

Mandibular Anterior Tooth Wear of Individuals from Liang Bua, Lewoleba, and Melolo: an Indication of Cultural Activity Related Patterns *

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Bull Int Assoc Paleodont. 2019;13(2):23-30.

Abstract

Aim. The aim of this scientific study was to delineate tooth wear captured in part of anterior mandible of individual remains as a result of excavation done in several sites such as in Liang Bua, Lewoleba, and Melolo of East Nusa Tenggara, Indonesia. The focus of the investigation was to identify the pattern of tooth wear on mandibular incisors. **Materials and Method.** The investigation was carried out upon seven mandibles of individuals excavated from the three sites. Macroscopic observation was occupied to identify the stages of tooth wear and wear type on mandibular incisors. **Result.** The result depicts high level of stages of occlusal surface wear and oblique wear type on incisors of subjects acquired from Liang Bua, Lewoleba, and Melolo. **Conclusion.** Such evidence implies that the occurrence of high level of stages of occlusal surface wear can be indicated to have correlation with meat based diet. Meanwhile, the occurrence of oblique tooth wear suggests its correlation with an activity of chewing 'Sirih Pinang' or betel-nut chewing, a kind of betel vine popularly done by individual dwelling in those areas. Also, an indication of intentional dental modification upon incisors was found on subjects acquired from both Liang Bua and Lewoleba.

Keywords: tooth wear; Liang Bua; Lewoleba; Melolo; Indonesia

* Author is responsible for language correctness and content.



Introduction

Tooth wear is a particular dental disorientation, commonly associated with dental activities that lead to the alteration of occlusal surface of the teeth. The forms of tooth wear could be classified as attrition (tooth to tooth contact), abrasion (tooth and ingested substance), and erosion upon tooth surface. (1) Tooth wear occurrence is commonly relatable to digesting food and several cultural practices. (2) Several studies about activities involving teeth upon prehistoric society posited that the shift of lifestyle from hunter-gatherer to agriculture in Neolithic era had a major influence upon the level and pattern of tooth wear (1, 3, 4, 5, 6).

Investigations of tooth wear commonly focus on its levels and pattern on posterior teeth, which is in line with their mechanical function of mastication, along with the shifts of subsistence and diet of prehistoric society (2, 7, 8). Meanwhile, such phenomenon that happened on posterior teeth, other than correlated with the alteration of both subsistence and diet, is also believed to be influenced by cultural activities (3, 5, 6). The frequent uses of anterior teeth for other purposes instead of diet, or, in other words as a 'tool' to cope with daily chores must be the factor behind that phenomenon. Those activities allowed a particular form of tooth wear to occur (2, 9).

This study was aimed to illustrate tooth wear that were found on anterior mandibles of individuals from Liang Bua, Lewoleba, and Melolo, East Nusa Tenggara, Indonesia. Pattern of tooth wear on mesiodistal surface of mandibular incisors was the main aspect observed during the investigation. The result of the observation indicates that diet pattern and cultural activities, other than teeth modification, influenced the varieties of tooth wear pattern, especially on anterior teeth of individuals from the three sites.

Materials and methods

The observation took the mandibles of individuals from Liang Bua, Lewoleba, and Melolo, East Nusa Tenggara, Indonesia. Liang Bua. Liang Bua is a cave located in Teras village which belongs to Cancar sub-district, approximately 11 kilometres from the downtown of Ruteng, the capital city of West Manggarai province. The first investigation in Liang Bua was carried out by Dr. Th. Verhoeven in July 1965. The excavation resulted in the discovery of ten human skeletal remains buried in primary burial. Besides, it was

also indicated that the site in Liang Bua also served secondary burial based on the findings of artefacts, bone fragments, and human teeth in a stoneware. The artefacts found, such as flakes, Neolithic axe, and potteries, indicated that the population of Liang Bua lived in the transition of Neolithic/agricultural period (10). Dating analysis revealed that those individuals lived in approximately 3390 \pm 270 BP to 3830 \pm 120 BP (11).

Lewoleba. Lewoleba is a site located on a cliff by the beach. Administratively, this site of Lewoleba belongs to Lewoleba village, Lebaktukan sub-district of East Flores district. There were three sites of investigation in this site, which are Lewoleba I (LL I), Lewoleba II (LL II), and Lewoleba III (LL III). The findings of research in Lewoleba were in the forms of human skeletal remains, animal remains; which is believed to serve as food supply; and molluscs shells, and some fragments of stoneware. Based on the finding of the stoneware and handcraft made of molluscs shell, the population of this site is indicated to live in the transition of Neolithic period (11). Dating analysis confirmed that this site dated back to 2990 \pm 160 BP (11).

Melolo. Melolo is a site where burial jars were found. The key findings from this site were the remnants of human skeletons. This site administratively belongs to Lembukori vilage, Rindi Umalulu sub-district, East Sumba district. It is located approximately 200 metres from the shore, and the site itself is situated in the height of 10 metres above the sea level. The findings were the result of a couple of excavations carried out by several researchers such as Prof. E. R. K. Rodenwaltd in 1923, which were examined further by Prof. Dr. J. P. Kleiweg de Zwann (code 1-34); Dr. L. Onvlee in 1936 (code A – K); and Dr. Willems in 1938 (code I-VI). The collection of those previous research findings were then investigated deeper by Prof. Dr. C. A. R. D. Snell in Surabaya (13). The findings of artefacts such as burial objects in the forms of beads, ear rings, bracelets, and rings, and stonewear which suggested an indication that the site in Melolo dated back to early metal age (13). C14 analysis also unveils that the site dated back to 2870 \pm 60 BP (11).

The whole mandibles, as the subjects of this study, originated from seven individuals (Table 1). Three of them were the findings in Liang Bua (LB/1, LB/3, LB/6), the other three were from Lewoleba (LL I2, LL I3, LL I4), and one was found

in Melolo (Urne 3) (14). These seven mandibles were selected based on the unabridged condition of the anterior side of the mandibles, with either the whole incisors or a couple of remaining.

This study employed macroscopic observation, which requires observation and keeping records on the scores of stages of occlusal surface wear and wear types on the occlusal surface of incisors. The levelling of stages of occlusal surface wear was conducted on the basis of Smith's (4) method, which classifies the stages of occlusal surface wear on teeth, not only anterior

Results

Table 2 presents the stages of occlusal surface wear and wear type of anterior mandibles of individuals from Liang Bua, Lewoleba, dan Melolo. On individuals of Liang Bua, LB/1, the stages of occlusal surface wear of left I1 dan I2 was recorded to be in level 5, and they belong to oblique (distal-mesial direction) wear type along with flat occlusal surface type (Type 52). In contrast, LB/3, the stages of occlusal surface wear on all incisors were categorised in level 5. The wear type of LB/3 left I2 and I1 were recorded



Figure 1 Mandible of LB/3 (left) and Urne 3 (right).

but also posterior teeth, into 8 levels. The classification of wear type was made possible by the use of Molnar's (15) categorisation which is divided into two parts. The first part deals with the direction of the attrition, descending from the highest to the lowest level of occlusal surface of the tooth. This is classified into eight categories: 1) Natural form, 2) Oblique (buccal-lingual direction), 3) Oblique (lingual-buccal direction), 4) Oblique (mesial-distal direction), 5) Oblique (distal-mesial direction), 6) Horizontal (perpendicular to the long axis of the tooth); 7) Rounded (buccal-lingual direction); and 8) Rounded (mesial-distal direction). The second part categorises the shape of attrition on the occlusal surface of tooth which is classified into 8 categories, 1) natural form; 2) flat surface; 3) one-half of surface cupped; 4) entire surface cupped; 5) notched; and 6) rounded. To put an ease in classifying, wear type could be recorded by using numeric codes based on the type and the shape, for instance, oblique (distal-mesial direction) and notched attrition shape is recorded as Type 55.

to be oblique (distal-mesial direction) while the surface shape of the occlusal was cupped (Type 54); the right I2 dan I1 were oblique (mesial-distal direction) while the shapes of the occlusal surface were cupped (Type 44). The finding on subject LB/6, suggested that three remaining incisors showed the stages of occlusal surface wear on level 3, with the wear type of the right I1 as oblique (mesial-distal direction) along with a flat occlusal surface (Type 42), the left I1 as oblique (distal-mesial direction) and a notched shape of occlusal surface (Type 55), as for the left I2 was in natural form based on both the direction of attrition and the shape of occlusal surface (Type 11).

On individuals of Lewoleba, LL I2 stages of occlusal surface wear of the incisors were classified in level 5 for both left I1 and right I1, and level 4 for left I2. The wear type on the teeth of LL



Figure 2 Mandible of LB/6 (left) and LL I2 (right).

I2; left I1 showed an oblique (distal-mesial direction) type while the shape of the occlusal surface was cupped (Type 34); and the right I1 tooth was oblique (mesial-distal direction) while the shape of the occlusal surface was cupped (Type 44). In contrast, the stages of occlusal surface wear on left I1 of LL I3 was classified as level 6, while for the other three incisors (left I2, and right I1 - I2) were categorised as in level 5. The tooth wear type of LL I3: the left I1 was oblique (buccal-lingual direction) while the shape of the occlusal surface was cupped (Type 24); the left I1 tooth was oblique (lingual-buccal direction) while the shape of the occlusal surface was cupped (Type 34); and the right I1 tooth was oblique (mesial-distal direction) while the shape of the occlusal surface was cupped (Type 44). In addition, the wear type on the remaining incisors of LL I4 which was the right I2 tooth was recorded to be in level 5, with the wear type as oblique

(mesial-distal direction) while the shape of the occlusal surface was flat (Type 42).

On individuals of Melolo, the stages of Urne 3 of occlusal surface wear on the right I1 and I2 was in level 4 and 3 respectively, while both the left I1 and I2 were in level 5. The wear type of Urne 3 shared some features. Both the right I2 and I1 teeth were oblique (mesial-distal direction) while as for their shape of occlusal surface were both cupped (Type 44). On the other hand, the left I2 and I1 teeth shared oblique type (distal-mesial direction) and cupped shaped of the occlusal surface (Type 54).

Discussion

Two-thirds of the total teeth gathered from individuals from Liang Bua, Lewoleba, and Melolo performed attrition classified as level 5. Such condition, examined from artifactual viewpoint, indicated the fact that even though the lifestyle of those individuals was in the transition towards agriculture, the diet pattern remained in domination of hunter-gatherer activities. Several studies that were conducted (5, 6, 16) proposed the high stages of occlusal surface wear could generally be found in hunter-gatherer or fisher-gatherer society which must be influenced from the specific diet which was mostly meat based diet. The continuity of such lifestyle was confirmed by the finding of fragments of animal skeleton and the shell of molluscs in the excavation sites (14).

The high stage of occlusal surface wear of mandibular incisors found on those individuals from the three sites also indicated the presence of other factors that were mixed in dietary. Deter (1) explained that an attrition on tooth enamel is



Figure 3 Betel-nut chewing ingredients in Papua: Areca catechu nut, betel fruit, and lime.



Figure 4 Processing betel-nut demonstrated by Mama Imelda Manggaprow: a) cracked and peeled Areca-nut; b) filleted the inner part of cut up skin of Areca-nut; c) residue of cut up skin of Areca-nut; and d) cut up the betel fruit that covered by lime powder.

irrefutably in correlation with digestive system which could be initiated by the presence of other substances which coincidentally mixed with food. This, in the case of subjects from the three sites, could be in the form of sand which was very highly likely considering the environment of the three societies which were situated in caves and seashore.

Oblique wear type was identified on 20 teeth which were investigated from all individuals of Liang Bua, Lewoleba, and Melolo. Only one of them was identified to feature natural form (Type 11), which was the left I2 of LB/6. From those 20 teeth with oblique wear, 14 of them featured cupped shaped surface. In terms of wear type, should incisors are seen as one unit of function, then, it can be indicated that they are also used for non-mastication purposes. Examined from anterior mandibular side, the mandibular incisors of individuals from Liang Bua, Lewoleba, and Melolo showed a concave shape, with the highest

level was in between the interproximal area, adjoining teeth area, of I2 and left and right sides of C, while the lowest level was situated in the interproximal of left and right sides of I1. This pattern, concave shape, was identified on subjects with both complete mandibular incisors, such as LB/3, LL I3, and Urne 3 (figure 1), along with individuals whose incisors were incomplete, only remaining three, which were LB/6 dan LL I2 (figure 2). Such pattern could be classified as a specific pattern. Molnar (15) posited that a specific wear type on teeth has a strong relationship with other possible uses of teeth as a device. In this case, teeth might have been employed to hold or pull some particular materials frequently or intensively, which led to the presence of a particular tooth wear type.

The presence of concave pattern on incisive teeth of subjects from the three sites was indicated to be correlated with cultural activities of the people, which was betel-nut chewing. Such

indication was laid on the presence of reddish-brown trace left on teeth enamel of those subjects (17). The evidence unveiled in the previous studies also suggested the fact that chewing betel-nut could lead to attrition of incisors enamel as well as the occlusal surface of the teeth (18). This cultural habit, betel-nut chewing, has been very popular in South East Asia since prehistoric era and is still put in practise up to this time by the society (19, 20). In Indonesia, such behaviour is still held especially in the eastern area of Indonesia, such as in South Sulawesi, Papua, and East Nusa Tenggara. Several ethnographic studies which were conducted in Flores Island of East Nusa Tenggara and the surrounding



Figure 5 The maxillary incisors of LB/3 performed oblique wear type.

islands, such as Sumba and Timor revealed that betel-nut chewing is a cultural practice held since ancient time (21, 22, 23).

The stages in preparing betel-nut chewing (figure 3) are indicated as the main cause in the appearance of concave pattern in the incisors of individuals from the three sites. Reviewed from its preparation process in today's society in Indonesia, such as in Flores and Papua, Areca-nut is initially cracked and peeled by the use of incisors of maxilla and mandibles (figure 4a). The inner part of cut up skin of Areca-nut (figure 4b) is then filleted using incisors, while incisors of maxilla are used as a holder. The hand that is holding the skin of Areca catecu moves towards the anterior labial so as to fillet the inner part of betel skin (figure 4c). These procedures are repeated 5 to 10 times because one betel-chewing session commonly takes 5 to 10 pieces of Areca-nut. Incisive teeth are also used to cut betel fruit which has been soaked in a plastic bag containing lime powder mainly made of shells of

molluscs or ocean reefs. Sometimes, some parts of betel fruit which are cut up by teeth are covered with such powder (figure 4d). In line with Deter's (1) explanation, lime powder, as an additional substance, which is intentionally put on betel fruit, can bring abrasive effect on occlusal surface of teeth.

The detrimental influence of betel-nut chewing preparation does not only damage mandibular incisors but also maxillary incisors. For instance, the maxillary incisors of LB/3 performed oblique wear type (distal-mesial/mesial-distal direction) (figure. 5). Molnar (15) emphasised further that the presence of oblique wear type on maxillary incisors must be owing to abnormal food mastication. In this case, oblique wear type on maxillary incisors of LB/3 appeared because of their additional uses, as a cracker, a holder, and a cutter, in dealing with Areca-nut and betel fruit. In corresponding to betel-nut chewing, high stages of occlusal wear on incisors which were found on individuals from Liang Bua, Lewoleba, and Melolo, could also be the result of a long term betel-nut chewing. Such hypothesis is supported by the result of an observation conducted lately which also suggested that, in this modern time, betel-nut chewing starts in childhood. This could be witnessed in Papua as in this land betel nut chewing is not confronted by any limitation, such as age and gender. Betel-nut chewing in Papua is further explained to have no correlation with either maturity or initiation rites. The introduction to this particular cultural activity has even been done by parents to children below five years old, which is mostly done by dripping the juice of betel-nut chewed by parents on children's oral cavity (Erlin Novita Idje Jami, Research Center for Archaeology, Papua, Indonesia, personal communication).

Other than betel-nut chewing, oblique wear type on incisors of individuals from the three sites, especially on individuals LB/1 and LL 14, was indicated to appear as a result of other uses of the teeth which were done intentionally, which belongs to the category of dental modification. This indication is laid on the shape of the flat occlusal surface upon the remaining incisors of the two individuals, which were left I1 and I2 of LB/1, and right I2 of LL 14. Examined from anterior side, the occlusal surface of the tooth tilted to mesial side (LB/1) and distal (LL14) with flat occlusal surface (figure 6). On top of that, if mirroring is done upon the incisors of LB/1 and LL14, there will be an appearance of a 'V' shape upon the occlusal surface. This shape, if found on occlusal surface, can be an evident prove which



Figure 6 Mandible of LB/1 (left) and LL I4 (right), with wear type 52 and 42 (white arrow) that indicating intentional dental modification.

is related with dental modification which was quite popular among prehistoric society of Indonesia (17, 24). To provide further enlightenment, more-focused studies with higher accuracy that employ diverse methods of analysis, such as microwear, to clarify whether the V shape on the occlusal surface of incisive teeth of individuals LB/1 and LLI4 was the result of an intentional dental modification.

Conclusion

A relatively high level, stage 5, of incisors occlusal wear was revealed from the subjects from Liang Bua, Lewoleba, and Melolo which was indicated as an influence of meat based diet which was relatively dominant. Another possible affecting factor that initiated high level of occlusal wear was the mixture of abrasive materials within the masticated food. Oblique wear type and the shape of occlusal surface which was predominated by cupped shape, as well as the concave shape of the incisives of subjects from the three sites suggested a strong relationship with cultural activities of the society, which was betel-nut chewing. The V pattern on the surface of the incisors of LB/1 and LL I4 as a whole indicated the presence of intentional dental modification.

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Table 1 Biological profile of individuals of Liang Bua, Lewoleba, and Melolo

No	Series	Dating	Sex	Age
1	LB/1	3390 ±270 BP	Male	17-25 years
2	LB/3		Male	25-35 years
3	LB/6	3830 ±120 BP	Female	17-25 years
4	LL I2	2990 ± 160 BP	Male	25-35 years
5	LL I3		Male	25-35 years
6	LL I4		Male	25-35 years
7	Urne 3	2870 ± 60 BP	Male	25-35 years

Table 2 Stages of occlusal surface wear (Stg) and wear type (Typ) of mandibular anterior teeth of individuals Liang Bua, Lewoleba, and Melolo

T	Series													
	LB/1		LB/3		LB/6		LL I2		LL I3		LL I4		Urne 3	
	Stg/Typ		Stg/Typ		Stg/Typ		Stg/Typ		Stg/Typ		Stg/Typ		Stg/Typ	
	R	L	R	L	R	L	R	L	R	L	R	L	R	L
I ₁	-	5/ 52	5/ 44	5/ 54	3/ 42	3/ 55	5/ 44	5/ 34	6/ 44	5/ 34	-	-	4/ 44	5/ 54
I ₂	-	5/ 52	5/ 44	5/ 54	-	3/ 11	-	4/ 55	5/ 34	5/ 24	5/ 42	-	3/ 44	5/ 54