

# **Deliberate ante-mortem dental modification and its implications in archaeology, ethnography and anthropology**

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## **1. Introduction and methodology**

The modification of human teeth has interested researchers in archaeology, ethnography and anthropology since the early years of this century. As awareness of the practice grew, through pioneering works in the Americas, researchers in the social sciences began to see the importance of acknowledging the emerging patterns and intriguing inconsistencies demonstrated by dental remains altered deliberately during life. Upon investigation, data sets from single cultures, such as the Maya or the Aztec showed bewildering variety and ingenuity in the ways in which teeth were carved, incised and decorated with inlays of exotic material. Were these patterns of modification signs of social status, occupation, or simply decorative in nature? As archaeology has developed over the last century, methods of scientific investigation and field practice are allowing a reassessment of dental remains. The complex cultural messages embodied in modified teeth are now being investigated by a new generation of scholars.

This paper will focus on the variation in deliberate ante-mortem tooth modification through archaeological, anthropological and ethnographic examples. Non-deliberate dental alteration will be discussed as a means of differentiating deliberate, culturally driven modifications, from accidental or occupationally related change. Teeth will often survive better than bone in archaeological contexts. With this in mind, this work will consider the classification and appearance of dental modification and the motivations for such practices. This study will also attempt to highlight the potential in dental anthropology for the identification of status indicators, cultural markers and other indications of past human behaviour in archaeological dental remains. Suggestions will be made for the possibilities of future studies in this area.

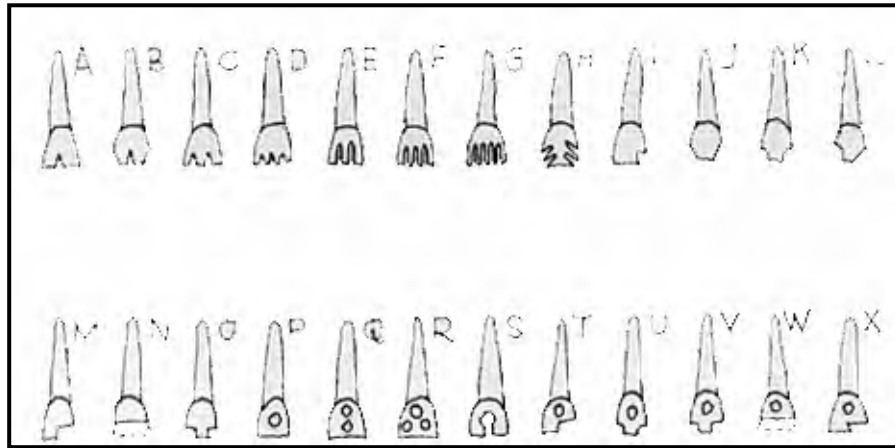
*Note:* The term ‘modification’ will be employed throughout this work, as opposed to the term ‘mutilation’, prevalent in earlier studies. It is felt that modification better describes the act of consciously altering one’s appearance for socio-cultural reasons, while the term mutilation has certain negative connotations that this work seeks to avoid in the discussion of past and present cultural practices.

## **2. Classification of Dental modifications**

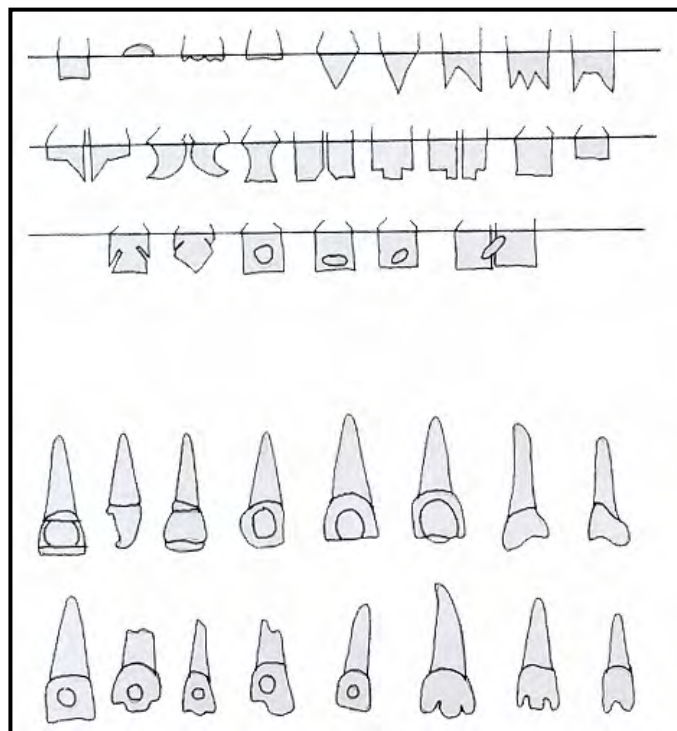
### **2.1. Morphological classification**

Much of the classificatory work appearing earlier this century focused on the Americas, involving largely descriptive accounts of archaeological remains (Borbolla 1940: Fig 1.; Delfino 1948: Fig 2; Romero 1958, 1970: Fig 3.). Alberto Delfino’s work on dental modification around the world brought a corpus of material together

in an early attempt to classify types of dental modification and the motivations behind these practices.



**Figure 1** Rubín de Borbolla's classificatory system – Mexico, 1940 (redrawn from Whittington et al. 1998)



**Figure 2** Ambrosio Delfino's classificatory system – Argentina, 1948 (redrawn from Delfino 1948: 117)

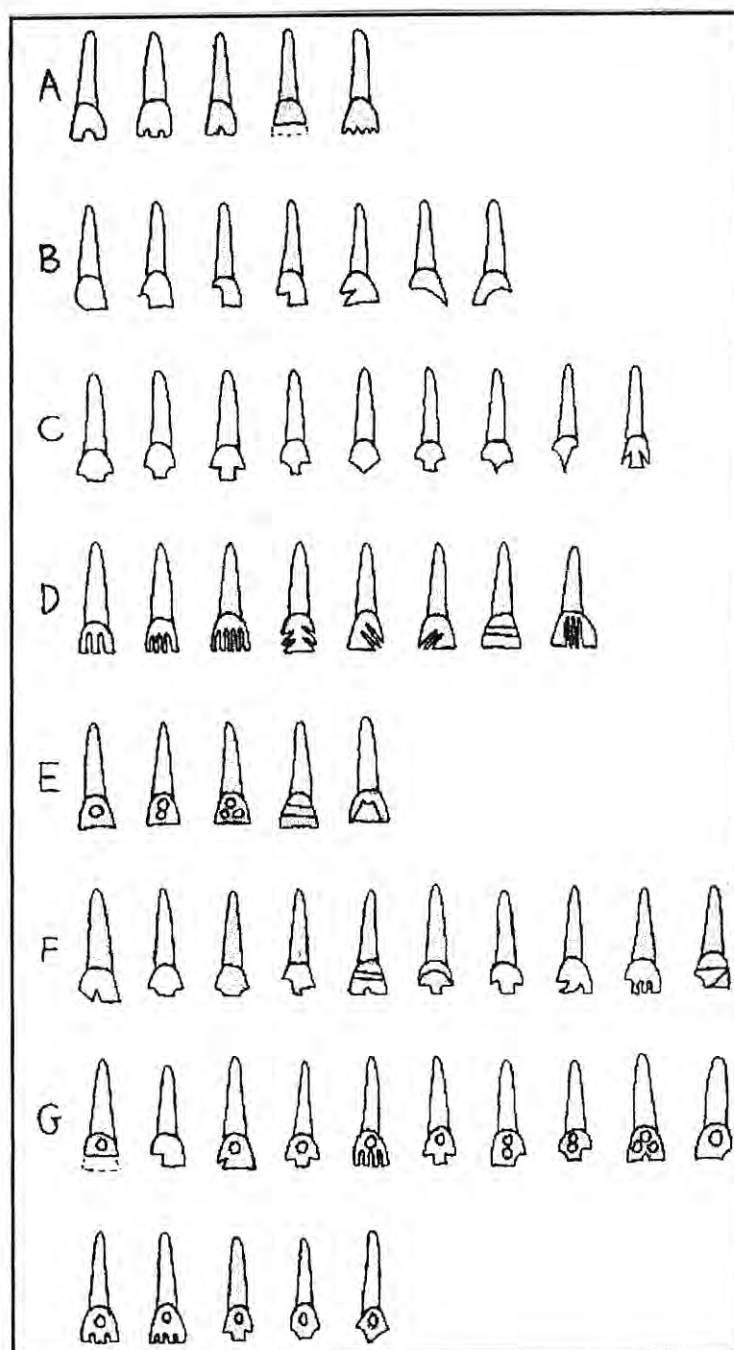


Figure 3 Javier Romero's classificatory system – Mexico, 1958, 1965, 1970 (redrawn from Romero 1970: 51)

Classificatory sequences were produced for certain regions in an attempt to answer questions relating to the methodology and chronological development of this practice. Javier Romero's work in Mexico covered a database of over a thousand individuals and allowed the production of a typological chart, becoming a standard in the field. Romero was also able to demonstrate a level of cultural transmission by emphasizing the widespread nature of dental modification throughout the Americas. Interpretations involved simple linkages between modifications present in burial contexts and the depiction of the same in ceramic effigies, allowing speculation on status differentiation. This pioneering work brought dental changes to the attention of scholars in Mesoamerica, with more recent works reflecting advances in the field (Milner and Larsen 1991; Alt and Pichler 1998).

These classificatory systems were produced by studying material derived from single geographical locations. Although useful in increasing awareness of the practice amongst archaeologists and anthropologists, no single work attempted cross-cultural comparison, either morphological or behavioural. This was to come much later.

## **2.2. Behavioural classifications**

Following Romero's work, Milner and Larsen (1991) developed a new system, moving away from formal description, with dental alteration seen as relating to four classes of human behaviour: dietary, implemental, incidental cultural and intentional cultural. Alt and Pichler (1998) further refined this system into a less cumbersome and more archaeologically applicable form. Alt and Pichler's (1998: 388) work considers two basic classes of modification: passive and active.

### **2.2.1. Passive or unintentional (including accidental) dental modification**

Unintentional or accidental changes are seen as those caused by differential food preparation and consumption, by the use of teeth as tools and by inadvertent changes caused by habitual activities. Mechanisms of wear include abrasion, attrition and erosion. The processes involved have been discussed as commencing with the loss of surface enamel, followed by a build up of secondary dentine to protect the pulp chamber (Larsen 1997:248).

#### **a) Tooth wear in relation to food consumption**

Food itself may or may not contain particles harder than enamel that cause abrasion. However, preparation techniques can often involve the use of stone grinding tools, which add traces of abrasive material, such as silicates or sand, to the final product. Wear can be produced by contact between the incisal and occlusal surfaces of teeth through abrasion, attrition or erosion. Particles carried in the mouth can cause a loss of surface detail through abrasion.

Archaeological remains can exhibit traces of abrasion that are accidental in origin, through the consumption of foodstuffs containing abrasive material or through deliberate modification, such as drilling. These patterns can often be distinguished by examination under an electron microscope. Attritional changes in dental morphology can be caused by contact between occlusal and approximal tooth surfaces, often the result of chewing. Pathological changes occur due to the grinding of teeth (Bruxism) or unusual positioning of dentition (Alt and Pichler 1998: 390). Several classifications have been developed to demonstrate occlusal attrition stages, with

Scott's system of quadrants demonstrating the least inter and intra-observer variation (Hillson 1997:233). Abrasive and attritional processes have been utilized to support interpretations relating to subsistence, dietary habits and social or sexual differentiation. Erosive changes may occur due to the impact of hard materials contained in fluid such as saliva (Hillson 1997:250). This creates indentations and deformation.

#### **b) Wear through the use of teeth as tools**

Examples of the use of teeth as a 'third hand' or extra tool are common in both modern and archaeological populations in connection with particular occupations. For example, musicians' mouthpieces may cause damage to their anterior teeth, while workers in particular industries, such as chemical factories, may suffer from acid induced erosion. In archaeological examples, grooves observed on anterior and cheek teeth have been attributed to a number of causes. Schulz' (1977) study of anterior tooth grooving in Californian Indians utilized ethnographic examples to demonstrate how variable wear patterns on archaeological teeth could be the result of plant fibre preparation for the production of basketry.

“Any process proposed to account for this pattern must be a habitual activity of both sexes and all ages, affecting anterior teeth, but not molars, and producing the variability actually observed. The likeliest process is a task activity involving the teeth in the preparation or use of plant fiber cordage.”  
(Schulz 1977: 90)

The Eskimo use their teeth to crush bone, process leather, tear meat and in preference to knife blades (Molnar 1972: 515). This leads to 'pressure chipping', stress and very heavy wear on the dental arch. Differential chipping may even occur on different teeth used for different purposes. The variety in abrasive nature of the materials being processed leads to differential wear patterns, detectable archaeologically.

#### **c) Habitually caused morphological change**

The anomalous wear of teeth is often characteristically individual and can be found on anterior dentition. Examples include oval apertures in anterior teeth produced as the result of pipe smoking and the use of labrets, which can produce unintentional changes to the upper and lower incisors, canines and premolars. These examples are, however, culturally and socially specific. A great deal of variation exists.

In archaeological remains, dental erosion may also be the result of feeding methods, in that the use of feeding devices in a variety of dietary practices may result in accidental dental modifications (Alt and Pichler 1998: 402). Frayer and Russell's (1987) study of artificial grooves on Krapina Neanderthal teeth led to interpretations connected to dental hygiene. Little variability was evident in the Krapina sample, with grooves consistently appearing on the mesial and distal root walls of permanent molar and premolar teeth (Frayer and Russell 1987: 393). These grooves were characterised by polished channels, thought to be the result of the use of toothpicks. This argument is supported by the longitudinal striations evident in the sample and the consistent appearance of grooves on relatively inaccessible teeth. Frayer and Russell see the Krapina study as 'one of the oldest examples of tool use in the human fossil record' (Frayer and Russell 1987: 404). Habits such as tobacco chewing or the

use of drugs like coca or tobacco can cause an increase in tooth wear and the destruction of the tooth as a functional organ (Molnar 1972: 514)

### **2.2.2. Active or intentional dental modification**

Intentional changes are considered to be those that are related to socio-cultural factors or changes carried out for medical reasons. Intentional modification clearly involves a conscious investment of time and often a willingness to endure pain and the danger of infection, emphasizing the cultural significance of these actions. Tooth modifications relate to tattoos and body piercing as a means of expressing individual or group identity. Since the vast majority of body decorations do not survive archaeologically, teeth are an important source for the study of inter and intra-societal differentiation.

#### **a) Modification for cultural reasons**

The motivation for altering ones appearance through dental modification is difficult to approach in archaeological material. Ethnographic and anthropological studies have aided archaeology in seeking answers to the questions surrounding such practices. Alterations to the dentition fall into several categories:

- Inlay: This method involves the drilling or boring of a cavity, often in the central incisors and canines, to facilitate the placement of material such as jade, pyrite or gold (Romero 1970; Marcellino 1972).
- Dental evulsion: Often associated with initiation rites, dental evulsion can involve the removal of any number of deciduous or permanent teeth (Konnild nd.; Whittington et al. 1998).
- Filing: A common trait, involving the reshaping of the anterior teeth by filing into points (Bailey 1989), or by the removal of the incisive edges. This process can lead to exposure of the dentine, resulting in medical complications.
- Scoring: Similar to filing in that it involves removal of enamel by scoring patterns into the surface of anterior teeth (Buikstra and Uberlaker 1994).
- Artificial colouring of teeth: A practice common in South-East Asia, usually involving blackening or other such discoloration, thought to be derived from a desire to differentiate humans from animals (Hobart 1996).

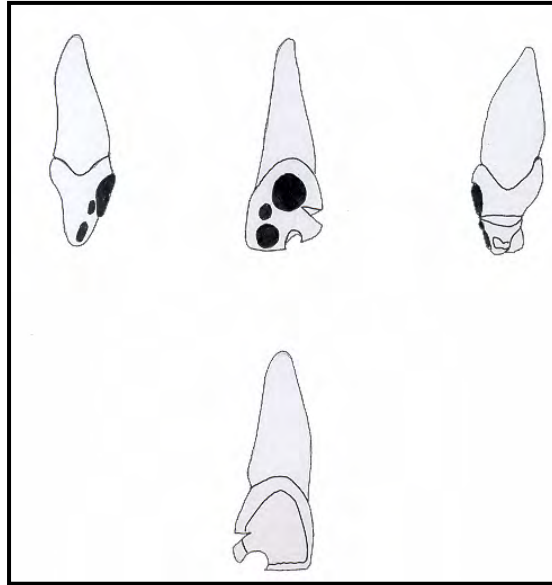
Methods for producing these effects vary according to the culture in question, with several areas of the world demonstrating a widespread tradition of intentional dental modification. These include Central and South America (Romero 1970; Delfino 1948), South-East Asia (Lansing 1995; Hobart 1996) and Africa (Konnild nd; Bailey 1989). It is hoped that a selection of these alterations, along with the techniques used to produce them, would be best illustrated by considering archaeology, ethnography and anthropology, all disciplines in which dental modification has been studied, and including examples from the regions mentioned above. In this way, differential practices will be highlighted, along with variation in approaches and interpretations.

*Case study 1. The Maya – Central America – an archaeological example*

Archaeological studies all over the world have considered dental modification. Ethno-historic sources have been particularly useful in the Americas, as early Spanish chroniclers such as Bishop Landa described the practice amongst native populations. The significance of dental modification has been interpreted in a variety of ways, including rites of initiation, as having 'magical' or religious connotations, and as status/kinship markers (Romero 1970; Konnild, nd). These conclusions have been drawn for several reasons. Dental modification in the Americas has been linked to religion due to evidence found in material culture. Ceramic effigies of deities often appear with mutilated teeth that are subsequently imitated in cultural practices. For example the 'T' shape modification of the two central incisors in the upper jaw, resembling the Maya glyph for 'Ik' meaning 'life', appears in ceramic effigies of the 'sun-deity'. However, the examples below serve to demonstrate the difficulty of making confident interpretations with limited material.

N. Lopez Olivares work on dental alterations in Guatemala looks at dental samples acquired between 1983 and 1993 from the sites of Uaxactun, Ixcol, Ixtonton and Yaltutu, all situated in the southeastern Peten region in Guatemala. Lopez Olivares analysis considers dental remains from contexts including both systematic excavations and looted tombs, concentrating on socio-cultural elements of modifications present. Although the teeth recovered from these archaeological investigations were not all deliberately altered, Lopez Olivares sample includes a total of nineteen individuals exhibiting differential forms of dental modification, which the author classifies according to Romero's system (see above, 1958, 1970). Lopez Olivares then goes on to consider temporal and spatial variations in dental modification and examines age at death for the individuals under study. Her findings appear to indicate spatial differences in style, linked with proximity to resources for inlay and access to specialists, and a certain level of continuity in practice over time, although inlays appear to become more common in later periods. Conclusions relating the age of individuals to instances of modification are complicated by the paucity of data. The author includes an example of a new form of dental modification discovered at the site of Yaltutu (Fig 4.). This goes some way to demonstrating that Romero's classifications, although extremely helpful as a guide, may not apply throughout Mesoamerica, and perhaps demonstrates the usefulness of developing culturally specific classificatory systems in order to approach temporal and spatial issues regarding changes in practice.

Lopez Olivares' study is limited by an extremely small database. However, her work does allow the demonstration of temporal continuity (especially for the modification of upper incisors) and regional variation. Lopez Olivares does not attempt to draw many conclusions regarding the meaning or method behind the dental changes in evidence, apart from possible social differentiation. It seems clear, however, that the recent increase in work of this kind in the Maya region (Whittington et al. 1998) will further attempts to approach these questions. It is hoped that the ethnographic and anthropological examples given below may help to demonstrate how a holistic approach could help dental anthropologists in attempting to determine socio-cultural motivations behind this practice as demonstrated in the archaeological record.



**Figure 4** A new type of dental modification from the Peten, Guatemala (Lopez-Olivares 1998: 113)

*Case study 2. The Masaai, Kenya/The Efe, Zaire – ethnographic examples*

Ethnographic studies can serve a useful purpose in reminding archaeologists of the variety of meaning connected to cultural practices involving dental modification. Any attempt to interpret archaeological remains, such as those described above, must consider ethnographic accounts, as these may include evidence of practice, reflected in the archaeological record.

The Masaai are a pastoral people living in Kenya. Johannes Konnild's extensive anthropological and ethnographic research conducted all over Africa during the 1950's and 60's has given academia a legacy of first hand and historic accounts of modification practices all over the continent. Unfortunately, Konnild's exemplary work is not referenced and is unpublished.

Here, I will use his work, but will be unable to cite exact details of reference. The Masaai, as one of Konnild's many examples, demonstrate clearly defined modification practices involving the removal of teeth – often for folkloric reasons (e.g. the avoidance of illness). Unlike archaeological investigations, direct first hand interviews and accounts exist, allowing a unique insight into the cultural motivations behind dental alterations. Konnild refers to the travels of Captain W. Merker, a German military officer during the last century, through what was then Masaai dominated territory. His observations shed light on the multifaceted motivations for the evulsion or alteration of the dentition. Merker reports,



“It is customary soon after they have cut their second teeth to have the two (central) incisors knocked out. If you ask them about this they say it is done for ‘mwago’ or beauty. The origin of this custom is supposed to date back to when tetanus was a great scourge amongst them and they discovered that it was a comparatively simple matter to feed a man suffering from lockjaw if two of his front teeth were missing.” (Konnild nd.)

It seems that there are both cultural *and* practical reasons for dental evulsion in this case. Throughout Africa, variations of the practice described above exist in a large number of ethnic groups. The Efe, from the Ituri forest in Zaire practice a form of dental modification involving the sharpening of the anterior teeth into points (Bailey 1989). This practice is associated with initiation rites and marriage. Concepts of beauty seem intimately connected with the practice, with potential wives being selected only if they show the correct dental pattern.

### *Case study 3. Bali – an anthropological example*

Dental filing and colouring appear to be the most common forms of modification in Southeast Asia. Several anthropological studies of cultures in Vietnam, the Philippines and Bali, exemplify the complex socio-cultural reasoning behind this practice. In a large number of cultures in this region the concept that dogs, or animals in general, are unhygienic is widespread (Reed 1988). Individuals seek to distance themselves from the animal world by deliberately altering their appearance. Dogs have white teeth, leading to the cultural and archaeologically visible (in some cases) practice of blackening the teeth with Betel nuts (Lansing 1995). In Bali, tooth filing is performed on the incisors and upper canines, designed to reduce their appearance as ‘fangs’. Candidates lie on a mattress and suffer a painful operation, carried out with a spittoon, mirror, hammer, chisel, file and towel (Hobart et al. 1996). This process is considered a rite of passage into adulthood for men and women, carried out so as to minimise the following human passions in a young adult:

1. kama – lust/desire
2. kroda – anger
3. loba – greed
4. mada – arrogance
5. moha – intoxication
6. matsaria - jealousy

These six ‘vices’ are ‘removed’ by the modification of the body, making it more attractive to the opposite sex. The process itself must be extremely painful, with additional dangers involving dental disease and gum infections.

### **b) Modification for medical reasons**

Treatment of dental problems in the past can be demonstrated in the archaeological record as far back as the 1<sup>st</sup> millenium BC, with the discovery of Phoenician, Etruscan and Attic remains showing the splinting of loosened teeth to prevent tooth loss (Alt and Pichler 1998). Historical remains show a higher incidence of dental treatment, with the use of prosthetics to replace lost anterior teeth, such as the

example of an individual from Oberhofener churchyard, Goppingen, Germany. Here, an ivory bridge for the anterior area was attached to the maxilla with gold wire. Bridges may also be made of bone, hippopotamus teeth and walrus ivory (Alt and Pichler 1998: 408). Similar corrective measures include fillings of gold or tin.

Dental modification is often a painful process, which can lead to medical complications. Treatment in the past may have involved the use of medicinal plants as with the Maya (Konnild nd.), or operations to remove teeth or treat abscesses. Complications may arise, including an increased susceptibility to dental caries, periodontal disease, abscesses and cysts (Hillson 1997).

### 3. Practice

Actually conducting operations to produce the effects described above must have been a painful and prolonged process. Once more, ethnographic evidence can present information, which may help in the interpretation of archaeological remains. Techniques for modification vary with the desired affect; these may include chipping, filing, inlay, evulsion and colouration. Chipping could have been achieved with a variety of stone tools, whilst filing usually requires a technique involving a toolkit, like that of the Efe. The method employed by this group involves the 'victim' biting on a hardwood stick as a shaman performs the operation using an abrasive stone tool (Bailey 1989). Inlaying precious metals or stone into the teeth is not common amongst African groups. This is in contrast to archaeological remains of the Americas, where inlay forms an important part of the modification process. Romero's work involved the idea that inlays seen in Mesoamerican skeletons could have been carried out,

“...by rotating a fine tube of quartz or other very resistant stone against the surface of the enamel with the addition of water and some abrasive powder, such as fine sand.” (Romero 1970: 53)

Dental evulsion is common in Africa, with a variety of techniques employed for the removal or particular teeth. The Nuer of Sudan employ different methods for different teeth,

“When the infant is from a few days to a month old the canines are dug out of the jaw with a piece of iron, while the lower incisors are removed with a fish hook.” (Konnild nd.)

Among the Anouk of the Upper Nile, special 'dentists' within the tribe effect the removal of six anterior lower teeth. This operation is performed with the aid of a small iron spike. The spike is inserted in between the teeth to loosen them and then used to prise them out. Colouring of the teeth is a less painful and more easily achieved method of altering ones appearance. This can be done intentionally simply by chewing a certain plant, like the use of Betel amongst certain groups in South-East Asia, or unintentionally, such as the staining given to the teeth of Peruvian Indians by the chewing of Coca leaves or tobacco.

Clearly, a wide variety of techniques exist to produce changes to the dentition. The use of tool kits, which may be discovered in archaeological contexts, and the materials from which these are made can help the dental anthropologist determine the method used and may aid in making clear distinctions between wear patterns and intentional alterations.

#### **4. Interpretative approaches**

Early descriptive accounts of dental modification often involved relatively little interpretation as to the meaning behind the behaviour described in this paper. Marcellino's 1972 study of dental modifications in Argentina begins to approach meaning with a summary of ethnographically collected reasons for this practice,

1. Initiation rituals and rites of passage
2. Vanity or aesthetics
3. Intimidation of enemies
4. Totemic imitation
5. A means of mourning a loved one
6. Cannibalistic reasons
7. Tribal identity
8. Avoidance of evil influences
9. Avoidance of dental disease
10. Prevention of lockjaw
11. Practical reasons – use of teeth as tools

In addition to the above, some researchers have suggested factors such as language pronunciation (MacDonald 1999) and even improvement of sexual performance (Konnild nd.) as motivators for the practice. The varied behaviour described above emphasizes the role of teeth as a visual marker for a host of socially important messages relating to personal identity and the communication of status or emotion. The endurance of pain as a demonstration of maturity also appears to be an important factor in the removal or repositioning of the dentition in some cases (Konnild nd.). Romero's discussion in the *Handbook of Middle American Indians* (1970) considers forms of modification in the light of archaeological finds reflecting the practice,

“...the great Zapotec funeral urns, representing male and female gods with all of their supernatural attributes, frequently exhibit distinctive patterns of dental mutilation,.....This association suggests a religious basis for the psychological motivation, which induces some people to develop this peculiar custom.”

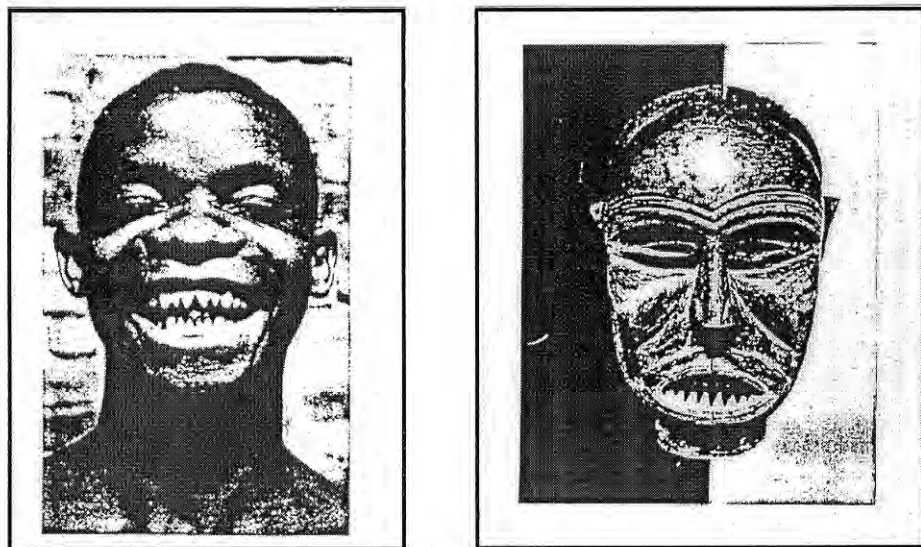
(Romero 1970: 55-56)

This association is also clearly demonstrated in Africa, with totemic symbolism reflecting not only archaeological remains, but also ethnographic sources. Johannes Konnild (nd.) describes ethnographic art throughout Africa reflecting mutilations found in past and present cultures (Fig 5.).

A strong emphasis exists, in Africa and Australia, on the importance of the removal of particular teeth for religious or 'medical' reasons,

“The Shilluk (southern Sudan) believe that if a child is allowed to keep the first canines, the child will contract diseases, especially intestinal ones like diarrhoea or dysentery. They believe the canines are first affected by ‘worms’ – these worms eventually give the child diseases, so the canines are removed as soon as they show above the gum.” (Konnild nd: 36-37)

“...many Australian aborigines include tooth evulsion among the physical ordeals of male initiation rites. The removed tooth may be associated with contagious magic. It may, for example, be placed under some tree bark near a water hole; if ants run over it, then it is believed the child will suffer from mouth disease.” (Favazza 1996: 126)



**Figure 5** African tooth filing reflected in material culture (Konnild nd: 1,129,140)

Ethnographic and anthropological examples such as these are invaluable in approaching archaeological remains. In archaeological situations, however, considerations such as differential preservation, sample size and context must be taken into account before any reliable interpretative statements can be made. Examples of dental modification in the Maya region have been used to make tentative interpretations regarding the practice as a status marker (Romero 1970; Whittington et al. 1998). However, excavations in elite, ‘middle class’ and ‘commoner’ contexts in Belize have all produced modified teeth (Guderjan, pers. comm.; Iannone, pers. comm.). Unfortunately the number of these examples is very low and with the wide variety of modifications seen in Mesoamerica it seems reasonable to assume that certain types of decoration may have represented status or occupational differences rather than the presence or absence of the practice itself.

## **5. Recording Dental modification in archaeology**

Successfully recording human teeth should be a comprehensive process. This involves a consideration of dental form, disease and development, as well as a necessary emphasis on ensuring that the recording methodology involved covers standards in the field, allowing comparability with information recorded by other researchers. With the great variety in dental modifications around the world as well as the motivations behind them, the recording of this phenomenon should allow for clear description, including a discussion of changes to specific surfaces and the introduction of foreign materials (Buikstra and Uberlaker 1994: 58). The 1994 standards for recording human skeletal remains emphasizes five aspects of dental alterations that should be considered, and provides a recording form for this purpose.

1. Filing
2. Drilling
3. Dental restorations and appliances
4. Dental wear caused by artifact use or production
5. Tooth ablation (evulsion)

In an analysis of elements such as the techniques used to produce alterations, the use of electron microscopy can be invaluable. This technique allows for the identification of use-wear facets and the marks left by tools used to produce effects such as inlay or drilling. Certain difficulties can arise in the recording process, such as the problem of distinguishing between tooth loss and tooth evulsion. It can be particularly difficult to identify deliberate removal of the deciduous teeth, particularly after the eruption of permanent dentition (MacDonald 1999: 5). The identification of ante-mortem tooth loss can be achieved through the recognition of certain processes such as alveolar bone remodeling. It should not, however, be assumed that all ante-mortem tooth loss was a deliberate act.

Dental health in the population under study should be taken into consideration, as a number of dental diseases can produce similar effects to deliberate evulsion. The identification of deliberate removal can be aided by employing three criteria; the ruling out of other causes (such as disease), a visible symmetry in tooth removal and the repetition of this symmetry in more than one individual from a single population. Ethnographic records, as has been emphasized above, can also help in confirming patterns of dental alteration in archaeological populations (MacDonald 1999: 5).

A consideration of excavation methodologies should also be taken into account at any site where a study of dental modifications is undertaken. Inlay materials can often be lost in archaeological contexts due to inadequate recovery techniques, such as poor sieving. Damage to teeth during excavation can also confuse analysis and should be avoided by creating an awareness within a field team of the correct recovery procedures.

Recording systems currently available are very comprehensive, with further developments on the way (Hillson 1999, pers. comm.), however, the key to understanding cultural drives behind modification practices can only be by cross-cultural comparison, and a healthy use of ethnographic and anthropological sources.

Only by using recording systems that allow such comparison in analysis can interpretative efforts in this field be advanced.

## 6. Discussion/Conclusions/Potential

Evidence for dental changes in the archaeological record can clearly be a valuable resource for information regarding cultural processes and social differentiation in the cultures within which they appear. The good preservation rate of teeth also provides the archaeologist with a source of information that may be the only remaining part of an interred individual. This factor alone is a strong argument for a greater emphasis on this area of dental studies as a means of drawing conclusions regarding socio-cultural behaviour in the past and approaching motivational factors in interpretation. This type of interpretative work is only possible with the assistance of studies conducted in related fields such as anthropology and ethnography. The researcher needs a good knowledge of archaeological approaches to dental remains, both in the field and in the laboratory. He or she should also employ cross-cultural and interdisciplinary approaches in any attempt to posit statements designed to explain archaeologically detectable behaviour of this kind. Potentially, modified teeth could indicate social relations, either vertical or horizontal, religious affiliations and even fashion. Only by comprehensive recovery and analysis can frequencies and spatial relationships of these finds begin to reveal possible meanings behind them.

This author would suggest that future studies of deliberate culturally motivated dental alterations should focus on the following issues;

1. **Practice.** How were dental changes made? Are the toolkits recoverable archaeologically? How long did particular alterations take? Do dental changes significantly increase the likelihood of dental disease?
2. **Classification.** Classificatory systems should be expanded to include locational information – where do the different patterns originate? Can changes in fashion be traced chronologically and spatially?
3. **Interpretation.** Conscious attempts to link ethnographically observed behaviour with traces in the archaeological record – the potential links between the two disciplines would benefit from further exploration. A holistic approach is necessary.

The above are simply intended as personal opinions regarding the future of investigations into dental modification. It is hoped that this paper has succeeded in emphasizing the potential of dental modification studies for archaeological interpretations of past human behaviour. At present, more comprehensive work is beginning to be conducted in this field (Alt and Pichler 1998), but little attempt has been made in areas such as Mesoamerica to unlock the meaning behind a practice that must have been visible and socially significant on a daily basis.

### Acknowledgements

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