Chapter 23

Oral Health From Dental Paleopathology

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Additional information is available at the end of the chapter

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1. Introduction

Since when have humans been afflicted with dental diseases? It is not easy to find an answer to this question. There are two main methods to examine what types of disease our ancestors suffered. One method involves the history of medicine or a study called "medical history," which mainly examines pathologies written in ancient documents and ancient writings and attempts to identify the diseases. Michinaga Fujiwara was a powerful individual in the Heian period of Japan (794-1192 AD) [1]. He was speculated to have died of complications of diabetes based on the records of his pathology in the literature. This type of finding is the result of research in the history of medicine (a study of medical history). The other method involves a field of study in physical anthropology called "paleopathology," in which the author of this paper specializes. In paleopathology, the research materials are hard tissues such as bones and teeth from humans of ancient times and obtained from archeological excavations (needless to say, the soft tissues have long decomposed and returned to soil). Thus, it is possible to learn about the frequency of certain diseases in the past in groups of people and about the true pathology at the time of death. In this paper, a few dental diseases were interpreted from the perspective of an anthropologist who handles ancient human skeletal remains. These diseases can be indicators of modern oral health.

2. Two major diseases in the oral cavity are caries and periodontal disease

This statement is believed to have been true since the ancient times. In a previous study, the author of this paper described that, before the introduction of modern dentistry, people were more affected by caries and periodontal disease, the main cause of tooth loss, because they were unable to receive scientific dental care. Modern humans can obtain nutrients parenterally and via gastrostomy with the advancement of modern medicine. For the majority of human history, the mouth was the only means through which people have taken in nutrients. Therefore, tooth loss was speculated to have caused malnutrition and even death in many pre-modern individuals with numerous missing teeth. In the pre-modern times, longevity was likely dependent on the preservation of one's own teeth to obtain sufficient nutrients.

2.1. Tooth loss in human skeletal remains of Japan

Trinkaus reported on the problem of tooth loss in the La Chapelle-aux-Saints Neanderthal from approximately 60,000 years ago, the most ancient material that has been examined for this purpose [2]. He reported that 51.7% of the teeth were missing antemortem in this Neanderthal. In another study, Trinkaus also reported that 25% of the teeth were missing in the Shanidar Neanderthals [3]. It is difficult to obtain a large sample size of ancient human fossils, and consequently adequate statistical analysis cannot be performed due to small sample size. Therefore, the information from these ancient human fossils is merely for reference.

There are some case reports worldwide on tooth loss in Homo sapiens [4-8], but the number of studies on ancient human skeletal remains is not large. These researchers, except the author of this paper, used all examined individuals as materials. Thus, a bias likely occurred regarding the types of teeth, which were sometimes located in areas of defects in ancient human skeletal remains. The author of this paper examined remaining teeth in ancient human skeletal remains excavated from archeological sites of the pre-modern periods in Japan: the Kofun period (3rd–early7th century), Kamakura period (1192–1333 AD), Muromachi period (1335–1573 AD), and Edo period (1603–1868 AD). A total of 329 individuals were examined, of whom 145 individuals were selected as materials because their sex was determinable and their maxillary and mandibular alveolar bones were fully examinable (Table 1). This material selection method enabled data collection without bias for all tooth types. The estimation of age and determination of sex were performed by morphological observations of anthropological bones. Since the number of materials was not large, the individuals of different sexes were pooled together. The individuals were divided into three groups: early middle age group (approximately 20-39 years), late middle age group (approximately 40-49 years), and old age group (50 years or older).

In this study, the ancient human skeletal remains used as materials were grouped by time period and by age group. Table 1 shows the number of individuals and the number of examinable teeth. In all time periods as shown in Table 2, there was a tendency for the number of missing teeth to increase with age, progressing from early middle age to late middle age to old age. In the Kofun period, the mean number of missing teeth was 2.67 (SD: 1.63) in early middle age, 6.00 (SD: 2.00) in late middle age, and 16.00 in old age. In the Kamakura period, the mean number was 1.17 (SD: 1.47), 2.22 (SD: 2.10), and 4.50 (SD: 2.12), respectively. In the Muromachi period, the mean number was 1.80 (SD: 0.84), 5.80 (SD: 4.55), and 21.00, respectively. In the Edo period, the mean number was 2.31 (SD: 2.58), 5.18 (SD: 4.57), and 29.67 (SD: 4.04), respectively. Table 3 shows whether there is a difference in the number of missing teeth by age group after combining all the materials of different time periods. The results revealed that the number of missing teeth differed significantly ($p<0.01$) between the early middle age and late middle age groups and between the late middle age and old age groups, statistically indicating increasing tooth loss with age in pre-modern Japanese people. Table 4 shows the number of missing teeth in the maxilla and mandible. The number of missing teeth is shown by time period and by age group, but there were many time periods without a sufficient number of materials. Therefore, the lower portion of the table shows the number of maxillary missing teeth and the number of mandibular missing teeth of all time periods. A significance test was used to determine the difference in the number of missing teeth between the maxilla and mandible, and there was no significant difference between the jaws in any age group. Figures 1 and 2 show the percentages of missing teeth of all tooth types in the maxilla and mandible, respectively. In general, the percentage of missing teeth tended to be lower in the anterior teeth and the percentage tended to be higher in the posterior teeth.

Period	Group	Number of individuals	Number of Observed teeth[a]
Kofun	Early middle age	6	192
	Late middle age	7	224
	Old age	1	32
Kamakura	Early middle age	18	576
	Late middle age	18	576
	Old age	2	64
Muromchi	Early middle age	5	160
	Late middle age	5	160
	Old age	1	32
Edo	Early middle age	45	1440
	Larly middle age	34	1088
	Old age	3	96
Total		145	4640

[a]The number of observed teeth includes ante-mortem tooth loss and post-mortem tooth loss.

Table 1. The archaeological materials used from Kofun, Kamakura, Muromachi and Edo periods in Japan.

Period	Group	Lost teeth	Observed teeth	Average of number of ante-mortem teeth per person	SD
Kofun	Early middle age	16	192	2.67	1.63
	Late middle age	42	224	6.00	2.00
	Old age	16	32	16.00	-
Kamakura	Early middle age	21	576	1.17	1.47
	Late middle age	40	576	2.22	2.10
	Old age	9	64	4.50	2.12

Period	Group	Lost teeth	Observed teeth	Average of number of ante-mortem teeth per person	SD
Muromachi	Early middle age	9	160	1.80	0.84
	Late middle age	29	160	5.80	4.55
	Old age	21	32	21.00	-
Edo[a]	Early middle age	104	1440	2.31	2.58
	Late middle age	176	1088	5.18	4.57
	Old age	89	96	29.67	4.04

[a]Data were cited from Fujita[18].

Table 2. The number of ante-mortem tooth loss by age distribution.

	Significant
Early middle age-Late middle age	***
Late middleage-Old age	***

***: *P* <0.001

Table 3. Comparison of number of missing teeth by age distribution.

	Tooth type						
	Upper			Lower			
Early middle age	URM1	ULM1	Total	LRM1	LLM1	Total	Grand total
Observed	36	34	70	31	31	61	131
Average	3.13	3.24	3.19	2.16	2.27	2.23	2.74
SD	0.99	1.05	1.01	0.9	0.87	0.86	1.06
Early middle age vs Late middle age	P=0.165 ns	P=0.104 ns	P<0.05 L>E	P<0.05 L>E	P=0.218 ns	P<0.01 L>E	P<0.05 L>E
Late middle age	URM1	ULM1	Total	LRM1	LLM1	Total	Grand total
Observed	11	9	20	8	7	15	35
Average	3.91	3.89	3.9	3.13	2.71	2.93	3.49
SD	1.64	1.05	1.37	1.25	0.76	1.03	1.31

ns: not significance

E: Early middle age; L: Late middle age

Table 4. Alveoler resession of Somali people in Early middle age and Late middle age.

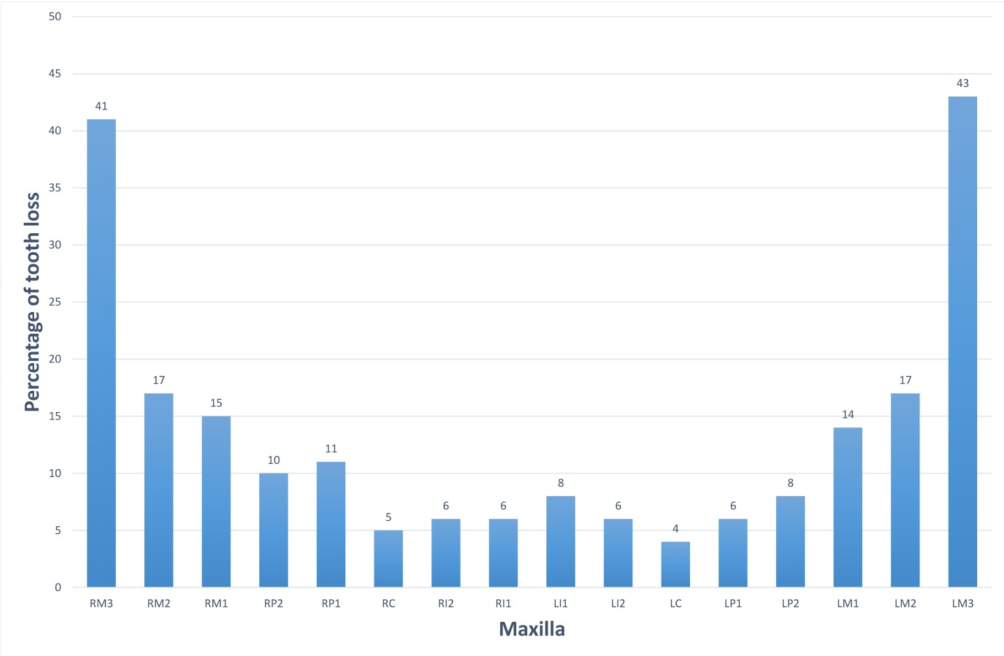

Figure 1. The rate of loss by tooth type in Maxilla in pre-modern periods in Japan.

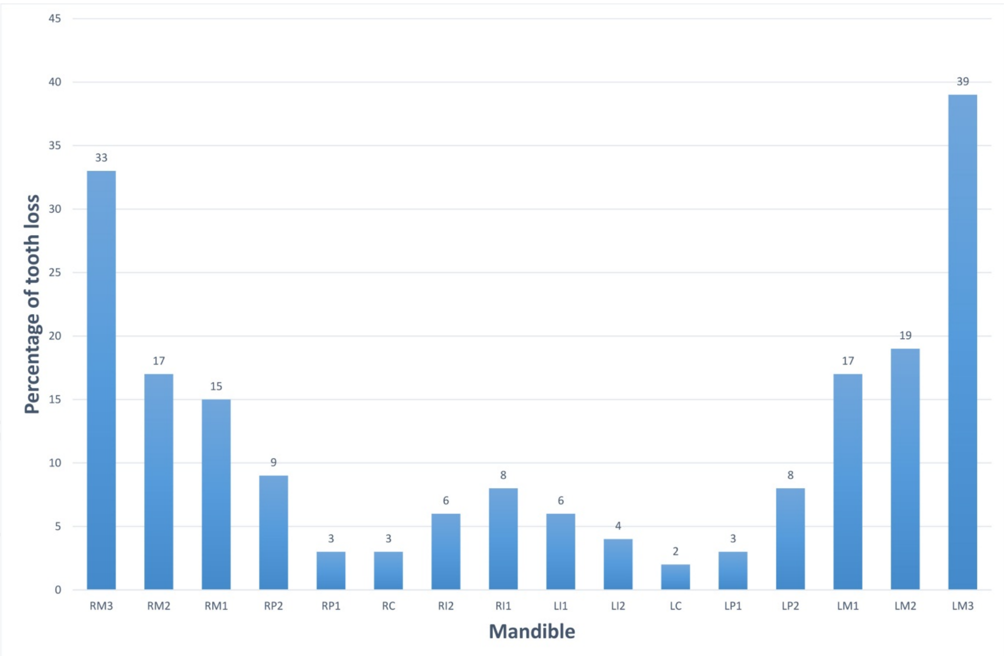

Figure 2. The rate of loss by tooth type in mandible in pre-modern periods in Japan.

In the early and late middle age individuals, the low number of missing teeth had been maintained at 1.11 to 6.00 teeth from the Kofun period to Edo period, spanning 1500 years. This result might be very surprising for health care providers as well as for the general public. The assumption is that people in olden times lost many teeth at an early age, but it is not consistent with the results of this study. At least to late middle age, the number of missing teeth was lower in pre-modern times than in modern time. Lopez *et al.* made a similar finding in a study comparing people of the Mediaeval Ages and modern people in Spain [5]. Sikanjic also made a similar finding in the number of missing teeth in human skeletal remains from the Iron Age in Croatia [6]. Diet and ingredients used in meals (i.e., nutrients) are expected to differ by country. Although it is difficult to generalize, modern people can receive scientific dental care, and tooth extraction can be performed easily and frequently. One cannot say that the dental treatment of tooth extraction was non-existent in the pre-modern times. However, it was likely not performed frequently, and the general public in those times were not as familiar with medical care as the general public of modern time [9].

The average lifespan of Japanese people is estimated to have been less than 15 years in the Jomon period and approximately 20 years in the Edo period [10]. The high mortality rates of infants and young children greatly decreased the average lifespan of the overall population. In these time periods, many adults also lost their lives due to various infections and parasitic diseases. Until the Edo period, Japanese people had a simple and plain diet, except for a small segment of the upper class. Such a diet did not contain much animal protein or fat. Diet in Japanese people began to change due to the introduction of more "American" foods, mainly with the post-war American occupation. Japanese people gradually began to consume more animal protein and fat. It is clearly consistent with the high correlation between increased average lifespan in Japanese people and increased consumption of animal protein and fat (Figures 3 and 4). Japan is currently a country with the longest lifespan in the world. This fact seems to suggest that there is a good balance of the two types of diet, a simple Japanese diet, mainly of vegetables and grains, and a Western-style diet.

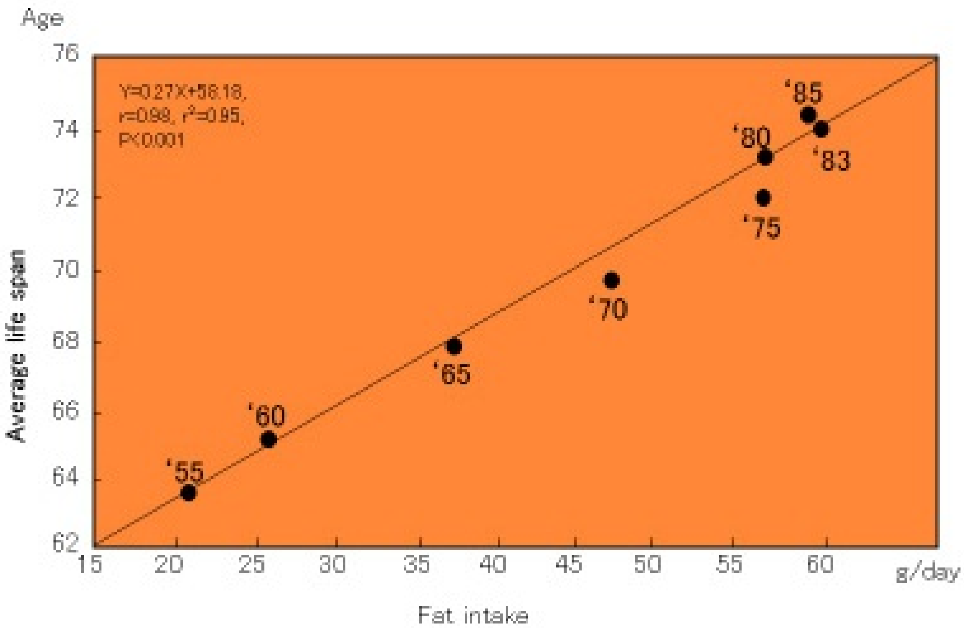

Figure 3. Relation between fat intake and Japanese life span

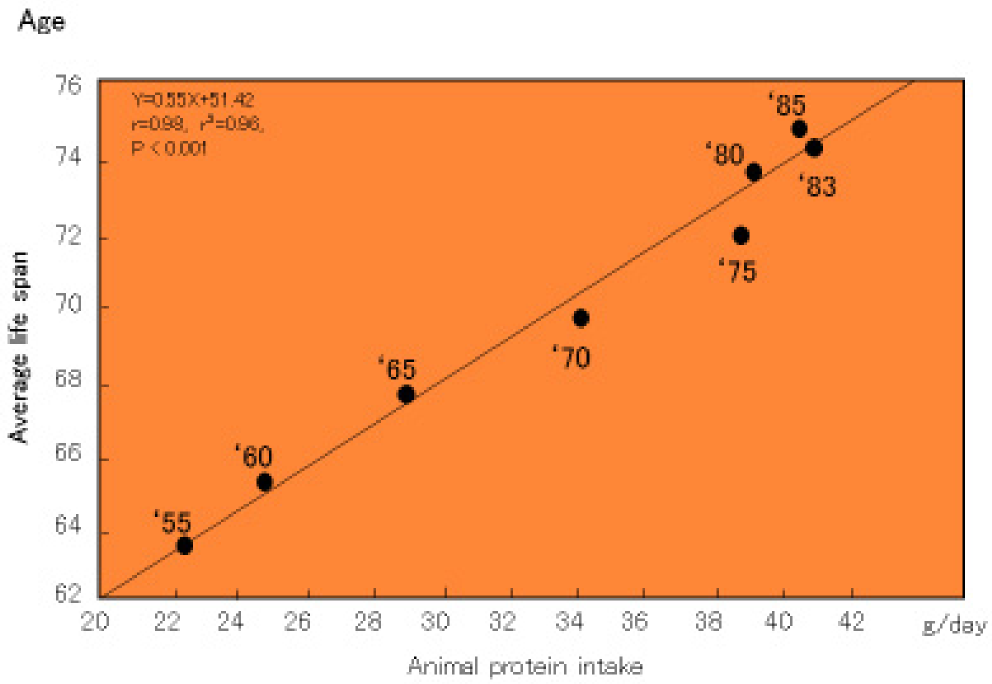

Figure 4. Relation between the animal protein intake and Japanese life span

Intravenous infusion was first introduced to Japan around 1960, and non-parenteral nutrition via gastrostomy was introduced much more recently. There are many restrictions and limitations when using these methods. In the time periods with only pre-modern medical care, the preservation of one's teeth was the only available way for people to get nutrients effectively. Thus, when people lost many of their teeth, they likely faced early death.

2.2. Tooth loss in ancient human skeletal remains from countries other than Japan

How was tooth loss in ancient human skeletal remains from other countries? The status of missing teeth was examined in human skeletal remains of the 3rd-7th centuries from the Yean-ri site in South Korea [11]. There were 2.7 missing teeth in the early middle age individuals and 8 missing teeth in the late middle age individuals, which are not large numbers. The status of missing teeth was also examined in modern Nigerian individuals who lived in the early 20th century and whose skeletal remains are stored at the University of Cambridge [12]. There were 1.3 missing teeth in the early middle age individuals and 3.3 missing teeth in the late middle age individuals, indicating very low numbers. No caries was observed in the examination of a total of 15 Nigerian individuals and 272 teeth. Similarly, when tooth loss was examined in Somali individuals living in the late 19th century to the early 20th century, AMTL was 2.60% in individuals in early middle age [13]. This percentage is a very low value, indicating the loss of at the most 1 tooth out of 32 teeth. In individuals in late middle age, AMTL was 17.02%, which is an approximate loss of 5.4 teeth. Thus, the number of missing teeth clearly increased with aging. There was a significant increase in alveolar bone loss with aging as shown in Table 4, while there was no change in caries rate with aging as shown in Table 5. It is speculated from these results that tooth loss in Somalis was due to periodontal disease and not caries. Although it is difficult to speculate on the details of their diet, they were believed to have had a low intake of simple sugars and carbohydrates. Thus, the diet of Somalis likely consisted of low cariogenic food. The Somali skeletal remains showed that they had periodontal disease from their early middle age. The disease progressed with age and caused alveolar bone loss, eventually leading to bone that could not support the teeth and consequently to tooth loss. The author observed an unexpectedly large number of remaining teeth in the late middle age individuals, much like in the Edo individuals in Japan. It indicated that Somali individuals also had low numbers of missing teeth.

	Tooth type										
	Upper					Lower					
Early middle age	I	C	P	M	Total	I	C	P	M	Total	Grand total
Observed	168	84	170	252	674	130	65	130	195	520	1194
Loss	9	3	1	8	21	0	0	3	7	10	31
SD	0.23	0.19	0.08	0.18	0.17	—	—	0.15	0.19	0.14	0.16
% AMTL	5.36	3.57	0.59	3.17	3.12	0	0	2.31	3.59	1.92	2.60
Early middle age vs Late middle age	P=0.135 ns	P=0.333 ns	P<0.01 L>E	P<0.001 L>E	P<0.001 L>E	P<0.001 L>E	P<0.05 L>E	P=0.051 ns	P<0.001 L>E	P<0.001 L>E	P<0.001 L>E
Late middle age	I	C	P	M	Total	I	C	P	M	Total	Grand total
Observed	52	26	52	78	208	44	22	43	65	174	382
Loss	7	3	5	18	33	6	3	5	18	32	65
SD	0.32	0.33	0.3	0.42	0.37	0.35	0.35	0.32	0.45	0.39	0.38
% AMTL	13.46	11.54	9.62	23.08	15.87	13.64	13.64	11.63	27.69	18.39	17.02

I: Incisors; C: Canines; P: Premolars; M: Molars in tooth type distribution.

ns: not significant

E: Early middle age; L: Late middle age

Table 5. Antemortem tooth loos (AMTL) of Somali people in Early middle age and Late middle age.

The lifespan remains short in developing countries of the 21st century. Similar types and proportions of disease are thought to have been maintained in modern populations (likely even in present-day populations) as in the populations of 1000-2000 years ago. It is speculated that missing teeth of populations of 1000-2000 years ago were maintained at very low numbers until late middle age despite the presence of periodontal disease, much like ancient human skeletal remains from Japan.

Early middle age				Late middle age				P-value
Tooth type	**Observed**	**Caries**	**% Caries**	**Tooth type**	**Observed**	**Caries**	**% Caries**	
UI	168	0	0	UI	52	0	0	-
UC	84	0	0	UC	26	0	0	-
UP	170	0	0	UP	52	1	1.92	P=0.537
UM	252	6	2.38	UM	78	0	0	P=0.384
U-total	674	6	0.89	U-total	208	1	0.48	P=0.896
LI	130	0	0	LI	44	0	0	-
LC	65	0	0	LC	22	0	0	-
LP	130	0	0	LP	43	0	0	-
LM	195	4	2.05	LM	65	2	3.08	P=0.991
L-total	520	4	0.77	L-total	174	2	1.15	P=0.994
Grand Total	1194	10	0.84	Grand Total	382	3	0.79	P=0.820

Table 6. Prevalence of dental caries of Somali people in Early middle age and Late middle age.

3. Stress markers and enamel hypoplasia

Stress in modern-day people signifies mainly "psychological stress" in the majority of cases. In ancient skeletal human remains, the focus is on the examination of signs of "physical stress" remaining in bones and teeth as a result of surviving in a very harsh environment. It is desirable to examine the level of such stress not in one or a few individuals but in a group, if possible in at least a few dozen to a few hundred individuals. Otherwise, the stress level in a certain group and differences in stress level among groups cannot be known.

Stress marker might not be a commonly used term. It is a lesion that is used to compare the level of health particularly among groups such as mentioned above. Stress markers on teeth are not very common. Enamel hypoplasia is one such marker and will be discussed below pertaining to ancient human skeletal remains.

Teeth are formed relatively early and enamel matrix is formed at approximately the sixth week of gestation for primary teeth. Enamel matrix formation begins early even for permanent teeth. For example, it begins to form at birth for permanent first molars. Enamel hypoplasia occurs when there is poor enamel formation at such stages. The cause is hypocalcemia due to conditions such as starvation and impaired food intake due to serious disease [14].

Enamel hypoplasia is a useful stress marker because: (1) it is a lesion which is found relatively frequently in ancient human skeletal remains, and (2) it is a lesion that occurs due to environmental factors such as those affecting the nutritional status. Briefly explained, the ancient human skeletal remains that we encounter represent one individual in a few thousands or a few tens of thousands of individuals who lived in the past from a certain time period. They represent a very fortunate discovery and are very important representatives. Therefore, if a disease occurred only in one in a few tens or hundreds of thousands, finding this disease in the excavated remains is greatly affected by chance. Therefore, such disease is not suitable for examining the stress level in a group or comparing the stress level with other groups.

As shown in Figure 5, enamel hypoplasia often appears linearly on the enamel surface. The crowns of healthy teeth should be smooth, but aplasia occurs in depressions of the crowns of teeth with enamel hypoplasia.

Figure 5. Linear enamel hypoplasia found in Jomon people of Japan

Although there are individual differences, the timing of crown formation by tooth type is roughly the same among individuals. Therefore, when enamel hypoplasia is seen in a certain site of a certain tooth, one can estimate the age at which the enamel hypoplasia occurred. If several lines can be seen in an individual (Figure 5), it can be speculated that this individual experienced multiple bouts of starvation or malnutrition due to serious disease. Some

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individuals have linear enamel hypoplasia of the entire dentition as in Figure 6. It shows that the individual was exposed to stress causing enamel hypoplasia during crown formation of different tooth types [14]. Therefore, this case is very important as such evidence.

Figure 6. Linear enamel hypoplasia found some tooth type in Jomon people of Japan

When does enamel hypoplasia occur? There have been several studies on this topic, including one by Yamamoto, who examined ancient human skeletal remains of Japanese individuals [15]. According to the study of Yamamoto, enamel hypoplasia occurs repeatedly between 3.5-5.5 years of age in the majority of the cases and very rarely occurs at ages younger than 3 years. Yamamoto gave as reasons for the onset: such stress was likely fatal in individuals at ages younger than 3 years in a pre-modern environment, and even if individuals survived the stress, they could not have tolerated subsequent stress and would have died before the eruption of permanent teeth. In contrast, enamel hypoplasia in modern-day individuals occurs repeatedly at 0-12 months after birth but rarely beyond 34 months [15]. That is, it occurs repeatedly early after birth but rapidly decreases thereafter. Thus, the ancient skeletal remains indicate that timing of hypoplasia differed between ancient people and modern-day people. It is speculated that improved health status, including due to medical advancement, helps modern-day individuals face conditions recorded in crowns as enamel hypoplasia without causing death.

The above findings show that it was very difficult for very young children, particularly infants, to survive in pre-modern times during which bouts of starvation were common and medical care was not advanced. This tendency was likely stronger in more ancient times, and countless young lives must have been lost before these individuals were able to leave any signs of enamel hypoplasia.

Stress markers develop on bones and teeth when individuals continue to survive under a poor environment. If individuals die in a short period of time due to disease or malnutrition, then there will be no stress marker on bones or teeth. For example, when individuals die of acute infections, including dysentery and influenza, it is very difficult to find signs of such infections in excavated bones and teeth. If individuals had chronic diseases such as advanced tuberculosis, leprosy, and syphilis of the bone for a few years to decades, then signs of such diseases will remain in their bones.

The frequency of enamel hypoplasia was 48.1% in the Jomon population, 36.4% in the Kofun population, approximately 60% in the Edo population, and 39.5% in the present-day population of Japan [15]. These numbers seem to indicate that the environment in the Jomon period was better than that in the Edo period. However, these numbers can be explained in another way. When Jomon people suffered various diseases or malnutrition, they likely did not recover and died a short time later. Therefore, they probably did not live long enough to develop enamel hypoplasia, resulting in a lower frequency of enamel hypoplasia in the Jomon period. Edo people also likely lived in a much harsher environment than present-day people. However, medical care and nutritional conditions were improved in the Edo period compared with those in the Jomon period. Therefore, Edo people with various diseases and malnutrition likely had higher chances of survival than Jomon people with such conditions. As a result, signs of enamel hypoplasia remain in individuals from the Edo period. Present-day people can have high-quality medical care and nutrition readily and sufficiently, and the infant mortality rate has consequently decreased. Thus, only a modest frequency of enamel hypoplasia is seen. Therefore, in this type of a situation, one should conclude that a group with a low frequency of stress markers had a worse environment and that a group with a high frequency had a better environment. This phenomenon is called a "paleopathological paradox." One needs to be mindful of this paradox when examining nutritional conditions, health status, and the difference in frequency of disease among groups or time periods.

What are the frequencies of enamel hypoplasia in various countries? When the frequency of enamel hypoplasia was examined in former inhabitants of what is now the State of Illinois in the U.S., it was 45% in the excavated individuals from the hunting and gathering period, 60% in the excavated individuals from the transition to the agricultural period, and a high frequency of 80% in the excavated individuals from the agricultural period [16]. Similarly, when the frequency was examined in former inhabitants of what is now Ohio, it was higher in the excavated individuals from the agricultural period than those from the hunting and gathering period [17, 18]. These findings indicate that poor harvests more greatly affected people in an agricultural society than frequent food shortages affected people in a hunting and gathering society. In addition, the agricultural people who lived in these areas had a diet which depended heavily on corn. Such a diet resulted in increased caloric intake and nutritional quantity but decreased animal protein intake and nutritional quality. Weaning diets were deficient in protein, and nutritional stress occurred such as diarrhea due to bacterial infection. Some researchers interpret the high frequency of enamel hypoplasia as a result of increased population density in the agricultural period, leading to a higher risk for infection and increased environmental stress such as outbreaks of endemic diseases [19, 20].

The author of this paper is not in agreement with the above explanations. There is no evidence that a hunter-gatherer economy enabled people to maintain necessary and sufficient proteins. There is also no evidence that people in an agricultural economy had repeated poor harvests and had lower animal protein intake than people in a hunter-gatherer economy. The term "hunters and gatherers" gives the image of hunting. However, it is speculated that people in a hunter-gatherer economy did not necessary have sufficient animal-derived foods, and the majority of their diet consisted of plant-derived foods. Even natural-born hunters like lions have very low hunting success rates. Therefore, it is valid opinion that hunters and gatherers must have had great difficulties maintaining a constant intake of animal protein even with human intelligence and use of tools. The diet of an agricultural economy could not have consisted entirely of plant-derived foods. Instead, it is speculated that hunting must have continued, and its techniques must have evolved from previous time periods to the agricultural period. Therefore, people must have continued to consume animal-derived foods in the agricultural period.

Even when societies transitioned from a hunting-gathering type to an agricultural type, it is very unlikely that the consumption of animal protein decreased sharply. Instead, the aforementioned enamel hypoplasia frequencies should be interpreted in the following ways: the types of people who were unable to survive in a hunter-gatherer society were more likely to survive in an agricultural society, and the average lifespan, an index of cumulative stress, increased.

4. TMD in human skeletal remains from the Edo period in Japan

Prolonged retention of primary teeth rarely poses clinical problems in modern people if these teeth are extracted and the eruptive paths of permanent teeth are normalized. A report in a Japanese journal has shown that when primary teeth were retained beyond the normal period, their extraction resulted in gradual improvement of TMD and in normal occlusion. In the field of physical anthropology, very few report has been published that simultaneously discussed prolonged retention of primary teeth, temporomandibular joint (TMJ) arthritis, and TMD [21]. The material discussed in this section was skeletal human remains from the Edo period (17-19th centuries) in Japan. The mandible showed signs of TMJ arthritis and TMD likely due to bilateral primary second molars. The skeletal remains were excavated from the Suhgen temple site in Shinjuku-ku in Tokyo and were of a woman in the early part of early middle age. Retention of primary molars was observed in the left and right mandible (Figure 7). Since first premolars were present anterior to them, the over-retained primary teeth were both believed to be primary second molars. Radiographs showed no formation of left or right second premolars, confirming that they were missing congenitally (Figures 8a and 8b). It was speculated that bilateral primary second molars remained in adulthood because second premolars were missing congenitally. Other permanent mandibular teeth, including the third molars, were erupted bilaterally, and it is consistent with the individual being in the early part of early middle age. Bilateral primary molars had more severe occlusal attrition of the distal area than on the mesial area, and dentin was markedly exposed. The occlusal attrition of the mesial area was confined to near the proximal aspect adjacent to the first premolar.

Figure 7. Persistence of both sides of second deciduous molars.

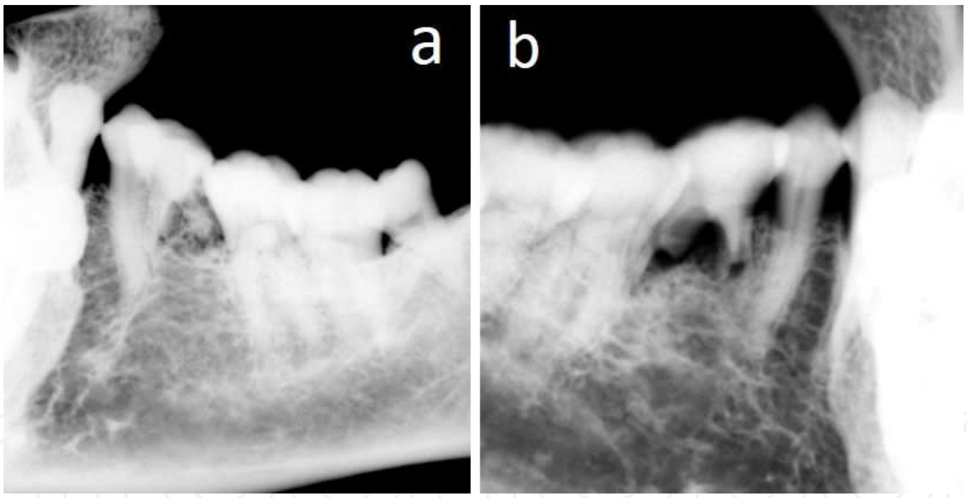

Figure 8. The lack of permanent second premolars are admitted in the roentgenograms. a: right side, b: left side, respectively. a: right mandibular condyle is normal. b: left mandibular condyle has caused the deformity by TMJ arthritis.

The right mandibular condyle was normal, but TMJ arthritis had developed in the left mandibular condyle with overall deformation (Figures 9a and 9b). It was of minimum expression under the Rando and Waldron classification [22]. The right mandibular fossa was normal. In the left mandibular fossa, a new articular facet had formed accompanying inflammation and deformation of the mandibular condyle, and it was evident that TMJ arthritis and accompanying TMD had developed (Figures 10a and 10b).

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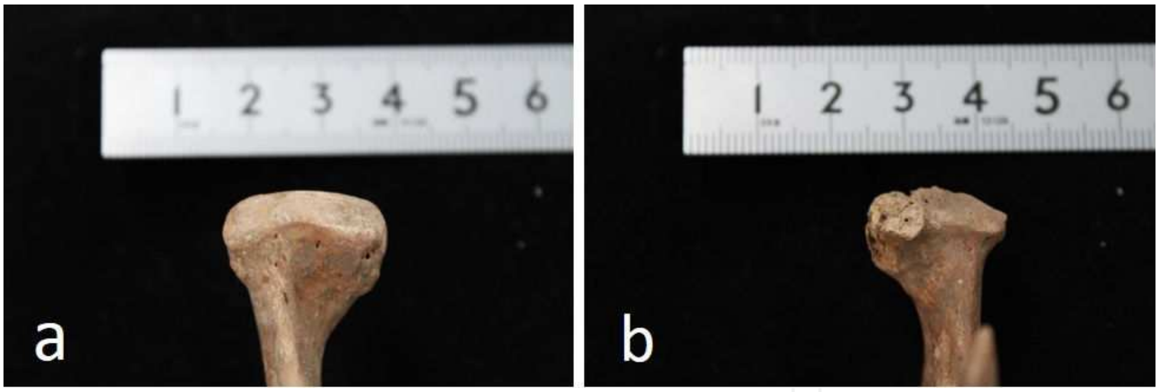

Figure 9. a: mandibular fossa of both sides. b: left mandibular fossa forms the false joint (arrow) and porosity is recognized in frame area.

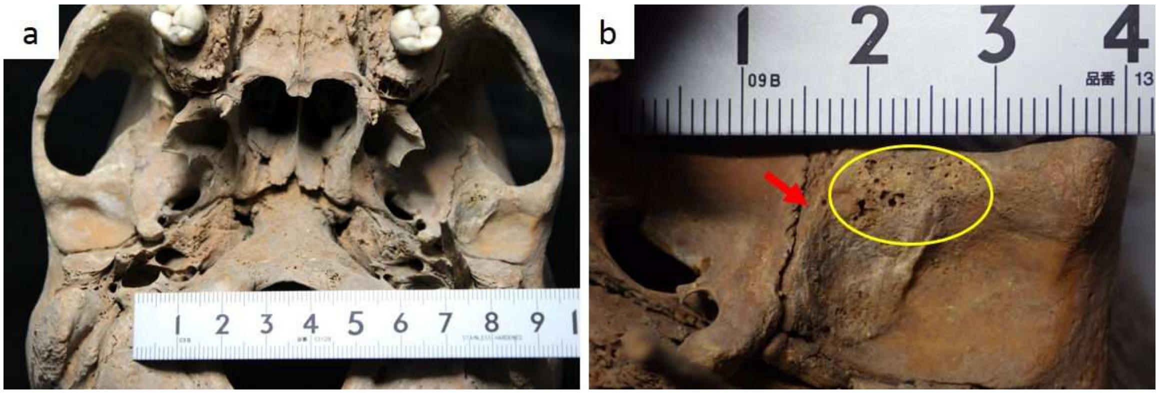

Figure 10. Periostitis found in the alveolar bone at right second deciduous molar (a) and left second deciduous molar (b).

There was bilateral periostitis of the alveolar bone supporting the primary teeth (Figures 11a and 11b). Periostitis was severe in the areas with over-retained primary second molars, and there was mild periostitis in all other areas, which was almost the entire maxilla and mandible.

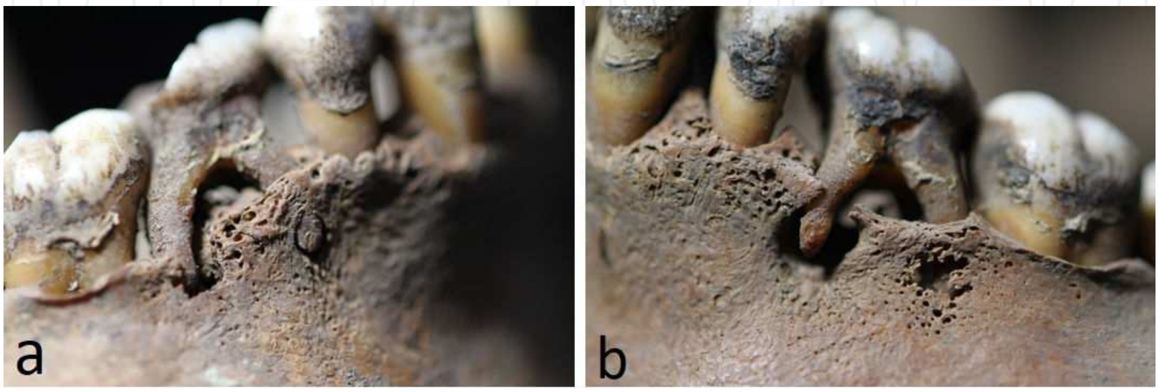

Figure 11. Slight periostitis is admitted in the widespread area of the alveolar bone.

Sumiya reported that the prevalence of prolonged retention was 0.58% for primary second molars in both Japanese men and women aged 21-25 years [23]. Onizuka examined 151 teeth in 106 individuals with over-retained primary teeth who were aged 14-47 years and reported that 63% had one over-retained tooth and 32% had two over-retained teeth [24]. It should be noted that over-retained teeth occurred symmetrically in the left and right sides of the maxilla or mandible in 33 of 34 patients with two over-retained teeth, indicating a very high proportion of patients [24]. The most commonly over-retained tooth was the primary second molar at 52.3% [24]. In the individual from the Suhgen temple site, there was prolonged retention of two mandibular primary second molars with bilaterally symmetry. The occurrence rate was 0.19% based on simple calculation, suggesting that such prolonged retention occurred in approximately 2 in 1000 adults. When one takes into account that the excavated skeletal remains were of the Edo period, this individual can be said to represent a valuable case of over-retained primary teeth in ancient human skeletal remains.

Although some reports have discussed that over-retained primary teeth can frequently cause TMD, treatment such as extraction of such teeth has been reported to improve the symptoms. In the individual from the Suhgen temple site, occlusal attrition was observed in the distal area of the left and right first molars. In the right first molar, the occlusal surface gently sloped upward from the distal to the mesial direction until there was no attrition. One area of the left first molar showed severe attrition where its distal area contacted the left second molar. It is nearly impossible to reproduce an accurate antemortem occlusion using a mandible and maxilla without soft tissue. However, there was likely abnormal occlusal force on the areas with attrition. When the maxillary dentition was examined, the teeth had normal positions in the left and right molar regions and there was slight attrition confined to the enamel. Attrition was confined to the lingual aspect for the left and right maxillary first molars. In this individual, the findings were strongly suggestive of malocclusion such as cusp-to-cusp occlusion. It is not known whether TMD occurred at a transition period from primary teeth to permanent teeth or after eruption of all permanent teeth. In any case, prolonged retention of primary second molars was thought to have somehow contributed to the development of TMD.

There are limitations in discussing TMD based on archeological materials, but there can be reports of new valuable cases of archeological materials. Modern-day individuals can have prolonged retention of primary teeth causing TMD and can have concurrent periodontal disease. Therefore, it is desirable to appropriately treat individuals with such conditions in modern clinical dental medicine. The material from the Suhgen temple site was an excavated archeological sample, but the implication of its findings can be important in modern dental medicine.

5. Conclusions

This paper discussed three topics from the perspective of physical anthropology which handles ancient human skeletal remains: antemortem tooth loss and problems of periodontal disease and caries, enamel hypoplasia as a stress marker, and occurrence of TMD due to prolonged retention of primary teeth. There are many other oral diseases in ancient skeletal remains that the author of this paper would like to discuss but was unable to, due to limitation of space. The diseases discussed in this paper are all in the oral region and have afflicted people from a few thousand years ago until the present day, i.e., diseases which have also afflicted our ancestors. The author hopes that the readers were able to appreciate that many new findings can be obtained from examination of diseases in the past. It is important to focus on the present to save patients who suffer from modern-day diseases. However, when one examines only the present, one will likely be unable to properly envision dental health of the future. The author is of the opinion that "knowing the past" or "learning from the past" is a very important point. Modern humans have existed for a long time, the ancestors of whom emerged about 7 million years ago. Thus, humans have a long past and modern humans should be thought of as being on the leading edge of this long human history.

Cooperation of physical anthropologists will be important in the creation of guidelines in modern medicine and future oral health. Such an effort can organically link the past, present, and future for the first time and can contribute to a better future. Another hope of this author is that the information and findings of this paper will be useful to many readers.

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