Etruscan Gold Dental Appliances: Origins and Functions as Indicated by an Example from Orvieto, Italy, in the Danish National Museum

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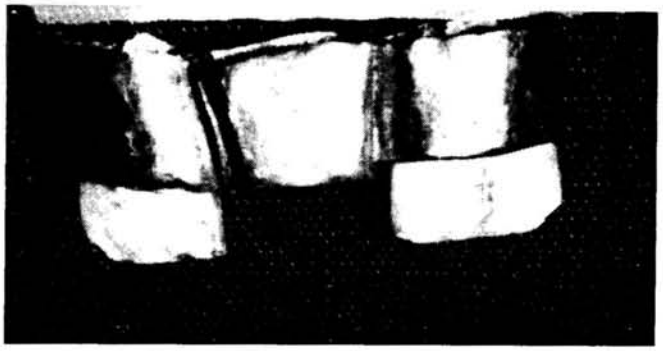

Fig. 1. Copenhagen Bridge (Etruscan), labial aspect. Gold appliance holding (left and right) maxillary right lateral and left central incisor crowns. Photo courtesy editors Danish Dental Journal.

ABSTRACT The ancient Etruscans invented the dental bridge over 2,500 years ago. The earliest known example, made from pure gold, was excavated from the ancient site of Satricum in central Italy. It has been dated to ca. 630 BC. At that time this village was within the Etruscan realm. All of the earliest examples of these dental prostheses derive from Etruscan contexts. Study of all of the known dental appliances from this part of the ancient world suggests that their use faded as central Italy came under Roman influence.

Among the 19 known prostheses from Etruscan archaeological contexts (Becker, nda) is an outstanding example, believed to be from Orvieto, now in the Danish National Museum in Copenhagen (Figs. 1, 2) (Becker, 1992). A detailed description of the Copenhagen example allows it to be compared with other known pieces. We now have a clear understanding of the various ways in which prostheses were made and used.

A significant discovery is that these Etruscan bridges were worn only by females, suggesting that cosmetics and vanity were important dental concerns. The unusual construction technique of the Copenhagen piece and its place within the typology of examples reflects the evolution of this technology over more than 400 years.

INTRODUCTION

Many scholars have reviewed the outstanding nature of Etruscan goldsmithing skills (De Puma, 1987). However, Etruscan primacy in applying related technology to prehistoric dentistry is less well known than their abilities to fashion complex jewelry and vessels from precious metals. Despite the abundant evidence, many scholars deny that the Etruscans made the first dental appliances and believe that such technology had its origins in ancient Egypt. Over 2,600 years ago Etruscan goldsmiths were the first to fashion complex dental appliances which had therapeutic as well as cosmetic value. This review, the first in a series of brief articles, offers the results of eight years of research relating to ancient prostheses, copies of prostheses, and various items mistakenly believed to be ancient dental appliances.

An extensive literature discussing ancient dental prostheses has emerged since 1885. These appliances are known from ancient literary sources, which were written at the time that these dental bridges were in use. Archaeological evidence confirming these classical texts emerged in the late 18th century (Böttiger, 1797:63).

Results of recent excavations demonstrate that the earliest examples date from the 7th century BC. A score of ancient dental appliances, in an amazing variety of shapes and sizes, are now known throughout the eastern Mediterranean from Italy to Syria (Becker, nda). Since Deneffe's (1899) early inventory, a considerable number of lists have emerged (Sudhoff, 1926; Casotti, 1947), and Tabanelli (1963) has attempted a true catalogue. Dental as well as other ancient prosthetic devices were reviewed by Bliquez (1983), who gathered specific information regarding various dental prostheses and their history (Bliquez, in press). The Bliquez inventory includes many of the best available photographs of these items (see also Emptoz, 1987).

Archaeological data for most of the known prostheses, however, are surprisingly limited. Also, as Waarsenburg (1990, 1991) notes, modern descriptions of the prostheses themselves generally are so poor as to create numerous errors in the literature. These various difficulties can be remedied only by detailed studies of each of the appliances, such as Clawson's (1934) outstanding contribution, and careful studies of the dental and skeletal materials found in association with these prostheses. Also important in understanding the contexts within which these appliances were made and used is the literary evidence (Becker, nda) of the relationship of practitioners of medicine to those who performed dental extractions. The manufacture of dental appliances was a skilled activity, which was the work of goldsmiths and other crafters, rather than the work of barbers or physicians.

ORIGINS OF DENTAL PROSTHESES

The earliest records of dental care can be found in Egyptian medical papyri of the 17th and 16th centuries BC (Badre, 1986). These texts relate only to medical treatments and include no references to dental prostheses. Clearly these texts predate the Hippocratic corpus, and are basic to understanding the early history of dental medicine. The treatment of oral disease, however, long precedes the development of dental appliances, which first emerge in the Etruscan world in the 7th century BC (Bliquez in press, citing Hoffmann-Axthelm, 1985:28-31,38-39).

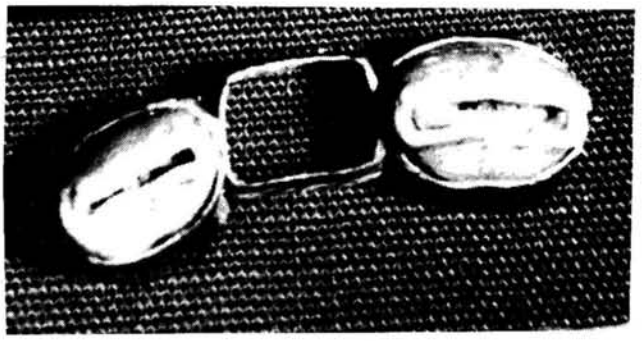

Fig. 2. The Copenhagen Bridge (Etruscan), occlusal aspect. Appliance encircling (from left to right) right lateral incisor, space for replacement right central incisor, and left central incisor. Photo courtesy editors Danish Dental Journal.

No example of a Sumerian or Egyptian dental prosthesis from before the 5th century BC can be verified (Masali and Peluso, 1985; Corruccini and Pacciani, 1989:61). Guerini (1909:28) suggested that the Egyptians may have decorated teeth with gold after death, but also concluded that they produced no dental prostheses. Emptoz (1987:546, fig. 1) noted that in 1914 Junker found what were called "wired teeth" in a tomb at Gizeh dating from 2,500 BC, but indicated that these "teeth" were actually an amulet (Becker, nda). The supposed primacy of Egyptian or Phoenician dental appliances (Lufkin, 1948; Woodforde, 1968) is nowhere supported by direct evidence. Clawson (1934:23-24) put it best when he stated that "contrary to the beliefs of various writers," whom he cites, "detached archaeological specimens of Egyptian prosthetic dentistry do not seem to exist."

The precise origins of gold dental appliances certainly predate the 6th century BC. By 630 BC (Becker, nda) a high status resident of ancient Satricum was buried wearing a complex and sophisticated dental appliance, suggesting that skills in the production of dental prostheses probably extend at least back to the middle of the 7th century BC. Over the next few hundred years the general availability of such gold prosthetic devices in Etruria, and to the south in Rome, is indicated clearly by the numbers of examples which survive, as well as the frequency of reference to them in the ancient literature and from the Law of the 12 Tables (a code of general laws, probably collected in Rome about 450 BC, and maintained in force for many centuries).

The Etruscans were the first to develop true dental bridges, in that these devices were anchored to sound teeth and usually provided the means for replacing as many as four missing teeth. My work has shown that all the wearers for whom gender can be determined were female. Thus, the use of these appliances may have been primarily cosmetic. The demise of technology in dental appliances paralleled the demise of Etruscan society, which was unusual in that women there enjoyed high status.

Quite interesting, however, is the fact that no examples of gold bridgework appear to survive from the period of the later Roman Republic or of the Empire, although literary references appear to attest to their presence (Bliquez, in press). Bliquez rightly dismissed Guerini's (1909:100) suggestion that by the Late Republic full sets of removable dentures were being produced. Even if this were the case, a demand for bridges would have continued and later examples should be known. Perhaps late examples of prostheses had been removed before burial or looted from graves. Another possibility is that they have been poorly documented when recovered. This last scenario would have led to their inclusion in the corpus without appropriate archaeological documentation which would have allowed us to assign a correct date. However, the possibility that these appliances faded with the Etruscans by the 1st century A.D. is offered here.

FUNCTIONS

While most of the known ancient dental prostheses from Italy appear to be cosmetic, at least some simple bands may have served to stabilize loose teeth. These may have been teeth loosened by a blow. However, the Etruscan and related examples more likely served to prevent (or retard) the loss of teeth loosened by periodontal disease. Some of the few prostheses known from the Phoenician world clearly were purely functional. Simple gold bands (and in the east, gold wires) were used in constructing these functional appliances. However, the decorative aspects of the Etruscan types cannot be ignored.

Both cosmetic and functional dental appliances are mentioned in the ancient texts (Becker, nda). Even those cosmetic appliances which appear to have been designed only to fill the gaps left by lost teeth also

would have served to maintain the remaining teeth in their correct places, thereby assuring continued proper articulation of the teeth and their continued efficient function. The individual's own teeth, presumably loosened by periodontal problems and removed by a specialist (cf. Ginge et al., 1989), would have been used in the appliance (Guerini, 1909:71-73, 79; Deneffe 1899:78; Casotti 1947:669). Such recycling of one's own teeth might also have guaranteed correct color and size match. The recent suggestion (Capasso and Di Tota, 1993) that one of these appliances may have been used deliberately to effect a "shifting of teeth" is easily dismissed by anyone familiar with goals, functions, and processes of orthodonture.[1]

As Martial (1897) records, various substitutes for human teeth, such as bone or ivory, and even the tooth of an ox, were commonly employed in ancient Italy. Pine and boxwood, such as that used for the dentures of President George Washington, are said to have been used by the Romans (Bliquez, in press). This all leads to the question of the identity of the makers of these prosthetic devices. Bliquez and others (Guerini, 1909:102; Hoffman-Axthelm, 1985:30) must be correct in concluding that goldsmiths, ivory carvers, and other artisans fabricated these appliances. The makers also probably fitted or applied these devices as a branch of cosmetology with therapeutic value, independent of dentists who did extractions, or of physicians who prescribed for diseases of the mouth.

THE COPENHAGEN BRIDGE (Inv. no. 8319) AND ITS CONSTRUCTION

The present location of this example is the National Museum, Copenhagen (Department of Near Eastern and Classical Antiquities). This piece remains almost unknown, although at least five authors have noted it in the literature (Bliquez, in press; Johnstone, 1932a:132, Pl. 94:17-18; 1932b; Marvitz, 1982:49; Pot, 1985:38-39; Poulsen, 1927:47). Riis (1941:161) believes that it came from Orvieto.

The appliance was made from three small, separate gold loops which had been cold welded together (Figs. 1, 2). The bridge looped the upper left central incisor, encompassed a replacement for the right central incisor, and was secured on the other end to the right lateral incisor. The associated teeth indicate that the appliance was meant to be worn by an adult female (Becker, 1992; nda).

The Copenhagen prosthesis demonstrates the use of a complex variation of the simple band technique, which is only one of at least four variations which are known (Becker, nda). The Copenhagen bridge was made of three separate rings. The bands had been created to surround either an anchor tooth or the false tooth, which is now missing (Anchor or post teeth were sound or living teeth to which the bridge was attached to hold it in place). All three bands, including the gold band or collar for the replacement tooth, were joined at their adjacent surfaces by invisible cold welds (Becker, nda). Each was custom designed to fit one element. The lateral loops were curved in such a way as to conform to the base of each existing crown (the left central and right lateral incisors), with specific fitting done after the false tooth had been set in place and the appliance was ready to be inserted.

While the lateral loops were designed to surround the curves of the natural teeth, the central band, made to hold the artificial right central incisor, had been bent into a sharply rectangular form to prevent the replacement tooth (of ivory or bone) from slipping in this collar. The replacement tooth set into this "box" would have been a "crown" only, with the upper and exposed portion carved to mimic the tooth which it replaced. The lower part or base of the false tooth would have been square-cut to fit into the "box" where the angular shape would prevent it from slipping in its gold collar.

A small band was made and then fitted with the replacement tooth the way a goldsmith would make a bezel setting. The rectangular setting would prevent rotation and facilitate a good fit. Then the replacement tooth would be secured in place by pressing the gold tightly, as had been done with the gold of the lateral loops. The result was the bridge, of a design remarkably similar to modern examples. Finally, the lateral bands were fitted to the living teeth, by simply pressing the soft (extremely pure) gold bands securely around them. The appliance was meant to be a permanent fixture. Interestingly, no rivet had used to fasten the single replacement tooth in this appliance, as was common in other types of Etruscan gold dental appliances, since the false tooth had been held in place the way a gemstone is fixed in its setting.

The thickness of the three gold bands varies, and this feature is exaggerated by the bending and fitting which probably made this appliance more effective than bridges which incorporate only a single long band. Although measurements were difficult to secure, due to the presence of teeth within the appliance and modern glue on many surfaces, fairly accurate readings could be secured at a number of locations. The left element, surrounding the left central incisor, is a band beaten or worked to a thickness of about 0.3 to 0.4 mm. The thickness around the central element, which would have held the replacement right central incisor, is close to 0.3 mm, and that around the right lateral incisor is under 0.3 mm, possibly as thin as 0.2 mm.

These variations in thickness suggest a gradual thinning of these bands. Perhaps, a single long strip was the source of all three units, and this source was thicker at one end than the other. While this may have been the case, the measurements may reflect random variation, slight bends or disturbances which occurred after death, and even thinning which was part of the fitting process. Quite clearly, the only point of considerable importance is that the thickness of the gold band appears to fall between 0.2 and 0.4 mm.

The breadth of the gold band forming each unit also shows minor variations. These breadths are indicated at various points along each unit by an arrow pointing to the band opposite a "tick" at the opposite side of the band, with the measurement placed at the end of the arrow (Figs. 3, 4, 5). The center of the labial surface of the left unit measures 5.8 mm high (not shown). An encrustation of glue obscures configuration of the rear surface. The height of the band forming the central unit is 6.1 mm along the labial surface where it attaches to the left unit (not shown). This strip broadens toward the midline of the labial surface where it is approximately 6.5 mm mesio-distally (not shown). The right unit is formed from a band which is a bit under 6.0 mm high at the lingual-distal corner, but widens to 6.1 mm and continues to increase in height toward the front of the tooth where it reaches 6.3 mm high at the labial-mesial corner (Fig. 3). As noted above, these variations may be due to changes effected in the gold band during close fitting rather than from variations in the shape of the gold strip or strips from which the appliance was formed.

The shape of each unit clearly reflects the tooth or tooth substitute which was meant to be enclosed (Figs. 2, 3, 5). The left unit is relatively oval in plan at the lower margin, but nearly square at the top where it surrounded the widest aspect of the tooth. The central unit is nearly a perfect rectangle in plan both at its top and at its bottom, with the lower aspect being slightly smaller than the upper (Becker, 1994). The right side unit is a very irregular square at the upper side and an irregular oval at the lower edge.

The nature of the false tooth that was firmly fixed into the central socket of this appliance is unknown. It probably had been fashioned from ivory or an animal tooth, or even from bone. Since the upper diameters of the surrounding gold band are larger than the lower, there was no danger that the tooth could drop out, and a firm set against the gum (or even a tooth stump) would have prevented the tooth from working its way upwards and out of the yoke. The probability is that the gum would recede away from this "tooth" and that a new element would have to be fitted from time to time. This could be done with relative ease, or at least as easily as the removal of the entire device from the adjacent teeth.

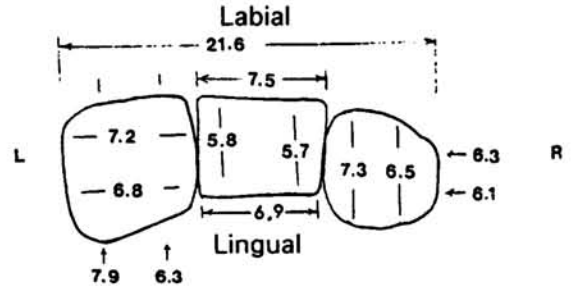

Fig. 3. The Copenhagen Bridge (8318) (Etruscan). Line drawing showing dimensions (in mm) of the occlusal (inferior) aspect. Left to right: left central incisor, bridge for the replacement right central incisor, and right lateral incisor.

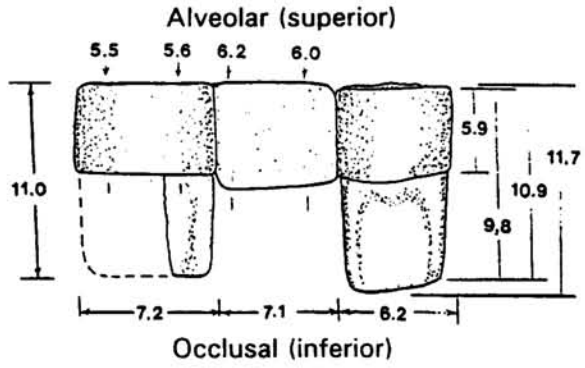

Fig. 4. The Copenhagen Bridge (8318) (Etruscan). Lingual surface of appliance with teeth in place. Drawn in 1987 showing damage to left central incisor which postdates photographs in photographs in Figs. 1 & 2. Left to right: left central incisor, bridge for replacement right central incisor, right lateral incisor. Dimensions in mm.

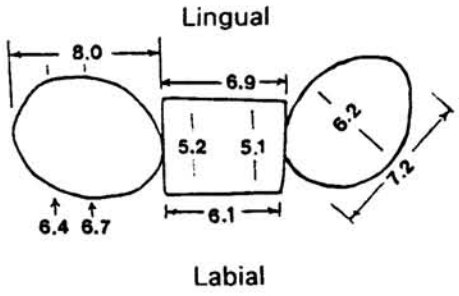

Fig. 5. The Copenhagen Bridge (8318) (Etruscan). Line drawing showing dimensions (in mm) of the alveolar (superior) aspect. From left to right: left central incisor, bridge for replacement right central incisor, and right lateral incisor.

THE ANCHOR TEETH OF THE COPENHAGEN BRIDGE

Photographs of this bridge depict the intact crowns of the anchor teeth (left central and right lateral incisors) within the lateral loops of the bridge (Figs. 1, 2; see also Marvitz, 1982:49). When examined in 1989, the left central incisor, when viewed from the lingual aspect, was badly fractured (Fig 4), and what appeared to be transparent glue covered much of the lingual surface of the teeth and gold piece. The damage and glue may be the result of the display of this item about 1982.

The crowns of the flanking anchor teeth survive, but the artificial insert for the right central incisor is absent, probably having deteriorated post mortem. Processes of decay may have dissolved the roots of the anchor teeth, as well as most of the dentine within the crowns (Fig. 2). The left central incisor still has much of its neck area preserved within the area of the gold band despite damage to the crown, which is largely missing except for the labial-mesial aspect of the enamel.

Both extant teeth appear to have been worn along the occlusal or cutting edges just into the dentine, but there is no trace of secondary replacement in the dentine area. There is, however, general loss of dentine due to post-mortem decomposition (Fig. 2). The entire crown of the right lateral incisor is intact and shows very little recent damage. Some tiny chips along the occlusal surface reflect continued biting of hard materials or coarse elements (Fig. 1). A trace of shoveling (1 on a 0-4 scale) is evident. Shovelling also appears along the mesial margin of the left central incisor, and is seen as a trace on the distal margin (not visible in the figures).

Maximum diameters cannot be measured directly, but may be estimated from the dimensions of the enclosing goldwork. The left central incisor can be estimated to have been 7.8 mm mesio-distally (not shown), the right central incisor about 7.5 mm mesio-distally (Fig. 3), and the right lateral incisor only 6.9 mm mesio-distally, although the band enclosing it has an inferior diameter of 7.2 mm (Fig. 5). In height the left central incisor is estimated at 11.5 mm, which is greater than the 11.0 mm which remains, as indicated in Figure 4. The left central incisor appears to be approximately 10.9 mm high (Fig. 4).

The small size of these teeth and the gap which was bridged by this appliance suggest that the wearer of this bridgework was a female. Although age determination by degree of wear requires a comparative population of some numbers and is less effectively applied to anterior teeth, the individual represented by these teeth appears to have been over 30 years of age, but probably under age 50.

The catalogue card for the Copenhagen appliance states that it was a gift from the Ny Carlsberg Foundation in 1924. The National Museum has an excellent photograph (Neg. No. M 194; FOI 132). The attribution of this appliance to Orvieto derives from Riis (1941:161), and is discussed extensively by Becker (in press). Most of the vessels noted by Riis, only some of which may have been in the same tomb as the dental appliance, suggest a date of approximately 500-490 BC.

DISCUSSION AND CONCLUSIONS

Just over 100 years ago, Lanciani (1892:353) noted that the tombstone of an ancient Roman dentist named Victorinus depicted an instrument of his trade, a pair of dental forceps. Other medical practitioners in Rome, of both Greek and Roman origin, also had similar tools shown on their funerary monuments (Lanciani, 1892; Jackson, 1988:119). The numerous medical kits known from antiquity, however, do not include the specialized tools which are needed by the goldsmith. Nor do we find any literary evidence which might suggest that gold dental appliances were fashioned by any of the people more directly involved in the medical arts (Becker, nda).

Quite clearly the three elements of the Copenhagen bridge, as is the case of other appliances using a series of welded rings, were extremely carefully fitted to the teeth that they surround as well as to each other. This skilled application may have provided a much better fit and, therefore, greater stability than is achieved through the use of a single long band. However, this apparent improvement need not reflect chronological aspects of ancient dentistry. The use of a more successful method of fitting a dental appliance may reflect only the great concern of this "dentist," or greater skills of a goldsmith who was fashioning the bridge. Although both skills may have been employed by the goldsmiths making long band bridges, this may not be the case with this appliance. Both sets of skills (knowledge of teeth involving the fitting of gold to them and knowledge of goldsmithing) are quite highly developed in the Copenhagen example. That these may also have been the skills of a single individual would suggest that such a person was an extremely talented crafter.

If the Copenhagen bridge represents an evolved form of dental appliance within the ancient world, then we can see a stage, from which the next logical step would be the formation of a solid gold tooth which might have mastication among its functional aspects. The greater expense of a solid gold appliance, as

compared with ivory or natural teeth, may have retarded its development, but we can see that the attachment of gold loops to a solid tooth certainly was within the technological capabilities of these ancient dentists.

The earliest dental appliance, the Satricum band with a gold tooth attached (ca. 630 BC), is the only one known to use a gold tooth (Waarsenburg, nd; Becker, 1994, in press). Since we have no evidence to indicate that this technique was ever repeated, we may conclude that it was soon discontinued. This observation suggests that soon after, or perhaps by 600 BC, the use of false teeth, human or carved to look like natural teeth, had become the fashion. This appears to relate to the finding that where a specific evaluation of gender has been made, the Italian wearers of these gold bands all appear to have been women.

Johnstone (1932b:448) indicates that the Etruscans were the first to construct true dental bridges, and all subsequent research supports this hypothesis. The tentative sequence for these dental appliances suggests a gradual development in the techniques of applying dental bridges (Becker, ndb). Various examples suggest that a few talented individuals may have carried their craft to unusual heights, but those achievements were not continued after the decline of ancient Rome and had to be re-invented by modern practitioners.

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[1]The digression in the note by Capasso and Di Tota (1993:6-7) into the subject of the gold dental appliance from Pieve offers a brief commentary on an artifact for which we had no detailed description (Corruccini and Pacciani, 1989) and no documentation of any archaeological context. This has now been corrected. In Bliquez's (in press) work, as well as in my own survey of these pieces involving direct examination and commentary on each known example plus tracking copies and "pieces" which have been fabricated in the literature, considerable numbers of errors have been discovered which resulted simply from the erroneous printing of negatives. While the greatest number of errors derive from the lack of direct examination of these appliances on the part of authors and other sources of error, note will be made here only of the ways in which published prints contribute to this problem.

Readers' attention should be directed to Capasso's photograph (1986:54) of the Firenze piece said to have been excavated at Poggio Gaiella in Citta' della Pieve, which is 7 km south of Chiusi and 43 km southwest of Perugia. Capasso's figure derives from the same negative as that used by Corruccini and Pacciani (1989: fig. 2), but one of the two is printed in reverse. Further note should be made of the drawings used by Capasso and Di Tota (1993: figs. 2, 3), which are exactly those used by Capasso (1986:55) in his popular piece, except that one is the reverse of the other. Capasso and Di Tota (1993) also assume that the mandibular lateral or central incisor of the Poggio Gaiella appliance was lost ante-mortem and that the lower left canine is missing. This is not the case, as demonstrated by colored plates in Laviosa, et al. (1993:131,figs.V4,V5). Corruccini and Pacciani's (1989:62, fig.1) age evaluation (16 years) is far too low since several features indicate that the age at death was greater than 25 years. Inferences that the break in this appliance occurred during the recent flood in Florence, like the idea that these appliances could be used to close gaps in the dental arcade, are not correct.

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Oral Condition of Three Yanomama Indian Tribes of South America

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ABSTRACT The permanent dentition and supporting tissue of 140 Yanomama Indians ranging in age from three to more than 40 years was examined for malocclusion, caries, attrition, and periodontal disease. Their oral status is characterized by malocclusion (79%), anterior tooth crowding (55%), a low frequency of caries (14%), periodontal disease (83%), and a linear progression of occlusal attrition with age. The Yanomama are recognized as having been geographically, genetically, and linguistically isolated for a minimum of 500 years. This situation permits the use of their dental condition to assess the hypotheses that admixture and/or tooth use is chiefly responsible for the widespread malocclusion found in many modern Yanomama populations. Because the Yanomama have seemingly not been affected by foreign admixture, and because they possess marked tooth wear evidencing heavy mastication, neither admixture nor lack of masticatory function can be responsible for a high degree of malocclusion.

INTRODUCTION

The dentition and jaws of many contemporary populations are characterized by high incidence of static and dynamic malocclusion, ranging in frequency from 22.4% to 91.4% (Hrdlička, 1935; Mills, 1963; Horowitz, 1970). Although malocclusion is rarely found in early hominid and prehominid fossils (Pereira, 1972), it has been observed in the form of tooth crowding in some australopithecine material (Oppenheimer, 1967). Still, high frequencies of malocclusion are apparently a relatively recent development in some groups of *Homo sapiens*.

Precise causes for changes in the human masticatory system have not been established, but several hypotheses exist for the reduction in jaw and tooth size. Some of the notable hypotheses are: (1) a reduced need for heavy chewing (Benjamin, 1962; Dahlberg, 1963; Mahler, 1967); (2) the advent of tools as substitutes for teeth (Brace, 1964; Brace and Montague, 1965); and (3) possession of some adaptation that reflects selective pressures on a whole functional matrix which involves the teeth and jaws (Bailit and Friedlander, 1966). Another factor that may have contributed to increase in malocclusion, other than the three factors outlined above, is admixture resulting in large teeth in small jaws (Mills, 1963).

Therefore, the primary purpose of this paper is to examine the hypotheses concerning dental crowding in a living population which possesses two necessary conditions: (1) low to absent admixture and (2) a hunter-