POSTMORTEM TOOTH LOSS IN HUMAN IDENTIFICATION PROCESSES

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ABSTRACT

Teeth provide essential data for human identification. However, they are frequently lost during the process of skeletonization or under manipulation during exhumation. Because of the high frequency of postmortem tooth loss, this phenomenon was examined in three different samples, in an attempt to simulate the actual circumstances experienced in the forensic processes of identification of human remains. The method employed aimed to describe and quantify dental spaces, distinguishing between loss after death or before by extraction. The results showed a high prevalence of postmortem tooth loss: 41.37% in sample A, 56.83% in sample B and 3.96% in sample C. These losses were most frequent in the maxillary incisor group in all three samples analysed. These data underline the need for redoubled care in recovery, transportation and storage of crania, so that teeth are not lost, which could seriously compromise the identification process. **(J Forensic Odontostomatol 2000;18:32-6)**

Keywords: Forensic Dentistry, postmortem tooth loss, human identification

INTRODUCTION

The process of human identification can be undertaken in two ways. In the reconstructive approach there are no antemortem data available and the aim is to establish generic elements for a general identification. In the second or comparative approach, records from before the individual's death, including dental charts, are used as the basis for individual identification.

Teeth can provide decisive information for human identification[3]. Although they may be missing, it is still possible to examine the remaining alveolar bone to establish whether loss occurred before or after death. If loss was by extraction shortly before death, the period can be estimated by using alveolar remodelling chronology.[2]

Once these observations have been made, comparative analysis of the remaining anatomical and restorative aspects of the teeth can begin. This is made possible by obtaining satisfactory ante-mortem dental records including radiographs, the importance of which cannot be overestimated because they are often the most reliable way to identify an individual.

The use of anatomical structures and dental restorations is so important that the material must be preserved at all costs even though identification by DNA is becoming more prevalent and reliable. It cannot however outweigh or rule out the use of the former.[5]

Teeth may be missing at the time of identification and this will hamper the process. Tooth loss occurring after death may be due to factors relating to the natural process of skeletonization that destroys the attaching periodontal tissues and the conical nature of the roots of single rooted teeth makes them particularly susceptible. Careless handling in the collection, transportation, preparation, packing and dispatch for examination of human remains from crime scenes or in exhumations further contribute to tooth loss.

Another risk factor for postmortem tooth loss is the age of the individuals at death. Whittaker and Molleson[7] examined 92 crania of known age and found a greater prevalence of postmortem tooth loss in older individuals, suggesting that greater care be taken during exhumation if age is known.

The environment where the body was found can also contribute to this process. Places which are highly exposed to the sun, places in shade provided by trees, remains which have been embalmed, or kept in plastic bags for long periods, or submerged in water, as well as changes in the weather (in countries with marked differences between the seasons), all influence postmortem tooth loss. For this reason the study of tooth loss in conjunction with the environmental conditions can provide supplementary clues for an estimation of time of death.[4]

Given the importance of tooth loss in hampering human identification, the present study aimed to analyse the incidence of postmortem tooth loss in three samples and draw attention to the resulting problems.

MATERIALS AND METHODS

Three samples were studied in order to explore different circumstances encountered during the identification process.

The first sample (Sample A) comprised 151 crania from the Museum of Human Anatomy of the University of São Paulo's Institute of Biomedical Sciences. The collection was compiled between 1920 and 1960 and has been used exclusively for research purposes in recent times. The material was considered suitable because it is curated by the University and is handled and conserved appropriately. Secondly, owing to its age, it would have undergone thoroughly the process of skeletonization and therefore, in their current state, the crania studied would provide a fair approximation of the various conditions encountered in real forensic circumstances.

Sample B comprising 100 crania, was obtained from a cemetery in the city of Salvador, state of Bahia, which routinely stores material from exhumations in tagged sealed plastic bags until the legal and administrative terms have expired, at which point they are handed over to the family to be suitably disposed of, or if unclaimed, reburied in a common grave. By its nature this material also replicates the typical features of a forensic examination.

Sample C was obtained from the University of São Paulo's Museum of Archaeology and Ethnology. Five crania, three complete, two without mandibles and five isolated mandibles were examined. This material was collected from archaeological sites on the littoral of the State of São Paulo, occupied between approximately 2980 BC and 75 AD. These sites were excavated in the 1970s and the material has been in the custody of the Museum since then.

All examinations were carried out to observe and record the presence or absence of teeth. Missing teeth were classified as extracted during life or lost postmortem depending on whether the alveolar sockets showed signs of tissue healing, in which case they were considered lost postmortem.

The classification of Whittaker and MacDonald[6] was used to identify postmortem tooth loss, differentiating it from antemortem dental extraction. According to these authors, when the tooth is lost after death the bone surrounding the socket will not have reacted to the loss of the tooth and the margins of the socket would have retained a sharp profile. On the other hand antemortem tooth loss includes blood clot formation in the socket which rapidly organizes into granulation tissue, new bone is progressively laid down on the walls of the socket and within the granulation tissue and as the new bone mineralises the socket will have developed a granular appearance.

In order to estimate the reproducibility of the observation, we calibrated the dentists that performed the examinations, and we measured inter- and intra-examiner concordance by re-examining 9.9% and 6.6% respectively of Sample A. The set of observations was subjected to statistical analysis using SPSS 8.0, 1997.

RESULTS

Figs. 1 and 2 show alveolar sockets not occupied by teeth, with and without signs of alveolar healing, corresponding respectively to classifications of teeth extracted during life and postmortem tooth loss.

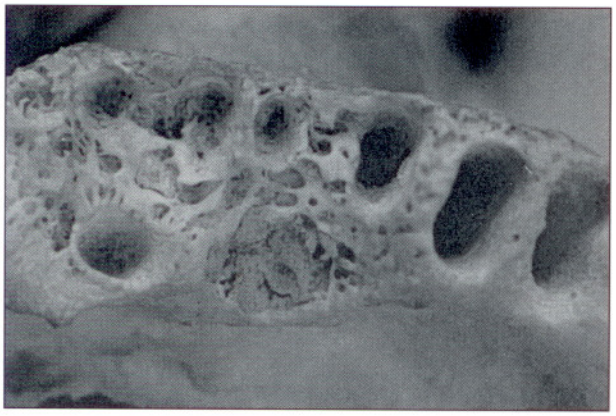

Fig.1: *Molar region with evidence of alveolar healing, characteristic of antemortem tooth loss*

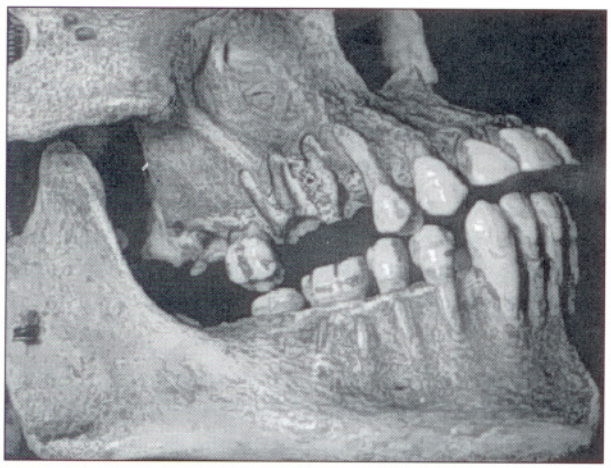

Fig.2: *Molar and pre-molar region without alveolar healing, characteristic of postmortem tooth loss*

Table 1 presents the set of analysed teeth and dental spaces for each sample. "Dental spaces" were subsequently classified as "present tooth", "ante mortem extracted tooth" or "postmortem tooth loss". Tables 2, 3 and 4 show the total number of "present teeth" and dental spaces in samples A, B and C respectively that did not undergo extraction during life, as well as the percentage of dental spaces classified as postmortem tooth loss.

Comparative analysis of the data obtained for sample A showed that the group of incisors presented significantly higher prevalence of postmortem tooth loss than other types of teeth ($p<0.05$), while premolars came second, with significantly higher prevalence of postmortem tooth loss than molars and canines ($p<0.05$). With regard to the latter two tooth groups, no significant statistical difference was observed ($p=0.795$).

A significant difference was observed in comparing the upper arch with the lower arch ($p<0.05$), with a greater percentage of postmortem tooth loss for maxillary teeth.

A significantly higher rate of postmortem tooth loss was found in Sample B than in Sample A ($p<0.001$) but no significant differences were observed between maxillary and mandibular teeth ($p=0.840$). The only dental group recording a significantly higher frequency of postmortem tooth loss was the incisors ($p<0.05$), an observation which ties in with that in Sample A.

Complete absence of postmortem tooth loss in mandibular teeth was observed in Sample C, as well as a low frequency of loss in maxillary teeth, virtually restricted to incisors. This observation may be due to the greater care with which archaeological research is carried out, including delimitation of the surrounding area and the sieving of the earth in places where remains are found, factors that enable the recovery of dental elements which could otherwise have been lost.

Re-examination of 6.6% of Sample A by the same examiner and 9.9% of the same sample by another examiner in the team was carried out to assess the precision of the method employed and to check intra- and inter-examiners concordance. Re-examination by the same examiner scored 98.07% observed agreement (Kappa coefficient = 0.978), while re-examination by a different examiner scored 99.11% observed agreement (Kappa coefficient = 0.959). These figures prove that the method is reproducible and easily interpreted.

DISCUSSION

There was a higher prevalence of postmortem tooth loss in the upper arches in Sample A. This observation can partly be ascribed to the positioning and the exposure of the crania during storage over several years. To achieve greater stability the crania were rested on their mandibles, on the masseteric processes and the occipital bone, which subjected the maxillary teeth to forces of gravity and consequent dislodgement. Another influence may have been that the bone density of the maxilla generally is less than in the mandible.

Table 1: *Total of teeth and dental spaces ("present tooth", "ante mortem tooth extraction", "postmortem tooth loss") analysed in the three samples*

Dental type	Sample A	Sample B	Sample C	Total
Maxillary Molars	906	600	30	1,536
Maxillary Premolars	604	400	20	1,024
Maxillary canines	302	200	10	512
Maxillary incisors	604	400	20	1,024
Maxillary teeth	2,416	1,600	80	4,096
Mandibular Molars	906	600	48	1,554
Mandibular Premolars	604	400	32	1,036
Mandibular canines	302	200	16	518
Mandibular incisors	604	400	32	1,036
Mandibular teeth	2,416	1,600	128	4,144
Molars	1,812	1,200	78	3,090
Premolars	1,208	800	52	2,060
Canines	604	400	26	1,030
Incisors	1,208	800	52	2,060
Total teeth	4,832	3,200	208	8,240

Of all groups of teeth analysed, incisors presented the highest frequency of postmortem tooth loss, a fact which may be explained by their anatomical characteristics. The incisors can be considered generally to be single rooted teeth but canines, on the other hand, although they usually possess only one root, have the largest of the dental roots which are often slightly curved, and this tends to hook them in place. Premolars in general present a single twinned root, although bifurcation is common in the upper teeth. Molars in general possess three roots, except for the third molars which display varying morphology.

Our observation of greater prevalence of postmortem tooth loss in the incisors ties in with the findings of Borrman et al.[1] who analysed an approximately 9800 year-old human skeleton, finding postmortem loss of seven teeth, of which **five were incisors.**

In Sample B, many toothless dental arches were found, which may be due to the widespread use of total extractions as a form of dental treatment, and as the subjects were from an urban cemetery may also link them to an underprivileged socio-economic and cultural stratum. Another observation was the lack of pattern of dental loss and with no differences between the upper and lower arches, which may be ascribed to the method of storage of these crania in plastic bags along with the rest of the skeleton, and piled one on top of the other. A significantly higher prevalence of postmortem tooth loss was observed than in Sample A, which may be explained by the handling and storage conditions of this material in

Table 2: *Frequency of postmortem tooth loss in Sample A by dental type and potential number of teeth*

Dental types	% postmortem loss	Potential number of teeth
Maxillary Molars	29.528	352
Mandibular Molars	30.189	355
Molars	29.865	707
Maxillary Premolars	38.583	467
Mandibular Premolars	36.752	461
Premolars	37.705	928
Maxillary canines	28.829	254
Mandibular canines	32.394	247
Canines	30.575	501
Maxillary incisors	79.636	378
Mandibular incisors	48.813	447
Incisors	61.774	825
Maxillary teeth	44.611	1,451
Mandibular teeth	38.328	1,510
Total teeth	41.368	2,961

the cemetery, or may even be possible evidence of a deplorable practice which has not yet been eradicated in Brazil, that is the illegal trade in teeth for instructional purposes.

In Sample C a low incidence of antemortem dental extraction was observed – only six teeth out of a total 208 examined dental spaces – which seems to be characteristic of the specifically archaeological material usually targeted for research. The low percentage of postmortem tooth loss for this sample (3.96%) is indicative of the skilled and professional care normally taken in collecting and preserving this material during research. This degree of care should be adopted in the practice of forensic dentistry.

CONCLUSION

1. A high percentage of tooth loss was detected. It was possible to distinguish, with satisfactory accuracy, whether this occurred before or after the death of the individual by means of visual parameters (signs of alveolar healing).

2. In Sample A, postmortem tooth losses presented a higher pattern of prevalence in the upper arches and incisors.

3. In Sample B, there was no significant difference in postmortem tooth loss between the upper and

Table 3: *Frequency of postmortem tooth loss in Sample B, by dental type, and potential number of teeth*

Dental type	% postmortem loss	Potential number of teeth
Maxillary Molars	42.609	115
Mandibular Molars	35.000	100
Molars	39.070	215
Maxillary Premolars	44.737	76
Mandibular Premolars	53.846	156
Premolars	50.862	232
Maxillary canines	66.667	66
Mandibular canines	53.719	121
Canines	58.289	187
Maxillary incisors	71.795	117
Mandibular incisors	70.168	238
Incisors	70.704	355
Maxillary teeth	56.417	374
Mandibular teeth	57.073	615
Total teeth	56.825	989

Table 4: *Frequency of postmortem tooth loss in Sample C, by dental type, and potential number of teeth*

Dental type	% postmortem loss	Potential number of teeth
Maxillary Molars	3.57	28
Mandibular Molars	0.00	45
Molars	1.36	73
Maxillary Premolars	0.00	19
Mandibular Premolars	0.00	32
Premolars	0.00	51
Maxillary canines	0.00	10
Mandibular canines	0.00	16
Canines	0.00	26
Maxillary incisors	35.00	20
Mandibular incisors	0.00	32
Incisors	13.46	52
Maxillary teeth	10.38	77
Mandibular teeth	0.00	125
Total teeth	3.96	202

lower arches but a greater frequency was observed in incisors.

4. In Sample C, there was a very low prevalence of tooth loss, virtually restricted to the maxillary incisors.

5. Enhanced care should be taken in the handling of human remains. The standards of care normally employed in archaeological excavations should be extended to routine forensic dentistry in order to avoid postmortem tooth loss which can make identification more difficult.

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