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Author(s)	小寺, 春人; 小野, 裕子
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オホーツク人の歯の微咬耗痕、強度咬耗と顎関節の変性について

小寺春人
（鶴見大学歯学部解剖学教室）

1）歯の微咬耗

歯の表面に刻まれた微細なキズから、食性や歯の道具使用の可能性を探った。ただし現在のところ、まだ一部の試料を観察したにすぎない。前歯部のエナメル質のキズについて、Ryan(1980)にしたがって分類し、1mm^2 単位におけるキズの頻度を見た。微線状 striae の出現頻度が 10.7 で、その走行角度は歯冠の近遠心軸に対して平均 42° 、小孔 pits の出現頻度が 3.8 であった。ほかに削溝 gouges や薄削 micro flake なども個体によって見られた。この数値は Ryan and Johanson(1989)のデータと比較すると、イヌイットの値に近似している。大臼歯では、エナメル質に高頻度で微線状と小孔が見られる場合と、強度に咬耗を受けてエナメル質が失われている歯に、低頻度の平行な微線状のみが象牙質に見られる場合があった。

これらの事実から、固い穀類の粉砕や砂粒の混在した食物の摂取が予想される。また削溝 gouges や薄削 micro flake も見とめられることから、固い道具類を歯で固定したことも想像される。強度に咬耗した大臼歯の平行な微線状は対合歯の間の咬合によるものと考えられた。

1）強度咬耗と顎関節

オホーツク文化人骨では、およそ 20 歳代（年齢推定は頭蓋冠の縫合線による）までに、多くの個体では歯が水平に咬耗を受け、その後は舌側から頬側に向って下降する傾斜した咬合面となる傾向が顕著である。すなわち、咬耗面が水平なものと傾斜したものとは、咬耗度の進行の相違にあると考えられる。この進行過程の機構は、はじめに咬頭の斜面どうしの咬合があり、やがて咬耗によって咬頭が消失してくると歯冠が水平となる。水平な歯冠では、咬合・咀嚼効率が悪く、歯冠の辺縁を使った咬合へと移行する。これにより歯冠は不均一な咬耗を受け傾斜した面をつくると考えられた。

このような傾斜した大臼歯の咬合面での咬合には、左右どちらか一側のみを咬合させる必要があり、その時に下顎を大きく側方偏位させねばならない。そのために咬合しない側の平衡側の下顎頭は下顎窩からおおきく前方へ移動する。その結果、下顎窩の前方の関節結節には強度の骨の吸収 erosion が生じている。

2）まとめ

すでに報告されているように、オホーツク文化人骨の特徴の一つは咀嚼器官が発達する点にある。しかし、歯の大きさは格別に大きくはなく、歯は短期間のうちに強い咬耗を受ける。咬耗の進行は歯冠を水平から傾斜した咬合面と変え、顎関節に負担をかけるようになる。

歯の表面のキズから、固い穀物か硬皮をもった種子を噛み砕いたことによる小孔の形成、砂粒の混入による微線状の形成、歯を万力のように使用したことによる削溝 gouges や薄削 micro flake の形成が想像される。しかし、歯を皮なめしに使用した際に生じるとされる、前歯部の歯冠唇側縁に丸みをもった特異な磨耗は認められなかった。

オホーツク人の上下の対合歯は、一定の面的なひろがりどうしで咬合しており、これより生じる強度な咬耗は、おもにすりつぶし運動に起因すると考えられる。この点は、考古学的なデータと矛盾する（小野：抄録文参照）が、救荒食物として知られる樹皮類（内樹皮・形成層）の摂食の可能性も考える必要があろう。

また、今後は歯の表面のキズをいっそう詳細に分析し、実験的手法も用いてキズの原因を特定する必要がある。

Micro Wear, and Heavy Abrasion and Degeneration of Temporomandibular joint among The Okhotsk People : From the Viewpoint of Archaeology

Hiroko Ono

Hokkaido University Museum, Division of Studies of Basic Materials, Sapporo, 060-0810,Japan

Through a survey of Dr. Kodera it has been proved that heavy tooth wear of the Okhotsk people resulted from two causes that were based on food custom, and also on use of teeth as instruments. The small holes, small lines, gouges, and micro flakes observed on the surface of teeth by SEM (scanning electron microscope) were estimated to be the result of crushing hard grains or seeds with hard hulls, masticating sand grains mixed into food, and using teeth as a vise, respectively. On the pages that follow, some examinations of his report will be made from an archaeological standpoint.

I . Relationship between tooth wear, sex, and age

As the progression of tooth wear goes on horizontally→lingually→buccally, the degree of tooth wear in 16 bodies examined before last fiscal year were categorized into 3 levels. The horizontal crown is applied to '1', the lingual one is to '2', and the buccal one is to '3'. They are divided into 4 parts of the right and the left maxilla and mandible respectively (Table 1). These levels represent the heaviest wear on each part.

Table 1.

Site	Collection No.	Sex	Age	R Max.	L Max.	R Mand.	L Mand.	note
Ohmisaki	4	♀	adult	2	2	3	1	
(Wakkanai)	2	♂	adult	1	1	3	1	
	1	♂	40yrs.?	1	2	3	3	
	5	♂♀?	adult	1.5	1	2.5	1	
	10	♀	adult	0.5	0.5	0.5	0.5	nonwear found
	6	♀	adult	2	2	3	3	
	9	♂	20yrs.?	1	1	1	1	
	28	♂♀?	8yrs.?	0.3	0.3	0.3	0.3	milk teeth persist
UtoroJinjya Yama	5	♀	4・50yrs.	2	2	3	3	
(Shyari)	7	♀	old	1	1	1	1	
Susuya	586	♂♀?	8・9yrs.	0.2	0.2	0.3	0.3	
(Sakhalin)	587	♀	?	1.5	2	3	3	
	587	♂	?	—	—	3	—	
	588	♀	20yrs.?	2	2	0.5	1	
	590	♀	late 20s	1	1	2.5	2.5	
	592	♂	3・40s	?—	2	3	3	

Four points are shown below.

1) Heavy tooth wear appears in the mandible most frequently, especially in the right mandible.
2) Strength of tooth wear has no relation to sex.
3) Progress of tooth wear comparatively relates to age, and continues heavily in adults and weakly in infants.
4) Tooth wear appears early in the infant stage; however, there are adults scarcely having tooth wear, and old people with weak little at all.

It can be thought that tooth wear of the prehistoric Okhotsk people resulted from masticating of food, based on the fact that tooth wear already appears in the infant stage. It advanced with age, and there is no apparent difference between the sexes.

It is indicated that the masticatory muscle of the Okhotsk people is extraordinarily developed, and this is already found in the infant stage too (Mitsuhashi & Yamaguchi 1961*1). This supports the existence of a custom among the Okhotsk of masticating constantly. On the other hand, however, it is difficult to explain our findings of individuals having scarcely any tooth wear at all.

As analyzed specimens are few at the moment, we are unable to make a decision regarding the above as an exceptional case, or whether individuals having little tooth wear really existed to some extent; but I will try to examine archaeologically the objects masticated below, at least for the cases involving obvious tooth wear.

Ⅱ. Examination from Vegetable Remains and Archaeological Artifacts

It has been demonstrated that subsistence of the Okhotsk culture mainly depended on fish, and also on sea mammals, birds, land mammals, and livestock (Ohba & Ohyi 1976 & 1981*2; and Kaneko 1972 & 1974*3), though there are some differences between the northern Hokkaido group and the eastern Hokkaido group. The evidence of vegetable remains obtained is very limited; however, husk fragments of walnuts (Juglans ailanthifolia Carr.), seeds of silvervine (Actinidia sp.), raspberry (Rubus sp.), wild spinach (Chenopodium sp.), wild vine (Vitis L.), elder (Sambucus sieboldiana var miquelii Hara), and achene of smartweed (Polygonum sp.); and kernels of domestic plants, for example, barley (Hordeum vulgare L.), millet (Panicum miliaceum L., Setaria itarica (L.) P. Beauv), and pollen of buckwheat (Fagopyrum sp.) are found at sites along the Okhotsk Sea of eastern Hokkaido (Yamada1998*4, Yoshizaki1994*5).

It is indicated that the tooth wear examined by SEM is similar to the scratches due to mastication of hard grain and seeds with hulls. These seeds and kernels, however, do not need a high degree of mastication, but walnuts do, and it is difficult to

think that the Okhotsk people had the custom of crushing walnut husks with their bare teeth from early childhood, and that this was a direct cause of their heavy tooth wear.

The preceding studies indicate that the pattern of tooth wear is different for hunting groups and for agricultural groups, and that tooth wear with an occlusal surface gradient is remarkably found in agricultural groups whose staple diet milled by stone (Powell1985*6, Unger & Spencer1999*7). It is thought that their tooth wear resulted from exogenous grid mixed into food by the millstone and by sand-bearing wind.

As far as the Okhotsk culture is concerned, the question that arises is whether or not its domestic plants are for consumption would require milling on one hand, or heavy mastication on the other. Furthermore, we cannot demonstrate at the present time, on the basis of vegetable remains and artifacts alone, that certain foods and cooking devices have caused the heavy tooth wear observable in the archaeological remains of the Okhotsk inhabitants.

Ⅲ. Dietary Pattern of the Prehistoric Okhotsk people Estimated by Staple Carbon Isotope Analysis

It is estimated that the prehistoric Okhotsk had eating habits that depended on advanced marine products equal to these of fishermen on the Greenland and Scandinavia coast, according to the carbon stable isotope(δ 13C) value of the Okhotsk human bone from Ohmisaki, Wakkanai, and from Hamanaka on Rebun Island (Koike & Chisholm et. al.1991*8).

It is known at the present moment that the food of the prehistoric Okhotsk people extended to C3 plants, and that herbivores grew in the ecosystem of C3 plants and C4 plants. A more detailed dietary analysis should be launched for the purpose of investigating the prehistoric Okhotsk human bones, using both carbon(δ 15C) and nitrogen(δ 15N) stable isotopes.

Stable isotope analysis by Minagawa (Minagawa1999*9) revealed that the diet of indigenous people in coastal areas of Hokkaido depended on marine resources similar to these of prehistoric Okhotsk people from the Early Jomon period to the Ainu period. On the other hand, in the Epi-Jomon period, C4 plants found at the Usu site in southern Hokkaido indicate a high contribution rate to calorific value, though their contribution rate to protein was low. Accordingly, it is expected that the weight of domestic plants in the Okhotsk culture (which we are not able to estimate from the quantity of vegetable remains unearthed) will emerge through dietary analysis using stable isotopes of $\delta^{13}C$ and $\delta^{15}N$.

Even though some contribution of C4 plants as to calorific value will be developed, however, it is difficult to elicit the possibility of heavy tooth wear caused by vegetable matter used as food in the Okhotsk culture, because mastication of millet could not have resulted such heavy tooth wear.

Ⅳ. Tooth Wear Caused by Using Teeth as Implements

From observation by SEM, the usage of holding hard implements by means of the teeth is postulated. It is difficult to demonstrate archaeological evidence for this directly; however, it is possible to refer to ethnological data. For example, among the Sadlermiut, one of the groups among Hudson Bay Inuit, a tooth is called " the third hand", and it is reported that they give their teeth a heavy load in order to hold and fix objects in fishing, in kayak making, in tightening lines, in crushing the heads of birds, in tearing sinews, and in stripping skins (Merbs1983*10). It is found that the masseters of the Sadlermiut are well developed and that the mandibular rami are broad and oblique, similar to those of the prehistoric Okhotsk inhabitants.

Moreover, anterior tooth loss of relatively high frequency (22% in adults) is prevalent in the Sadlermiut, which is caused by heavy burdens placed upon them, and the rate of loss for women is higher than that of men. It is remarkably evident in the mandible, and osteoarthritic degenetation of the temporomandibular joint is also found.

These conditions are attributed to tooth use of very long periods of mastication for the softening skins, to the frequent heavy work of holding tools and utensils by means of the teeth, and to the cutting and splitting of skins and sinews. It is supposed that such tooth loss has resulted from the more serious effects of chronic mastication, and from high and frequent stress on teeth, rather than from an intensity of stress at any one particular time.

In case of the Okhotsk, anterior tooth loss has not yet been pointed out, and no remarkable loss of anterior teeth was discovered in this analysis. Horizontal wear on the occlusal surface is basically found over all teeth, and the area of incidence for wears inclining toward the lingual and the buccal sides tend to concentrate from the first premolar to the second molar in the right and left sides of dentition.

As heavy stress on the temporomandibular joint is also found in the Okhotsk people, similar to that of the Sadlermiut, it is possible to surmise that long-time mastication and heavy work causing highly frequent stress on teeth were probably performed among the Okhotsk, though there is a noted difference in using particular teeth between them.

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V. Conclusions

In this analysis it cannot be proved archaeologically that mastication of vegetative food matter contributed to the heavy tooth wear among the Okhotsk population. At the present moment, it is thought that the cause of tooth surface abrasion and attrition was most likely due to heavy work involving long and highly frequent mastication, I wish to point out below some of the problems stemming from this analysis and relating to the cause of tooth wear among the Okhotsk.

The relationship between food, the preparation of food, the misshapen nature of worn teeth, and striations on the occlusal surface have been explained too simply in the precedent studies on tooth wear. In the case of the Sadlermiut, a group whose lives depend in large measure upon a great deal of meat consumption, their tooth wear should have remained consistent on a horizontal plane, but in some cases it seemed to be with inclined wear on the occlusal surface.

As striations are left on the crown surface of the teeth at the last wearing away stage, a strict of verification for establishing the relationship between agents of heavy tooth wear involved in changing the figure of the crown, and the masticatory objects estimated from micro striations on the occlusal surface.

Furthermore, in order to determine which reason (whether toughness and preparation of food, or lengthy and repetitive mastication), gives more serious effect to metamorphosis of the crown and striations left on the tooth face, the need to develop methods for synthetically estimating the effects of those agents upon teeth is urged.

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