presented in Buikstra and Ubelaker's (1994) *Standards for Data Collection from Human Skeletal Remains*, to provide consistency between the new data collected and Bartelink's 2004-2012 collection of dental data for the final pooled sample. When the tooth was present for observation, dental caries was then scored by location on the tooth and dental wear was recorded using the Smith (1984) system for anterior teeth and premolars and the Scott (1979) system for molars. When assessing teeth for dental caries, all potential lesions were probed using a dental pick and evaluated using a 10x magnification hand lens. For the context of this research, tooth condition was recorded as either present in occlusion, AMTL, or PMTL. All other cases were excluded. Neighboring tissues in this context were represented by an examination of the teeth immediately mesial and distal to the selected tooth and the alveolar bone that surrounded those teeth. In the case of the third molar, there was no distal tooth, so the second molar was its only neighbor. As dental disease is not often isolated to a single tooth, we hypothesize that the condition of the tooth was affected by the presence of carious lesions in the neighboring teeth and/or by the presence of periapical lesions in the neighboring tissues, given that periapical lesions can weaken the tissues holding a tooth within the alveolar bone.

To be marked as "observable," a tooth must have been present and in the occlusal plane, with greater than 2 mm of vertical enamel surrounding at least 50% crown circumference, eliminating overly worn and loose teeth. Subadults were removed from the original sample to ensure all individuals had permanent dentition. Individuals with tooth loss due to potential congenital absence (judged by examining tooth positions relative to tooth types) were also excluded for ease of comparison.

The pooled data set consisted of 771 adult individuals from Late Holocene (5000-200 BP) archaeological sites in pre-contact California, which was created using the dental inventories and pathology assessments. The sample population was represented by individuals from CA-ALA-307, -309, -

328, and -329, sites located near the shoreline of the San Francisco Bay, the ancestral homelands of the Ohlone tribe, and from CA-SAC-06, -43, -60 and SJO-68, -142, and -154, sites located in the Central Valley, the ancestral homelands of the Plains Miwok tribe. This research used a combination of new data collected for this study and previously collected data from Bartelink's (2006) dissertation research. All dentitions were examined at UC Berkeley's Phoebe A. Hearst Museum of Anthropology, where they are currently curated. Permission to collect data were provided by the museum's curator and NAGPRA committee.

After instances of PMTL with all observable neighboring teeth were isolated, the collection consisted of two groups: (i) a control group, where the primary tooth examined was present and in occlusion, and (ii) an experimental group, where the primary tooth examined was absent postmortem. Teeth were pooled from right and left sides of the mandible and maxilla. Tooth counts of the total sample are presented in Table 1.

Table 1. Research sample size by tooth and condition.

TOOTH	# CONTROL (PRESENT)	# EXPERIMENTAL (PMTL)
M3	930	166
M2	815	20
M1	924	12
P4	854	118
P3	765	78
C	650	74
I2	522	113
I1	476	73

Results

The data analysis first considers whether instances of PMTL were more often associated with surrounding teeth or neighboring tissues that had already experienced AMTL. The presence or absence of the neighboring teeth was compared between each primary tooth that was present and in occlusion, and those recorded as PMTL. After organizing by tooth type (Table 2), the percentage of primary teeth with both neighboring teeth present was lower in every tooth group when the primary tooth being examined was lost postmortem. The smallest difference was a 2.3% decrease in third molars, and the largest difference was a 25.4% decrease in the fourth premolar. The average difference between having all neighboring teeth present between control teeth and PMTL teeth was a 15.3% decrease when all tooth types were considered. The visual representation (Figure 1) shows that the percent difference was especially high for posterior teeth. The average difference between anterior tooth types was a 12.3% decrease. The average in posterior teeth was a 17.1% decrease (20.8% when third molars were excluded).

When third molars were excluded for not meeting the criteria of having two neighboring teeth, instances of having one neighboring tooth present and the other absent were most often seen in the posterior teeth. In this analysis, greater than 20% of PMTL affected second molars, first molars, fourth premolars, and third premolars had one present and one absent neighbor. Although the change in percentage of teeth with two neighbors present was not as great between control and PMTL incisors, all anterior teeth showed a consistent decline in percent of present neighbors in each experimental group. Rather than a similarly high prevalence of the one present and one absent neighbor alternative, as was seen in posterior teeth, all the anterior teeth were more affected by AMTL on both sides.

Dental Caries and Neighboring Tissues

To understand the effects of specific dental pathological conditions on the prevalence of PMTL, an analysis of the neighboring tissues was also conducted to see how carious lesions and periapical lesions are associated with compromised surrounding tissues and overall tooth loss (Table 3). In this analysis, the control tooth was present without evidence of carious lesions, and the experimental tooth was again one in the same position that was lost postmortem.

Although all analyses showed that it is rare to have both neighboring teeth affected by the same pathological condition, in the case of carious lesions, there were two cases seen on canine teeth. Both control and experimental groups showed few differences when both neighboring teeth were present. The smallest difference in percent of all neighboring teeth with no caries was 0.8% in second molars, while the greatest difference was only 7.8% in first molars. Neighboring teeth of experimental groups for third premolars, canines, and both incisors all displayed no caries. Consistent with the literature on dental caries, posterior teeth were more affected than anterior teeth.

Most teeth showed a slight decrease in caries prevalence in the surrounding tissues in the experi-

Table 2. Prevalence of all three neighboring tissue categories.

Tooth	Condition	All neighboring teeth present (%)	1 tooth present, 1 tooth AMTL (%)	All neighboring teeth AMTL (%)
M3	Present	93.9	4.9	n/a
	PMTL	91.6	8.4	n/a
M2	Present	92.4	6.1	1.5
	PMTL	75.0	25.0	0.0
M1	Present	94.4	3.4	0.0
	PMTL	75.0	25.0	0.0
P4	Present	96.6	3.3	0.5
	PMTL	71.2	21.2	5.0
P3	Present	97.8	2.2	0.0
	PMTL	76.9	21.8	1.3
C	Present	97.5	1.8	0.6
	PMTL	78.4	9.5	12.2
I2	Present	97.7	2.3	0.0
	PMTL	87.6	7.1	5.3
I1	Present	99.6	0.4	0.0
	PMTL	91.8	4.1	4.1

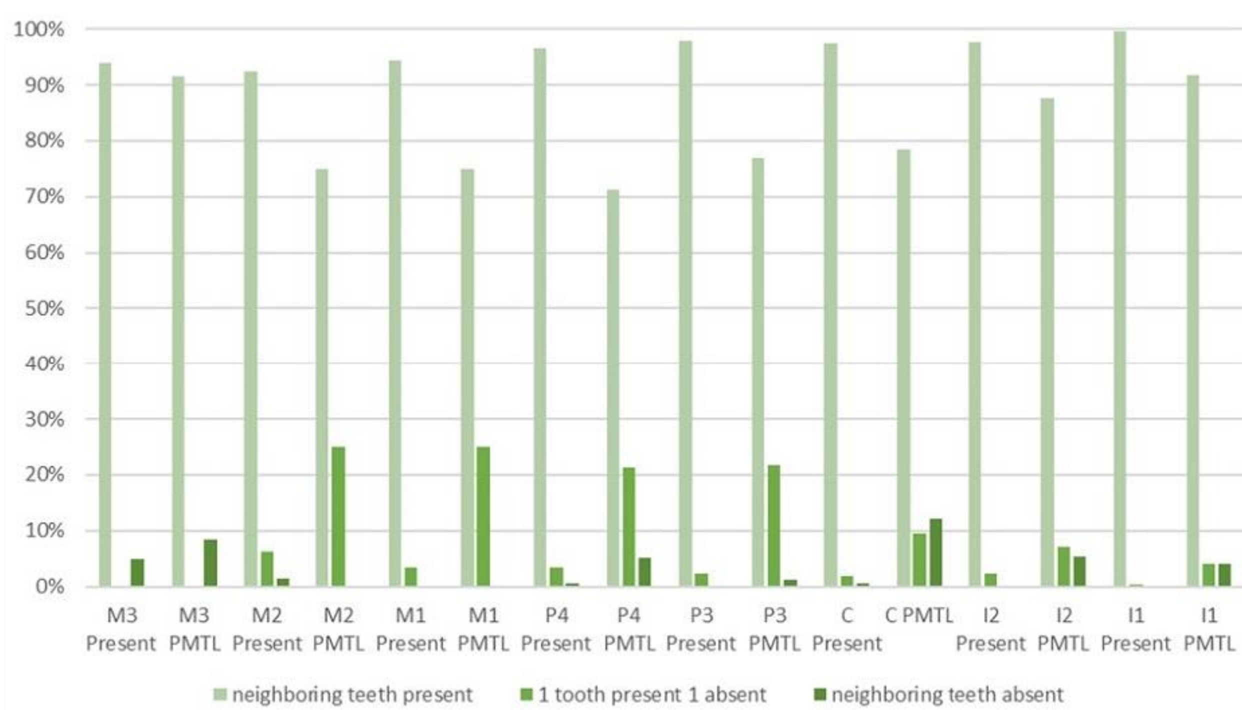

Figure 1. Visual comparison of the prevalence of neighboring tissue categories.

Table 3. Prevalence of all three dental caries inventory categories.

Tooth	Condition	All neighboring teeth no caries (%)	1 neighboring tooth with caries (%)	2 neighboring teeth with caries (%)
M3	Present	95.3	4.7	n/a
	PMTL	98.0	2.0	n/a
M2	Present	92.6	7.4	0.0
	PMTL	93.3	6.7	0.0
M1	Present	96.7	3.3	0.0
	PMTL	88.9	11.1	0.0
P4	Present	97.2	2.8	0.0
	PMTL	96.4	3.6	0.0
P3	Present	98.5	1.5	0.0
	PMTL	100.0	0.0	0.0
C	Present	98.9	0.7	0.3
	PMTL	100.0	0.0	0.0
I2	Present	99.0	1.0	0.0
	PMTL	100.0	0.0	0.0
I1	Present	97.9	2.1	0.0
	PMTL	100.0	0.0	0.0

mental group. Control groups for third molars, second molars, third premolars, canines, and all incisors each had a higher percent of neighbors with carious lesions than their experimental counterparts. When isolated to show teeth that had one neighboring tooth present and one with AMTL, carious lesions were only observed in posterior teeth, consistent with existing literature. Caries rates were again higher in the control group, with a large increase from 80% present second molars with the observable neighbor displaying no caries, to 100% in the neighbors of the PMTL second molars. There was no caries-focused analysis of the difference between present and PMTL teeth with both neighbors absent because, unlike periapical lesions that affect tissue other than on the actual tooth, neighboring teeth necessarily must be present to observe dental caries lesions.

Periapical Lesions and Neighboring Tissues

Following the framework of the caries-focused examination of neighboring teeth, the neighboring tissues (both tooth and alveolar socket) were examined for periapical lesions. Table 4 shows a comparison of the prevalence of periapical lesions when both neighboring teeth were present. The experimental group in every tooth group had more periapical lesions in the neighboring tissues than the control group, except for first molars which had a 1.0% increase in prevalence of no periapical lesions when the primary tooth was recorded as PMTL. The smallest change was a 0.4% decrease in central incisors, and the greatest change was the 18.4% decrease in lateral incisors.

Generally, periapical lesions had a greater influence on non-molar teeth, which was particularly apparent for periapical lesions in teeth with one neighboring tooth present and one lost antemortem. Although there is no particular pattern in the posterior teeth (i.e., minimal differences observed between control and experimental groups), the anterior teeth and fourth premolars show a consistent decrease in unaffected neighboring tissue in the experimental groups (as depicted in Figure 2). The difference between all control and experimental groups shows an average 27% decrease (23.5-33.3%, min-max).

There was not enough data to see a pattern in instances where both neighboring teeth were absent, but the inability to gather enough instances of control data to provide a comparison may be telling. No data showed PMTL with two AMTL neighbors, with a maximum count of nine when divided by tooth number, and with no molars fitting these criteria. With few exceptions, this data set failed to show a present tooth that had two AMTL neighbors. Twelve instances were recorded in second molars, four in fourth premolars, and four in canines. All other teeth had no instances of this tooth loss pattern.

It is possible that some oral pathological conditions may not affect neighboring tissues but are more limited to the individual tooth. Given the expectation that missing neighbors will compromise the maintenance of the primary tooth being analyzed, especially in the case of periapical lesions that affect tissues of the jaw as well as the tooth, it is not surprising that two missing neigh-

Table 4. Prevalence of all three periapical lesion inventory categories.

Tooth	Condition	No PL on all neighboring teeth (%)	1 neighboring tooth with PL (%)	2 neighboring teeth with PL (%)
M3	Present	96.8	3.2	n/a
	PMTL	94.1	5.9	n/a
M2	Present	93.0	7.0	0.0
	PMTL	80.0	20.0	0.0
M1	Present	99.1	0.9	0.0
	PMTL	100.0	0.0	0.0
P4	Present	94.1	5.7	0.2
	PMTL	84.5	14.3	1.2
P3	Present	99.9	0.1	0.0
	PMTL	93.3	5.0	1.7
C	Present	99.1	0.9	0.0
	PMTL	98.3	1.7	0.0
I2	Present	99.2	0.8	0.0
	PMTL	80.8	15.2	4.0
I1	Present	98.9	1.1	0.0
	PMTL	98.5	1.5	0.0

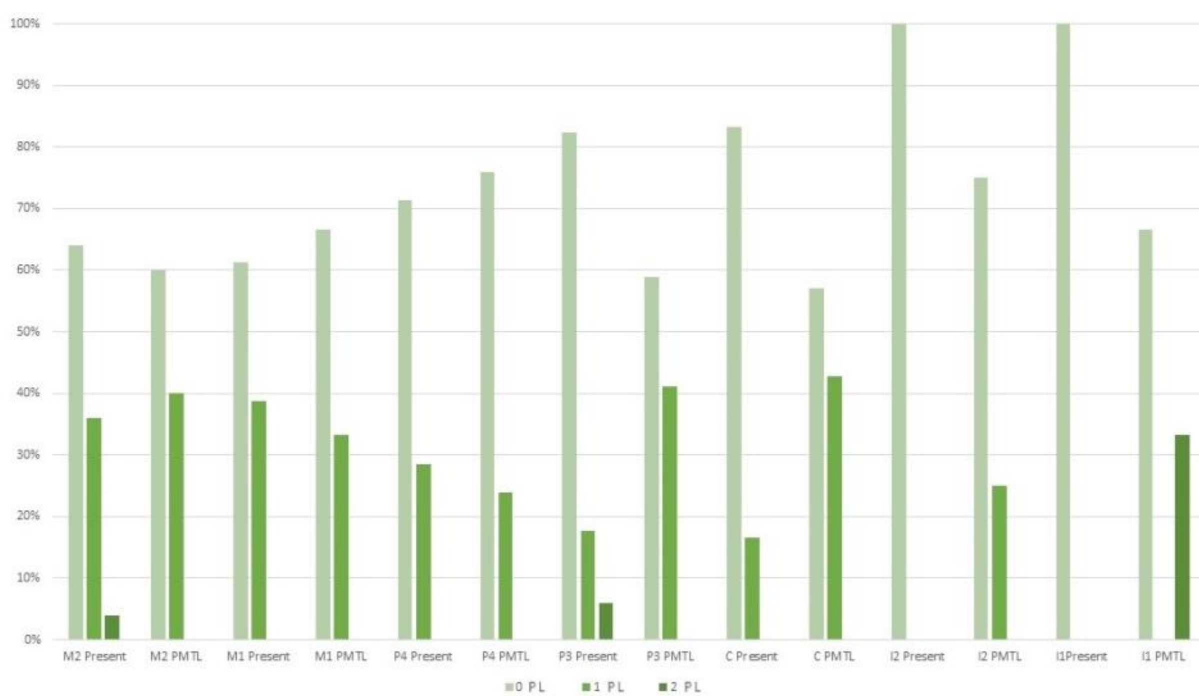

Figure 2. Visual comparison of the prevalence of neighboring tissues exhibiting periapical lesions when one neighboring tooth is present and one is AMTL.

bors make the tissues less likely maintain a tooth. Thus, a large enough control group sample was unavailable for this analysis. This was the only situation where the experimental sample was larger than the control sample.

Affected Neighbors

Because multiple dental conditions can be present in the same individual (even on the same tooth) and would not be accounted for when analysis narrows to focus on a single pathological condition at a time, the scope of analysis was expanded to look at the effects of neighboring tissues affected by either caries or periapical lesions. This included AMTL as an indicator of the final stage of either pathological condition, where the tooth could not be maintained in life.

Figure 3 shows the percentage of neighboring teeth for each tooth position (control) and PMTL, divided by no affected neighbors, one affected neighbor, or both neighbors affected. To be categorized as "affected," a tooth or its surrounding tissue needed to display carious lesions, periapical lesions, be absent antemortem, or any combination of the three conditions. Because third molars only have one neighboring tooth, they again could only be recorded as having one affected neighbor or no affected neighbors.

There is a clear pattern in the visual comparison that PMTL is often surrounded by "affected" or tissues without any indication of disease. In the control groups, the tooth had two unaffected neighbors an average of 92.0% of the time (Table 5). By contrast, the PMTL groups had only an average of only 70.5%. The smallest difference was between the control and PMTL groups for third molars (3.4%), while the largest difference was between the control and PMTL groups for first molars (36.0%).

The PMTL group with the highest percent of two unaffected neighbors was the central incisor. If neighboring tissues do not contribute to its loss in a significant way, then retention of the central incisor is the least influenced by tissue health and tooth loss must be attributed to other, taphonomic factors. This is perhaps the most common taphonomic loss due to the instability of a single location at the anterior of the mouth (exposing it to maximum pressure in burial and collection storage).

The difference in the distribution of one affected neighbor and both neighbors affected also showed an interesting pattern. Non-molar teeth had a much greater percentage of two affected neighbors. The average of non-molar PMTL with two affected neighbors was 9.0% and varied from 6.0 to 12.0%.

Although it is common to see a difference between third molars and the other molars because of the unique single-neighbor quality and differ-

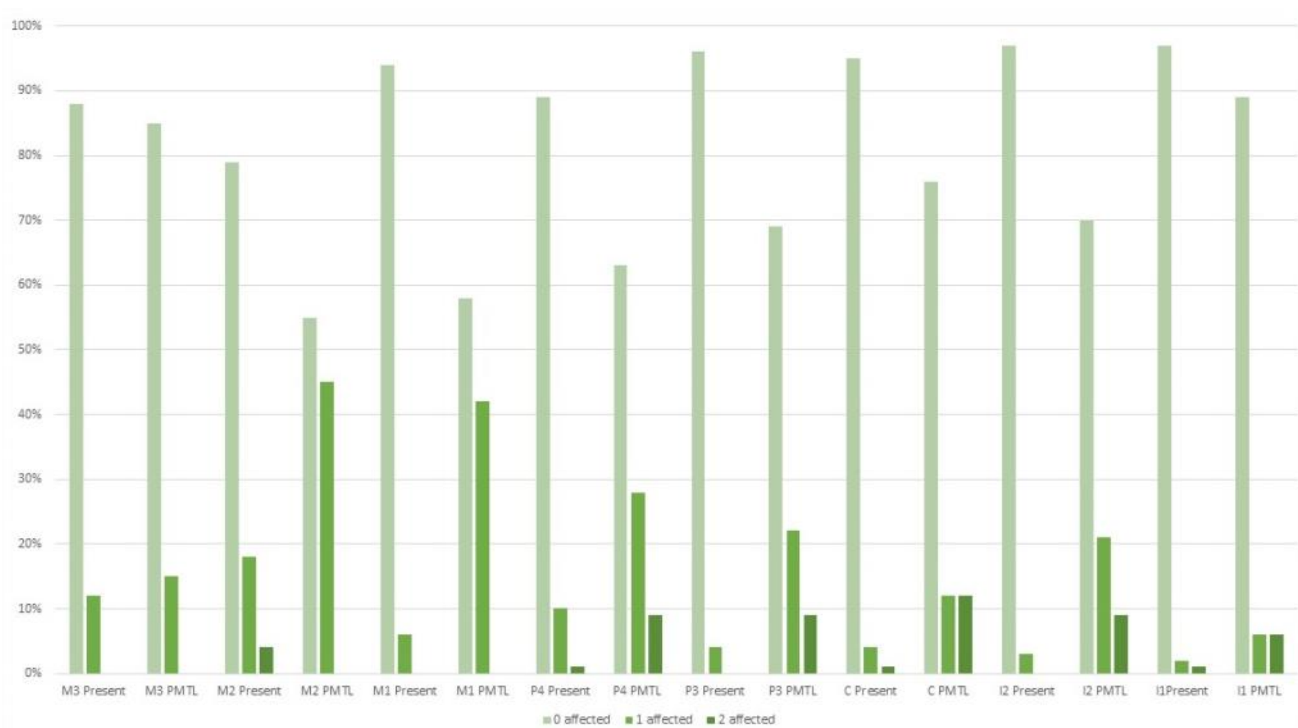

Figure 3. Visual comparison of the prevalence of "affected" neighboring tissues.

Table 5. Prevalence of all three "affected" inventory categories

Tooth	Condition	All neighboring teeth unaffected (%)	1 neighboring tooth affected (%)	2 neighboring teeth affected (%)
M3	Present	88.3	11.7	n/a
	PMTL	84.9	15.1	n/a
M2	Present	78.8	17.7	3.5
	PMTL	55.0	45.0	0.0
M1	Present	94.4	5.6	0.0
	PMTL	55.0	41.7	0.0
P4	Present	88.8	10.1	1.2
	PMTL	62.7	28.0	9.3
P3	Present	96.2	3.5	0.0
	PMTL	69.2	21.8	9.0
C	Present	95.5	3.5	1.0
	PMTL	75.7	12.2	12.2
I2	Present	96.6	3.1	0.3
	PMTL	69.9	21.2	8.8
I1	Present	97.1	2.1	0.8
	PMTL	88.7	5.6	5.6

ences in eruption times, this is one of the only comparisons from this research that showed variation between the second and first molars. They are typically assumed to have similar physical characteristics that make them susceptible to caries, but also are multi-rooted teeth, providing them similar connective stability.

Discussion

The "neighboring tissues" test was designed to determine whether oral pathological conditions influenced PMTL versus solely taphonomic explanations. Patterns between control teeth and PMTL indicate that the integrity of the surrounding tissues affects the retention of a tooth after death. Although there were specific patterns associated with periapical lesions alone, the overall patterns indicated that dental caries does not affect the ability of the tissues to retain a tooth after death. When both neighboring teeth were present, most teeth showed a decrease in carious lesions in the surrounding teeth in the experimental (PMTL) group. This is contrary to the expectation that missing teeth would have more affected neighbors in the presence of any oral pathological condition. However, the experimental group presented more periapical lesions in the neighboring tissues than the control group. Periapical lesions tended to have a greater effect on non-molar teeth. Although there were specific patterns associated with the presence of dental periapical lesions as a solitary pathological condition, dental caries lesions did not affect the ability for the tissues to retain a tooth after death.

To address tissues that have been impacted vs. not impacted by disease, rather than exclude compromising conditions by creating a false categorization that separates dental caries and periapical lesions, the data were lumped into an "affected tissues" test. This clear difference between control and experimental groups supports the research hypothesis that affected tissues are correlated with prevalence of PMTL.

Overall, the analyses conducted indicate that PMTL is often a consequence of pathological conditions rather than solely due to taphonomic damage. Thus, it should be possible to adjust data related to PMTL in the same way AMTL is corrected to generate more reliable caries rates. Using indicators of disease in the surrounding tissues, the presence of a pathological condition in the missing tooth can potentially be inferred, adjusting prevalence rates in a skeletal sample. As with the caries correction factors for AMTL, a sliding scale or population-specific method is needed. This would need to be calculated based on the integrity of the visible tissues and can only be accomplished if PMTL is considered a consequence of pathology, rather than simply the result of postmortem damage to the alveolar bone. More elaborate and precise observations need to be incorporated into the inventory methodology.

Current inventory recommendations only consist of practicing extra care while analyzing the fragile alveolar bone and recording missing teeth as "absent, without alveolar bone remodeling, postmortem tooth loss". There is no current method for recording teeth that are loose and replaced in their crypt, other than recording them as present, which does not distinguish them from teeth that are maintained in the crypt by supporting tissues. A new category should be added to the inventory methods to reflect this difference when inventorying teeth.

If teeth are "absent through postmortem tooth loss" or "present but loose/removable from crypt without force", observations can be made to examine the empty crypt for signs of pathology in the tissue. A closer look during analysis using clues of the surrounding tissue may help indicate the health of the missing teeth, given our improved understanding of how pathological conditions specifically affect tooth retention. Collecting this data will permit a wider range of calculations of dental pathology prevalence for data sets.

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