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Research Report

Dental modifications: a perspective of Indonesian chronology and the current applications

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ABSTRACT

Background: *Dental modifications are one of the forms of initiation rite. Thus tradition can be found in all of Indonesian regions, even in South East Asia, in previous era. Modes and dentistry, as a culture product, including its modifications or decorations toward body and teeth have appeared in present day, such as tattoo and decorations on teeth which are taken particular model and superimpose or inculcate ornament of jewel, diamond, gold and others. The first research aim is to describe how functions of modifications on teeth represent cultural affinity and population of biologic affinity that accompany it from time to time; starting from prehistoric period to present day, especially in Indonesian region. The second aim is to submit applicable proposal that is useful for medical area, particularly in dentistry.* ***Method:*** *The research materials include teeth of the adult human skulls of Java, Balinese, and East Nusa Tenggara from some paleoanthropological–archaeological sites, as well as isolated permanent dental sample from modern Balinese population. The methods used are visual comparative descriptive method, and browsed through ethnographic and archaeological classic literatures.* ***Result:*** *Chronologically, dental modifications as reference to the pattern of migration and the domination of the culture in the past, and these facts indicate to the biological affinity and indicate to how the culture influences other culture.* ***Conclusion:*** *Some effects of the practices of dental modifications are the emergence of some diseases. Therefore, it is necessary for the agent of health and the traditional practitioner to be aware when they practice the dental modifications. Nevertheless, on the other side, based on explanations the research results, it is clear that dental modifications provide broader knowledge, because it has a very long journey of migration history, occupancy, and culture in this Indonesian Archipelago, which stretches from the period of about ten thousand years ago until now. This knowledge can be used for either practical purposes of medicine and dentistry even forensic. Thus, it is also useful in forensic identification, as guidance with cultural background such as certain patterns of dental modifications cannot be disregarded. In the same way, patterns of modifications either intentional or unintentional can give a guidance to strengthen identification.*

Key words: *Dental modifications, Indonesian chronology, medicine and dentistry applications, Australomelanesoid, Mongoloid*

ABSTRAK

Latar Belakang: *Modifikasi gigi geligi adalah salah satu bentuk ritus inisiasi. Tradisi ini dapat ditemukan di seluruh wilayah Indonesia, bahkan di Asia Tenggara pada masa lalu. Persoalan-persoalan kecantikan dan dentistri sebagai produk budaya termasuk modifikasi dan dekorasi tubuh dan gigi geligi telah muncul pada masa kini, contohnya tatto tubuh atau dekorasi gigi geligi dengan ornament hiasan dari emas, intan berlian dan juga bahan lainnya. Tujuan awal dari penelitian ini adalah untuk mendeskripsikan bagaimana fungsi modifikasi gigi geligi mewakili afinitas kultural dan afinitas biologis dari suatu populasi yang saling berkaitan dari waktu ke waktu, dimulai dari masa prasejarah hingga masa kini, terutama di wilayah Indonesia. tujuan penelitian yang kedua adalah untuk menyumbangkan pemikiran yang aplikatif yang berguna untuk bidang kesehatan terutama dentistri.* **Metode:** *Bahan penelitian adalah gigi geligi dari tengkorak dewasa Jawa, Bali dan Nusa Tenggara yang berasal dari situs-situs paleoantropologis-arkeologis, demikian pula sampel gigi geligi permanen individual dari populasi Bali saat ini/modern. Metode yang digunakan adalah deskriptif komparatif visual, dan penelusuran literatur etnografi dan arkeologi klasik.* **Hasil:** *Secara kronologis, modifikasi gigi geligi adalah rujukan bagi migrasi pada masa lalu dan dominasi budaya masa lalu. Kenyataan ini menunjukkan adanya afinitas biologis dan menunjukkan bagaimana budaya yang satu dapat mempengaruhi budaya yang lain.* **Simpulan:** *Beberapa efek dari praktek modifikasi*

gigi geligi adalah timbulnya beberapa penyakit. Oleh karena itu, hal ini sangat penting diketahui oleh praktisi kesehatan modern dan praktisi kesehatan tradisional untuk mempertimbangkan kenyataan ini dalam melakukan praktek modifikasi gigi geligi. Di sisi lain, berdasarkan hasil penelitian ini, modifikasi gigi geligi memberikan pengetahuan dan wawasan yang sangat luas, karena modifikasi gigi geligi telah lama dilakukan melalui perjalanan yang panjang dalam sejarah migrasi, penghunian dan budaya di kepulauan Indonesia, dengan rentang waktu sekitar 10.000 tahun yang lalu hingga saat ini. Pengetahuan tentang hal ini dapat digunakan untuk kepentingan studi kesehatan dan dentistry, bahkan forensik. Khususnya untuk identifikasi forensic, modifikasi gigi geligi adalah petunjuk latar belakang budaya seseorang, dimana pola tertentu modifikasi gigi geligi tidak dapat diabaikan. ***Dengan demikian, pola modifikasi gigi*** *geligi baik sengaja (intentional) maupun yang tidak disengaja (unintentional) merupakan penguat dari identifikasi individual.*

Kata kunci: *modifikasi gigi geligi, kronologi Indonesia, aplikasi untuk kedokteran dan dentistri, Australomelanesoid dan Mongoloid*

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INTRODUCTION

Dental modifications are a form of initiation rite that was once very common, and in some places and certain ethnic groups still ongoing; which the human teeth was mutilated in some way so as to form a certain patterns according to their culture.[1-5] This event symbolizes that somebody has entered his adult phase.[6] It also means that this person has entered a marriage phase. The tradition can be found in all of Indonesian regions, even in South East Asia, especially in previous period.

There are a few researches, which concern on morphology of teeth from Indonesia, especially from ancient period to present period, which has various population groups. These conditions make comparison study on dental aspects very useful. This paper will discuss about dental modifications by using prehistoric and ethnographic evidences. Dental modifications will also be related to current studies and its application for today's medicine and dentistry. In another word, chronological dental modifications can provide knowledge and benefaction for present day life, which can be used to anticipate dental problems, especially dental modifications in our future life. Modes, as a culture product, including in it's modifications or decorations toward body and teeth have appeared in present day, such as tattoo and decorations on teeth which is taken particular model and superimpose or inculcate ornament of jewel, diamond, gold and others. Tiesler[7] has shown that cultivation jadeite, hematite, pyrite, turquoise and different organic substances were used as obturation material in Mayan society (Guatemala, South America) in Classic period is an a adulthood sign of its member (that somebody has entered 15 years old age). Dentistry also as a culture product, had emerged on prehisctoric periods, according to White *et al*.[8] of his finding of a prehistoric native American mandible from a Fremont site (circa AD 1025) in Colorado; it has a conical pit in the worn occlusal surface of the lower right canine. Natural causes for this modification are ruled out by the presence of internal striae, a finding confirmed by experimental replication. The canine was artificially drilled before the individual's death and is associated with a periapical abscess. This is one of a very few examples of prehistoric dentistry in the world, and the first from the American Southwest teritory.

The first research aim is to describe how functions of modifications on teeth represent cultural affinity and population biologic affinity that accompany it from time to time; starting from prehistoric period to present day, especially in Indonesian region. The second aim is to submit applicable proposal that is useful for medical area, particularly in denstistry.

MATERIALS AND METHODS

The research materials are permanent teeth of adult skull of Java, Bali and East Nusa Tenggara prehistoric population from some paleoanthropological–archaeological sites. Some permanent isolation teeth of modern Balinese population are also used as a comparison, although it is not being presented explicitly. The anatomical identification is based on standardization of physical anthropology and anatomy. Sequence of its antiquity, chronology of settlement and culture, and its biologic affinity related to Jacob,[5,9] Sukadana[10-13] and Boedhisampoerno.[14,15] Environmental and cultural context can give a broader inference.[16] Distinction of environment and cultural practices will result in physical distinctions that manifested on its bone and teeth.[17]

The first method is visual comparative descriptive research.[17,18] These selected material are observed, classified and compared, i.e. unmodified teeth were compared with modified teeth. Then, these teeth were compared by the modification treatment patterns. At this phase, we used modified teeth of modern population which its practice still being done in Bali. Here it is needed to emphasize that paleoanthropological–archeological materials which come from prehistoric human remains is limited in quality and in quantity, which needed special treatment in handling, analyzing, and interpretating.[5,13,19,20] The second method is browsed chronologically in previous sources such as archaeological reports and the first ethnographic reports which reported about practices of dental modifications, particularly in Nusantara/ Indonesian ethnic groups.

RESULTS

Table 1 shows the summary of the patterns of dental modifications associated with antiquity, racial affinity, and sex. There are four patterns of dental modifications that are identified among prehistoric Indonesian populations, i.e. dental extracting, sharpening, filing, and blackening (Figure 2 and 3). The spread of prehistoric until recent dental modifications can be seen on Figure 1. The first can be called as evulsion, while the next two could be called as ablation.

DISCUSSION

Normally, dental modifications were done more among male than female and indicated the rite of initiation and passages, and social status. Dental extraction is practiced among the Mesolithic until Neolithic populations such as Liang Bua, Lewoleba and Melolo in Flores Island. They were Australomelanesoid but there were some degree of Mongoloid. Jacob[5] also reported patterns of dental sharpening that some dwellers of this area had modificated lateral incisor and canine in sharp-pointedly form (*the peg*

Table 1. Paterns of dental modifications among prehistoric and early historic Indonesian series

Series	Antiquity	Patterns of dental modifications				Racial affinity*	Sex
		Extracting and its position	Filing and its position**	Sharpening and position	Blackening		
Liang Bua (LB)	Mesolithic	I2 – C (R/ L)	occlusal I – C		×***	Australomelanesoid/ Mongoloid	Male
Liang X (LX)	Mesolithic		labial I – C (R/ L) occlusal I – C	labial and lingual and or median and distal I – C (R/ L)	?	Australomelnesoid/ Mongoloid	Male
Gua Alo (GA)	Mesolithic		labial I – C (R/ L)	labial and lingual and or median and distal I – C (R/ L)	?	Australomelanesoid/ Mongoloid	Male
Liang Toge (LT)	Mesolithic		labial I – C (R/ L) occlusal I – C (R/ L)	?	×	Australomelanesoid/ /Mongoloid	Male
Lewoleba (LL)	Early Neolithic	I2 – C (R/ L)	occlusal I – C		×	Australomelanesoid/ Mongoloid	Male
Melolo	Neolithic	I2 – C (R/ L)	occlusal I – C		×	Australomelanesoid/ Mongoloid	Male
Puger (PGR)	Neolithic		labial I – C (?)	labial and lingual I – C		Australomelanesoid	Male
Ntodo Leseh (NL)	Paleometalic					Mongoloid/ Australomelanesoid	
Gunung Piring (GP)	Paleometallic		occlusal I – C (R/ L)			Mongoloid/ Australomelanesoid	Male
Semawang (SMW)	Paleometallic		labial I – C (R/ L) occlusal I – C (R/ L)	labial and lingual I – C	×	Mongoloid/ Australomelanesoid	Male Female
Gilimanuk (GLM)	Paleometallic		labial I – C (R/ L) occlusal I – C (R/ L)	labial and lingual I – C		Mongoloid	
Kelor (KL)	Classic		labial I – C occlusal I – C		×	Australomelanesoid	Male
Caruban (CRB)	Classic – Islam	I – C (R/ L)			×	Mongoloid/ Australomelanesoid	Male

Notes: * = The first mentioned race is the major one.
** = R is right, and L is left.
*** = is found.

Figure 1. The spread of dental modification in Indonesia.
Note: Acronym name of the location on this map should refer to Table 1.

Figure 2. A) extracting both maxillar right and left I^2 and C and dental blackening (Mesolithic Liang Bua, Manggarai, Flores); B) labial filing both maxillar right and left I–P and dental blackening (Mesolithic Liang Toge, Ngada, Flores); and C) dental staining probably because of betel-nut chewing (Mesolithic **Liang Bua, Manggarai, Flores).**

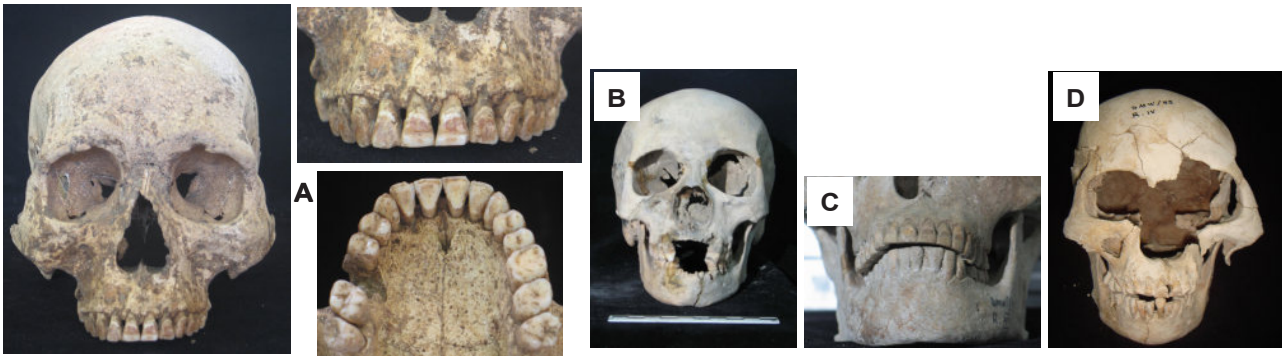

Figure 3. A) dental modifications (labial and occlusal dental filing and blackening) at Liang Toge's series; B) **dental modification** (dental extract/ evulsion and blackening) at Caruban's series; C) **occlusal filing both maxillar right and left I – P (Paleometallic** Gilimanuk, Bali); and D) dental blackening (Paleometallic Semawang, Sanur, Bali).

shaped); even this practice opened its dentin, while the others were only on its enamel. Dental filing on labial site was practiced among the populations from Liang Toge, Liang X, Gua Alo, Semawang, Puger, and Kelor. This kind of dental modification has a long of period i.e. from Mesolithic until Classic period. Dental filing on the labial probably reemerged in the later period. This evidence is reinforced by the racial affinity that was dominated by Australomelanesoid. Further, based on the observation, it is found that the most common modification was occlusal filing. This occlusal filing is even found and is still practiced to day (e.g. among the Balinese). Based on the commonness of occlusal filing and period of use that is relatively found in the sample from younger period, this indicated that occlusal filing was a new influence (culture) at that time. Related to the history of occupancy of Indonesia, this kind

of dental mutilation might be brought by the people of latest migration that so called Mongoloid. In other words, the Mongoloid people might bring the occlusal filing.

Dental blackening (dental coloring) is a primitive method of caries prevention in Southeast Asia.[21] Based on archaebotanical reports from areca nut (*Areca catechu* L.) residues those were guessed as the ingredients of betel chewing aged 13000 BP (Zumbroich, 2007/ 2008). Dentitions of 31 individuals excavated from the Bronze Age site of Nui Nap (Thanh Hoa province, Vietnam) were examined for the presence of *Areca catechu* (betel nut).[22] Many of the teeth of the Vat Komnou cemetery (dated between 200 BC and AD 400 or the early historic period in the Mekong delta, Angkor Borei, Cambodia) show evidence of betel staining.[23] Dental coloring is also found in other areas such as Polynesia and Micronesia even in Indonesian Archipelago such as Sumatra, Nias, Borneo, Celebes, Java, Madura, Bali, Flores, Timor, Papua, and other remoted islands. The coloring uses chalk, *pinang* (*Areca catechu*), *gambir* (*Uncaria gambir* Roxburgh) dan *sirih* (*Piper betle*). Papuan inhabitants made alternative several plant species i.e. *openg* (*Exocarpus latifollus*), *tawal* (*Celastraceae* sp.), *sambiwal* (*Erythroxylum ecarinatum*), *ntuo* (*Cryptocaria nitida*) and *agya* (*Endiandra montana*).[24] The mixture of *sirih pinang* with saliva generate brownish red on the teeth. To smooth all over the teeth, it is used tobacco (*Nicotiana* sp., L.) stroked all over the surface of the teeth. Once chewing *sirih pinang*, the stoke of the tobacco is done twice to five times. The intensity can leave carving on the teeth. Other variant that is found in Manggarai is using certain wood to black the teeth. Tradition of coloring teeth is still existed until nowadays as honor sign for guest and part of tradition in Manggarai.[25] Tayanin and Bratthall[26] reported that Kammu women in Laos and Vietnam habitually paint their teeth black with *Cratoxylum formosum* and *Croton cascarilloides* wood that purposed to be beautiful and caries–free, and it is now known only among the elderly although this practice existed for many generations. Suddhasthira *et al*.[27] also reported their experiment to the woods that habitually practiced in Thai people, this tradition was practiced around 5000 – 4000 years ago based on archeological remains. Nguyen[28] observed and reported the habit of applying black lacquer to teeth is widespread in Vietnam and its effect on incidence of dental caries and its usefulness in caries treatment.

Dental modification practices had been done since last thousand years in America, several parts of East Asia, Oceania, and in Africa.[18,29,30] This pattern of teeth vary broadly, but basically it has only covered 7 patterns.[18] Uhle[2] and has found 17 forms of dental modification which spread over among Indonesia ethnic groups. Lignitz[29,30] depicted widely that African ethnic groups practiced tradition of dental modification, either etnographically or biologically; Lignitz also figured in 25 dental modification patterns which were practiced. There is such an interesting explanation from Wilken[3] that areas which recognized tradition of dental modification has covered almost all Indonesia archipelago, particularly the regions which are dwelled by the tribes who have Mongoloid element; including Philippines archipelago. Von Jhering[1] previously elaborated the matter that this tradition had found in Africa, in Indonesian archipelago, and in area that has Mongoloid elements and in Indian ethnic groups in America. Finucane *et al*.[31] reported the earliest securely dated evidence for intentional dental modification in West Africa from 11 individual human remains which were excavated from the sites of Karkarichikat Nord and Karkarichikat Sud in the lower Tilemsi Valley of eastern Mali in Late Stone Age (circa 4500–4200 BP). The dental modification involved the removal of the mesial and distal angles of the incisor, as well as the mesial angles of the canines. The modifications did not result from task–specific wear or trauma, but appear instead to have been produced for aesthetic purposes. All of the filed teeth belonged to probable females, suggesting the possibility of sex–specific cultural modification. Haour and Pearson[32] reported prehistoric dental modification in the region comes from Kufan Karawa, Niger (circa AD 1300 – 1600), that the modification takes the form of interproximal grooving of the maxillary incisors resulting from task–related wear. The examples of America area has been explained above particularly are reported by White *et al*.[8] and Tiesler.[7]

Practices of dental modifications had been recognized by the end of prehistory period in Indonesia as a habit pattern. This habit has been also practiced in several areas at early agriculture period (end period of Mesolithic – early period of Neolithic). Some human remains from Gilimanuk (specimen R.XXVII and R.XXXII),[33] based on the dating of C^{14} have antiquity between 1486 – 2466 years ago and its charcoal have antiquity between 1805 – 1990 years ago, it have shown the filing at incisor, canine, and molar on its occlusal surface from maxilla and mandible. This dental modification pattern also can be found in Minahasa.[3] The teeth which were found in some caves of paleoanthropological–archaeological sites showed that these teeth had been modificated in simple manner, such as in Gua Alo and Liang X in West Manggarai (Flores Island), that is modification on dental labial surface without forming many patterns.[5] Other patterns were also reported by Jacob[5] that some dwellers of this area had modificated lateral incisor and canine in sharp-pointedly form (the peg shaped), even this practice opened its dentin, while the others were only on its enamel. These patterns can be found at the human remains of Neolithic Ban Kao from Thailand. This population had younger antiquity than the others cave dwellers in Flores island that its antiquity reach about 4000 years ago or end period of Mesolithic – early period of Neolithic, which has Australomelanesoid dominant elements. An interesting finding was also reported, it was concerned on dental modification by fracturing or repealing incisor and canine. Wilken[3] noted that this pattern represented mourning rite in Polynesia, and von Jhering[1] also mentioned that it was found in Melanesia and Australia.

Concerning to the peopling of Indonesia, some schollars concluded that those dominant elements of Indonesian population are Australomelanesoid and Mongoloid.[5,34-36] In the history of peopling of Indonesia, since early Holocene (about 10000 years ago) had been dwelled by Australomelanesoid race and it covered almost all the continent and archipelago of Southeast Asia. The relics of them can be found in Vietnam, Cambodia, Thailand, Malacca Cape, Sumatera, North Kalimantan, Java, Bali, Sumba, Flores, Lembata, Timor, Sulawesi, Palawan and Luzon, both skull, bone fragment, and teeth in caves and in cockle shell hill in ashore. Before early period of Neolithic (about 4000 years ago) migration flow of Mongoloid had shown its track sporadically, started from Southeast Asia through Malacca Cape to Sumatera and Java and through North Philippine to Sulawesi and Selayar. Polarization among its racial elements had become clearly during transition period of Neolithic to early period of Metal (about 4000–1500 years ago), in west and north sides of Nusantara (Indonesia) Mongoloid element were stronger or as a single element. While in east and south sides of Nusantara (Indonesia) Australomelanesoid element were stronger or as a single element.[5,9,35] This condition is still taking place until now, and the process of mongoloidization tends to move to east.[9,26,37–41]

Besides its function as initiation rites, dental modifications have shown as cultural affinity. Related to its tradition, these races have its manner and its treatment pattern on dental modifications; even though in fact the first represented influence of migration motion (mongoloidization) that occurred earlier in Indonesian region. Both treatments of dental modifications can be seen in several morphology of dental in Indonesia. Racial determination (representing biologic affinity) is important in Indonesian settlement history, paleoanthropology, human genetic and anthropology; because in the early period of present mongoloidization (about 15000–10000 years ago) the distribution of racial had changed gradually, this changing connected with several cultural aspects.[34] Richerson & Boyd[42] have shown that culture and human biology represent very subtle unity, and Foley & Donnelly[43] furthermore affirmed that to study its fields are needed an integrative study from various sciences, both social science and scientific science.

Dental modification traditions are well-known among ethnic groups in Indonesia archipelago.[1,3] This tradition has been conducted as a rite during human life span, generally as a symbol of maturity and in marriage rite; these traditions has been found in several areas in Indonesia. There are some evidences that dental modification also had been conducted as a mourning tradition; it was conducted when one of family member was death. These guidance can be found in Kedu, Bengkulu, Sula Archipelago, Selayar Island, and Alfuru in Minahasa.[3] Its inhabitants shall only conduct this tradition if their nuclear family member (their parents–one or both, sister or brother) have passed away; particularly in Selayar Island, a woman conducted dental modification tradition when her baby passed away (at that time or as soon as she lost her baby) and women also conducted it when her fiancée passed away. At this kind event, the tooth that was modificated is mandible's incisor. If they conduct this tradition when their nuclear family member is still alive, they believe that it will generate the death for their family. This fact has shown that there is a tight order of this tradition in that community.

At the same time, dental modifications as a mourning rite can be parallel with tradition of dental's extraction in Polynesia.[3] Extraction of two lateral incisors or canine proved that this tradition was conducted in Indonesia; these evidences can be found in several ethnic groups in Central Sulawesi (Tonapa, Tobada and Tokulabi). In these regions, adult women conducted this tradition, and in Enggano women conducted this rite when they were marriage. Wilken[3] furthermore noted that dental modification tradition represents refiner action (*een verzwakte*) than dental fracturing. The aim of this action–which is broadened by dental modification–is to sacrifice a part of human body (hair, finger, dental and so on) as a sign of mourn or has a function to refuse the danger. This opinion differs from von Jhering[1], he emphasizes at aesthetic function.

Some findings have shown treatment patterns of dental modifications from Mesolithic to Modern period, there are filing, sharpening and extracting.[40,41] The teeth are commonly modificated are incisor, canine, and first premolar. Occasionally, only incisor to canine is modificated, but sometimes its modification also has been done at first premolar. Dental filing has several variations including grinded on surface of mandibular occlusal and maxillar occlusal and labial. Recorded variation of sharpening phenomenon is to sharpen the teeth, particularly at incisor, canine, and premolar. Both dental filing and sharpening were done by attenuating and smoothing. Recording of these events have shown that filing pattern at occlusal surface is the most common to be conducted, then followed by dental sharpening and extracting. Both of these modification patterns are recorded at findings of Semawang (Sanur, Bali Island) and Caruban (Rembang, Central Java).[40] This pattern of dental modification has been found in some population in Polynesia, Melanesia, Australia, Tonabo, Tobada dan Tokulabi (the last third–place is in Central Sulawesi) as a mourn rite, and in Enggano this rite had been conducted by adult women as marriage rite.[1-3]

von Jhering[1] and Wilken[2] explained that the regions which practiced tradition of dental modifications cover almost all archipelago of Indonesia, particularly the regions which has been dwelled by ethnic groups who have Mongoloid characteristic or who had been mixed with Mongoloid. This explanation has shown the broadness of Mongoloid footstep region; it covers Southeast Asia, East Asia, Philippine Archipelago, Indonesia Archipelago, Polynesia, Melanesia, Australia, Africa, and America. Nowadays, this tradition is no longer conducted. This tradition is decreased for present generation relates to health problem and the increasing of education level.[44] Bali ethnic

still continues this tradition because of their religio–cultural reason.[45] Balinese's dental filing practice at the maxillary incisor and canine very smoothly. The practice aim is to eliminate evil character such as passion, anger, greed, covet, rebellious and drunken. In fact, although this tradition is being subsided, but occasionally as a mode, certain group or certain generation will appear this tradition once more; and the Mongoloid elements as biologic entity will continue to future generation.

Nowadays research about prehistoric human dental *Pithecanthropus erectus* (*Homo erectus*) from Sangiran area (Sragen, Central Java) has been accomplished by Arif & Kapid[46] based on fifty-two isolated teeth hominid specimens of von Koenigswald's collection. The result of study demonstrated the big size of upper third molar of the specimens from *Grenzbank*/ Sangiran (G/S) (near Sragen, Central Java) assemblage which might be affected by the incident of Carabelli's trait on their upper third molar. It is also reported that the findings of deciduous teeth (right i^1, left m_1, right m^2, and left m^2) are assumed belongs to relatively same species and same period which have been found in this area.[47]

Jacob[5] also conducts a complete research that covers space and time. Jacob examined human remains of Mesolithic–Late Neolithic period which spread out from Southeast Asia to East Nusa Tenggara; even though it was not concerned on patterns of dental modifications. Jacob[48] examined Anyar human remains' teeth, and concluded that this human antiquity is Neolithic and its dominant element is Australomelanesoid. Jacob[4] concluded that the Glimanuk population has Mongoloid element based on its teeth. Boedhisampurno[18] has examined the findings of human teeth from the Ulu Leang cave cemetery that refers early period of Metal Age (Maros, South Sulawesi) which has older antiquity than Gilimanuk and has Mongoloid element. Sukadana[10,12,14] has examined the findings of human teeth of Mesolithic Liang Bua (Flores Island), Neolithic Lewoleba (Lembata Island), Neolithic Melolo (Sumba Island) and Neolithic Ntodo Leseh (Komodo Island) in East Nusa Tenggara. He has concluded that inhabitants of this region have older antiquity with stronger Australomelanesoid element and so does with the inhabitants of region that passes further Wallacea line (more to the east of this region). On the contrary, more to west their regions have shown that Mongoloid element start to present and have younger antiquity. Some research has been done increasingly strengthen the argument of this research.[5,10,34,37–41]

Patterns of dental modifications related to its biologic affinity that had been tried to examine based on human remain findings from a period around 4000 years ago to present day. Koesbardiati and Suriyanto[40] have reported that dental filing represents the most common of findings which have Mongoloid element, particularly from later period (Neolithic – Paleometallic). This fact indicates that there is much more Mongoloid influence to Indonesia. In other words, Mongoloid migration from Southeast Asia mainland entered more intensively into Nusantara Archipelago (Indonesia). Moreover, Koesbardiati and Suriyanto[41] also have reported that dental sharpening and extracting represents older or early tradition, this findings are supported by evidence from Late Mesolithic – Neolithic (around 4000–3000 years ago). The last pattern is a tradition that is still practiced in ethnic groups in regions of eastern Indonesia, Polynesia, Melanesia, and Australia that have dominant Australomelanesoid element. Much more specific for Flores Island and the satellite islands, in a period around 5000–3000 years ago, represented two patterns of dental modification. This can be used as an indicator to determine whether Flores inhabitants originated from northern or southern culture.

Some dental studies and its modification have also been conducted toward modern population in Indonesia. Lie[44] surveyed Javan regions (Malang, Sidoarjo, Surabaya, Jogjakarta, Pacitan, Tangerang, Blitar, Tengger and Banyuwangi), Madura, Bali, Sumba, Flores, Adonara and Lomblen (Lembata). Research questions of this research that were exploitated are why dental modifications were conducted; when dental modifications were done; were the modification conducted before or after marriage; who were conducted dental modifications; what appliances were used; in what manner the dental sharpened and how long its process; how much it costs; where are the place to conduct dental modifications; which teeth will be modificated; there are a ceremony and abstention in conducting this tradition or not; and how long its pain after being modificated. There are some reasons of conducting dental modifications, for example aesthetic, initiation rite, sosiologic and sacrifice (belief, religion). Some arguments are also figured in, that research of dental modification is useful for anthropological research (both cultural and physical anthropology), particularly to determine spreading, movement and influence of anthropological groups in Indonesia, either in present day or previous period. Moreover, there are assumptions that dental modifications have positive elements in preserving the teeth.

The human remains and paleopathologic examination of ancient is useful for archaeologists, anthropologists and physicians (medicine, dentistry).[49,50] The techniques can also be applied to any desiccated tissues, including recent remains, as in forensic settings. That is clear that human remains from previous period along with its aspects, its life history to refind, the methods to gain and to identify and the degree of its extrapolation contribute to knowledge and to applied science for present day life, particularly related to medical aspects. Realizing that there are various ethnic and culture in Indonesia and abandon of fossil finding in Indonesia from the early period until present, Soedomo[51] suggested, it is important for the dentist to learn about dental evolution and variation, especially in Indonesian region.

Mentawainese has a habit to mutilate their anterior tooth (*sipiat sot* or *mapiat sot*). According to them, the main reason in dental mutilating is for identity Mentawai. They feel that they are not Mentawai ethnic member if

they do not mutilate their anterior dental. Anterior dental mutilation of Mentawai can be seen from sharpening form of their maxillary and mandibulary teeth. Besides as an ethnic identity, this is also meant to beauty purpose, style, and mastication so that they could bite as a wild animal. Koerniati's research[52] was found that relatively falls out at older age at cases of anterior dental mutilation, whereas falls out at younger age at cases of anterior unmutilation. This research also found a significant correlation between anterior mutilation and posterior attrition. In consequence of anterior mutilation, hence the burden of mastication activity has moved to posterior, thus part of posterior has a heavier burden, and it has caused the occurrence of posterior dental attrition. Here posterior dental attrition has caused food mastication process disorder; therefore, this food is not masticated properly so that causes problems toward disgestion.[52]

Cultural action that is influenced by cultural system can give guidance of disease and to find the possibility of disease causes that occurred on teeth and other aspect of health including periodontitis, antemortem tooth loss, mouth cancer, hypertension, diabetes, chronic kidney diseases, increasing the cardiovascular diseases, metabolism disorder and schizophrenia. Hour and Pearson[32] found the indication of tooth usage as a tool; and they mentioned it as"the third hand." Anterior dental is used to twist ropes that come from animal or plant. Because of this activity, a gap beetween anterior tooth sometimes has unequal form because of different pressure of twist. If this activity is repeated, it will strengthen anterior dental abrasion so that it will form a gap beetwen two anterior teeth. Some recheacher assumed that dental mutilations could cause alveolar bone pathology.[53] In Africa, the most common type of dental mutilation is inverted V-shaped. The effects of this dental mutilation in Africa are pulp exposure and periapical ostitis or radicular cysts. The most common effect is general loss of alveolar bone with a marked loss of the maxillary anterior labial alveolar bone plate.

Coloring teeth can be caused by betel–nut chewing activities. Betel nut chewing consists of betel leaves, areca nut (*Areca catechu*), burned coral or shell and or tobacco for wiping the saliva at the end of the proses of betel nut chewing. The effect is the saliva will be red–brownish, and will be permanent on the teeth. The medical effects are dental pathologies such as periodontitis, antemortem tooth loss, mouth cancer, hypertention, diabetes, chronic kidney diseases, increasing the cardiovascular diseases, metabolism disorder and in all-cause mortality.[54] Betel nut chewing activities brings to skizophrenia in Palau.[55]

Another important application of dental modifications for forensic study is tracing ethnic affiliation, especially for the countries that their inhabitants practice dental modifications, for example Indonesia, and African, American, Oceania, Southeast, and East Asian countries. Paleodontological research has proven that some form of cosmetic dentistry existed in ancient times.[56] Intentional dental mutilations, dental decorations and modifications on anterior teeth have been widespread occurrences in many cultures. The fact that there are various names for these phenomena indicates different interpretations of data gained from research into this type of intervention into human dentition. Although archaeological specimens of modified teeth are usually isolated and damaged, they broaden our knowledge of ancient nations and human behavior in the past. These behaviors in some places continuing as a tradition, and its importance is that it can assist the efforts of forensic identification i.e., what their cultural and race background.

As mentioned above, some effects of the practices of dental modifications are the emergence of some diseases. Therefore, it is necessary for the agent of health and the traditional practitioner to be aware when they practice the dental modifications. Nevertheless, on the other side, based on explanations above, it is clear that research on dental modifications provide broader knowledge because it has a very long journey of migration history, occupancy, and culture in this Indonesian Archipelago, which stretches from the period of about ten thousand years ago until now. This knowledge can be used for either practical purposes of medicine and dentistry even forensic. Thus, it is also useful in forensic identification, as guidance with cultural background such as certain patterns of dental modifications cannot be disregarded. In the same way, patterns of modifications either intentional or unintentional can give a guidance to strengthen identification.

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