의학박사 학위논문

16 -19세기 서시베리아 원주민과 러시아 이주민 치아상태에 관한 체질인류학적 연구

An anthropological study on the teeth of the native peoples and Russian settlers in the 16th to 19th century West Siberia

2019년 8월

서울대학교 대학원
의학과 해부학전공
이 혜 진

A thesis of the Degree of Doctor of Philosophy

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이 논문을 의학박사 학위논문으로 제출함

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이혜진의 의학박사 학위논문을 인준함

2019년 8월

위 원 장 (인)

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An anthropological study on the teeth of the native peoples and Russian settlers in the 16^{th} to 19^{th} century West Siberia

by
Hyejin Lee

A thesis submitted to the Department of Anatomy and Cell Biology in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Medicine at Seoul National University College of Medicine

August, 2019

Approved by Thesis committee:

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ABSTRACT

Introduction: Teeth are frequently analyzed and recorded in bioarchaeological and paleopathological research because they are highly mineralized, making them more resistant to taphonomic alterations. With the considerable numbers of teeth available in the archaeological evidence, dental status analysis has proved to be a useful tool in the assessment of health and diet of people in the past. In this study, dental remains from the two different populations having lived in West Siberia are examined in order to verify the differences of oral health status associated with distinct subsistence patterns: hunting and gathering and agriculture. Analyses focusing on the prevalence and severity of dental health standards, both within and among the groups of Siberian natives and Russian settlers, therefore test its possible differentials which may reflect the varying effectiveness of disparate adaptive systems.

Methods: Siberian natives (n=75) exhumed from Khanty, Nenet, Selkup and Tatar graves along with Russian settler skeletons (n = 79) from Izyuk were examined in this study. General dental analysis of dental wear, Antemortem tooth loss (AMTL), calculus and caries were used to assess the dental health status and possible dietary patterns of individuals who represented hunter-gatherers (Siberian natives) and agriculturalists (Russian settlers) in the 16th to 19th century West Siberia. All above-mentioned pathologies were documented according to the widely used standard methodology. The resulting statistical inferences were tested using package R.

Results: The Russian settlers showed a higher degree of dental wear (5.39) than did the Siberians natives (4.76) (t-test, p=0.0175). On the contrary, the prevalence of calculus deposition by teeth was significantly higher in Russian settlers (22.6%) than Siberian natives (10.8%). The agriculturalist Russian settlers also showed a significantly higher prevalence of dental caries (11.88%) than did the non-agriculturalist indigenous Siberian people (3.85%). As with the caries pattern, the prevalence of AMTL was also much higher in the Russian settlers than Siberian natives regardless of age.

Conclusion: In a study on 16th to 19th century West Siberian populations, it could be shown that agriculturalists ingesting a carbohydrate-rich diet would have higher rates of dental calculus, AMTL and caries than hunter-gatherers. These results are consistent with most previous studies, which confirmed the influence of increased carbohydrate intake on dental health. Meanwhile, in case of tooth wear, the Russian settlers showed higher prevalence than the native Siberians did. The data also suggest that the foods of Siberian natives who were predominantly dependent on hunting activities were not as tough as I expected.

Keyword: West Siberia, Dental caries, Dental calculus, Antemortem tooth loss, Tooth wear, Siberian native

Student Number: 2013-30600

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Introduction

Dental diseases are one of the most commonly documented pathologies in bioarchaeological investigation. These provides important information to define biological, adaptive, and behavioral characteristics of ancient people and society. It deals with the topics about diet, nutritional sufficiency, food preparation methods, dental hygiene, non-specific physiological stress, and cultural modification (Larsen, 1997; Ortner, 2003; Lieverse, 2007). The association between dental pathology and subsistence strategy has been studied for various human populations worldwide (Klatsky and Klatell, 1943; Herrala, 1961; Brothwell, 1963; Armelagos, 1966; Turner, 1979; Whittaker and Molleson, 1996; Vodanović et al., 2005; Esclassan et al., 2009). The tooth wear, dental calculus, antemortem tooth loss (AMTL) and caries between hunter-gatherers and agriculturalists were examined by several researchers (Littleton and Frohlich, 1989; Lillie, 1996; Lieverse, 1999, 2007; Delgado-darius et al., 2006). Detailed reports of previous studies are summarized as follows:

(1) Tooth wear often associated synergistically with factors such as caries and AMTL. It is a complicated phenomenon manifested in a degenerative change of dental tissues caused by chronic mechanical stress (Hinton, 1981; Pickles, 2006). Multiple factors including hardness of the diet, age, cooking techniques, and the teeth function in paramasticatory activities are known to affect tooth wear severity (Smith, 1984; Minozzi et al., 2003; Deter, 2009). The degree of tooth wear was often higher among hunter-gatherers than among agriculturalists, mostly due to the formers' tougher diets (Anderson, 1965; Greene et al., 1967; Molnar, 1971; Sciulli and Carlisle, 1977; Scott, 1979; Hinton, 1981, 1982; Smith, 1982, 1984; Patterson, 1984; Powell, 1985; Inoue et al., 1986; Molleson and Jones, 1991; Rose et al., 1991; Littleton and Frohlich, 1993; Lubell et al., 1994; Deter, 2009).

(2) AMTL can stem from multiple etiologies. Periodontal diseases and periapical abscesses, mostly a consequence of caries complications, often leads to subsequent AMTL (Mayes, 2016). The prevalence of AMTL was reported to be significantly higher in agriculturalists than in hunter-gatherers of the various sites (Beckett and Lovell, 1994). The combined analysis of caries and AMTL prevalence also provides understanding about diet and oral disease in past populations, providing evidences for biological, behavioral and socioeconomic factors that are involved in oral pathology (Cucina and Tiesler, 2003).

(3) Dental calculus progresses when non-mineralized biofilms, extremely abundant in oral bacteria, become mineralized with calcium phosphate mineral salts (Socransky and Haffajee, 2002). The mineralized biofilms generally occur both in supra- and sub-gingival areas (Schroeder, 1969). In living peoples, calculus accumulations are covered by non-mineralized plaque; it is thus this plaque that is the main pathological etiology for periodontal disease or gingivitis (Lukacs, 1989; Mandel, 1990; Hillson, 1996). These deposits can be valuable to paleopathologists and bioanthropologists who study ancient diseases because calculus might be useful in calculating the presence and degree of periodontal diseases in ancient populations (Brothwell, 1981; Ortner and Putschar, 1985). However, there are very few previous literatures on the relationship between diet and the dental calculus formation. Lieverse (1999) pointed out that the researches on dental calculus from archaeological human populations have not been widely conducted compared to other dental diseases.

(4) Dental caries is caused by acid-induced demineralization of enamel and dentine that is initiated by bacterial fermentation of carbohydrates (James, 1975; White, 1975; Kamp et al., 1983; Cucina and Tiesler, 2003). To paleopathologists, there are no diseases that yield as much information as caries does to understand the people's dental health in history. Therefore, for the past decades, many paleopathological studies on the dental caries of ancient skeletons have been published all over the world (Table 1).

In brief, an increase in caries prevalence can arguably be linked to dietary shifts entailing the consumption of carbohydrate-rich foods (Hillson, 1979; Turner, 1979; Kashket et al., 1994; Larsen, 1995; Herskovitz, 1998; Han et al., 2010). Although the mechanisms are complex, this seems to be linked to different pattern in the consumption of carbohydrates which affect oral pH and hence influence on cariogenesis (Larsen et al., 1991; Lukacs, 1992; Beckett and Lovell, 1994; Temple and Larsen, 2007; Watson, 2008; Cucina et al, 2011; Halcrow et al., 2013). Several archaeo-historical documents supported the relationship between high caries prevalence and the increase of carbohydrates intake in human populations since the beginning of agriculture (Turner, 1979; Larsen, 1997; Saunders et al., 1997).

Generally, researchers assumed that hunter-gatherers might have shown low caries frequencies whereas peoples of mixed economies, farming or gathering showed a higher caries rate (Turner, 1979; Powell, 1985; Lukacs, 1992; Hillson, 2001). However, the conjecture is still not satisfactory so far. The authenticity of previous studies on the tooth wear, dental calculus, AMTL and caries among tempo-spatially co-existed populations with divergent subsistence strategies is limited by the possibility of incurred inter-observer error. Actually, in most earlier relevant studies, the comparison of groups has been performed by different researchers; therefore, the resultant inter-observer error remained problematic.

In this regard, West Siberia is a very unique place where many people with different subsistence strategies have co-existed. From the 16^{th} to 19^{th} century, agriculturalist Russian settlers just moved from the European West started to live in proximity to Siberian native hunter-gatherer peoples. From the perspective of paleopathology, these two human population groups (Russian settlers and Siberian natives) with their different lifestyles are excellent subjects for research on dento-pathological differences between hunter-gatherers and agriculturalists in history. However, there has been very few related reports so far.

Therefore, as for 16^{th} to 19^{th} century Russian settlers and Siberian native peoples in West Siberia, anthropological studies were performed in this study. The objective of this anthropological study are as follows: 1) to analyze the differences in dental health of these populations; 2) to assess their health status within the circumstances of their subsistence and environment; and 3) to propose a fundamental model for the correlation between diet and dental health that could be applied to further studies in the future.

Table 1

Caries prevalence of human skeletons from archaeological and anthropological studies all over the world

Economy	Population	Location	Other Information	Caries Prevalence (%)	References
Hunter-gatherers	Siberia	NE Siberia	Skeletal	0.0	Klatsky and Klatell, 1943
	Neanderthal	Europe	Paleolithic	0.0	Brothwell, 1963
	Aleut	Alaska	Skeletal	0.0	Turner, 1979
	Fourche Malin	Oklahoma	ND	0.07	Powell, 1985
	Eskaleut	Pan-Arctic	Skeletal	0.08	Klatsky and Klatell, 1943
	Cis-Baikal	Siberia	ND	0.23	Lieverse et al., 2007
	Old Copper Indian	Wisconsin	5,600 BCE	0.4	Herrala, 1961
	Indian Knoll	Kentucky	3,000 BCE	0.4	Herrala, 1961
	Gray site Indian	Saskatchewan	3,200 BCE	0.7	Knutson, 1975
	Homo sapiens	Eurafrica	Upper Paleolithic	1.0	Brothwell, 1963
	Nubian	Sudan	Mesolithic	1.0	Armelagos, 1966
	Eskimo	Greenland	Skeletal	<1.0	Pedersen, 1938
	Aborigine	Australia	Skeletal	1.6	Campbell, 1925
	Indian	California	Skeletal	1.6	Klatsky and Klatell, 1943
	Eskimo	Greenland	Living	2.2	Pedersen, 1938
	Aborigine	Australia	Skeletal	2.3	Steadman, 1939
	SJo-68 Indian	Central California	1,000 BCE	2.4	Turner, 1979
	NW-MZ Final Late Holocene	Patagonia	1,500-500 BCE.	3.3	Bernal et al., 2007
	Aborigine	Australia	Living	4.6	Campbell, 1938
	Aborigine	Tasmania	Skeletal	5	Steadman, 1937
	NW-MZ Final Late Holocene	Patagonia	1,500-500 BCE	5.19	Bernal et al., 2007
	Paleoindian	Brazil	ND	9.0	Neves and Cornero, 1997
	Mesolithic	Portugal	ND	14.3	Lubell et al., 1994
Mixed Economy (hunting, agriculture, fishing)	Melanesian	New Britain	Skeletal	0.44	Klatsky and Klatell, 1943
	Black	West & South Africa	Skeletal	1.0	Klatsky and Klatell, 1943
	Polynesian	Pacific Island	Skeletal	1.7	Klatsky and Klatelt, 1943
	Bantu	South Africa	Skeletal	2.3	Shaw, 1931

	Sauk	Illinois	1,800 CE	2.6	Herrala, 1961
	White	Europe	Neolithic	3.2	Wells, 1975
	Papuan	New Guinea	Living	3.81	Sinclair et al., 1950
	Dickson Mound	Indiana	1,300 CE	7.4	Herrala, 1961
	Mirnbrenos	New Mexico	1,600 CE	7.8	Bentzen, 1929
	Oakwood Mound	Indiana	1,600 CE	8.2	Herrala, 1961
	Jomon	Central Japan	1,000 BCE	8.6	Turner, 1979
	Polynesian	Pukapuka	Living	9.3	Davies, 1956
	Angel Village	Indiana	1,300 CE.	10.3	Herrala, 1961
Agriculturalist	Chinese	China	Living	2.14	Anderson, 1932
	Egyptian	Egypt	26th -30th Dynasty	2.3	Brothwell, 1963
	Mongoloid	Central China	Living	2.46	Afonsky, 1951
	Neolithic	Portugal	ND	3.1	Lubell et al., 1994
	Ying Shang Period	Anyang-China	ND	3.45	Sakashita et al., 1997
	Joseon dynasty	Korea	16th-18th century	3.9	Han et al., 2010
	Mongoloid	China, Japan, Korea	Skeletal	4.1	Klatsky and Klatell, 1943
	White	France	Neolithic	4.2	Brabant, 1969
	White	Europe	Neolithic	4.26	Brabant et al., 1968
	Egyptian	Egypt	Skeletal	4.4	Klatsky and Klatell, 1943
	Mexican	Mexico	Skeletal	4.64	Klatsky and Klatell, 1943
	Puebloan	Mancos Canyon	1,200 CE	4.9	Robinson, 1976
	Greek	Greece	2,000-150 BCE	6.2	Angel, 1944
	South American	Bolivia etc.	Skeletal	6.25	Klatsky and Klatell, 1943
	Hopi	Old Walpi, Arizona	Pueblo IV 1,300-1,700 CE	6.3	Ryan, 1977
	Puebloan	Mancos Canyon	1,200 CE	6.5	Nickens, 1974
	Harappan	India	Iron Age	6.8	Lukacs, 1992
	13th century	Bizantine Turks	ND	6.8	Caglar et al., 2007
	Puebloan	Northeastern Arizona	Pueblo II 1,000-1,150 CE	7.1	Ryan, 1977
	Mongoloid	China	Living	7.65	Montelius, 1933
	White	Europe	Post –Neolithic	8.1	Wells, 1975
	White	Europe	Skeletal	9.62	Klatsky and Klatell, 1943
	CW-SJFLH	Patagonia	ND	10.17	Bernal et al., 2007
	Black	South Africa	Living	11.5	Friel, 1910

	X-Group	Nubia	Skeletal	11.9	Armelagos, 1966
	Greek	Greece	3,000 BCE	12.0	Angel, 1944
	Clopton	England	Medieval	12.0	Tattersall, 1968
	17th century	Sweden	ND	12.0	Lingström and Borrman, 1999
	Meriotic	Nubia	Skeletal	12.4	Arrnelagos, 1966
	Maitas	Northern Chile	ND	14.4	Kelley et al., 1991
	Christian	Nubia	Skeletal	14.8	Armelagos, 1966
	Puebloan	Northeastern Arizona	Pueblo III 1,150-1,250 CE	15.0	Ryan, 1977
	Gran Quivira	New Mexico	Skeletal	15.2	Swanson, 1976
	Peruvian	Peru	Skeletal	15.4	MacCurdy, 1923
	Pachacamac	Peru	Skeletal	15.5	Stewart, 1931
	ND	Gran Canaria-caves	ND	15.7	Delgado-Darias et al., 2005
	Greek	Greece	Living	15.9	Angel, 1944
	Japanese	Japan	ND	17.98	Sanui, 1960
	Iron Age	Omanő	ND	18.4	Nelson et al., 1999
	Yayoi	Japan	200 BCE	19.7	Sanui, 1960
	Pue´mape Salinar	North Coast Peru	ND	20.67	Lanfranco et al., 2010
	Pue´mape MF	North Coast Peru	ND	21.73	Lanfranco et al., 2010
	Los Pinos LIP	North Central Coast Peru	ND	22.07	Lanfranco et al., 2010
	Confederate veterans	Texas	ND	24.4	Danseizer and Baker, 2004
	Quadrella	Roman Empire	ND	24.7	Belcastro et al., 2007
	Greek	Greece	1,300 CE	26.5	Angel, 1944
	Tristan da Cunha	Atlantic	Living	26.9	Holloway et al., 1963
	Pampa Grande	North-West Argentina	ND	34.3	Kozameh and Barbosa, 1996
	19th century	Upper Canada	ND	35.95	Saunders et al., 1997
	Quitor-5	Northern Chile	ND	48.1	Kelley et al., 1991

* CE, Common Era; BCE, Before Common Era; ND, not determined; Skeletal, ancient skeletal series; Living, living individuals for anthropological examination

Materials

Geological Consideration

West Siberia is a territory extending from the Arctic ocean to the dry steppes of Kazakhstan and from the mountains of the Urals to the Yenisei river (total area=2.4 million square kilometers). The rivers of the area including Nadym, Ob, Pur, and Taz flow north, empty into the Kara Sea. About 80% of the West Siberia is located within the West Siberian plain, the area of heavily waterlogged depressions. West Siberian hunters and fishermen resided in the vast lowland consisted of forest-steppe, taiga, forest-tundra, and tundra. Their economic and cultural systems highly depend on environmental factors.

Siberian Native Peoples

Neolithic Siberian peoples already had four different sorts of subsistence economies, predominantly based on hunting or fishing. They maintained different kinds of lives: (1) seasonal fishing and hunting in the forested areas along the Irtysh and Ob Rivers; (2) hunting of wild ungulates in the east of the Ural Mountains and in the forested areas of the Upper Ob River; (3) sedentary fishing in the Lower Tobol River area; and (4) wandering reindeer hunting in the tundra (Liudmila, 2000). The information about different Siberian native peoples is summarized in this thesis.

(1) Khanty: They were an indigenous people who now inhabit the wide expanses of the West Siberia Plain. They lived on the banks of the Ob River and its tributaries in West Siberian taigas, tundra, and swamps. They were mostly hunters and fishermen, settled in the territories of the forest-tundra and north-taiga zones of the Lower and Middle Ob regions. Khanty were hunters-gatherers of reindeer herding. Fishing became their fundamental industry because about one-third of the territory is fish-abundant water area. Hunting was also important because the hunting ground occupied 56 million acres in the area. Ermine, fox, muskrat (with muskrat being the most important), sable, and squirrel were hunted for their valuable furs (Perevalova, 2004; Bagashyov, 2017).

(2) Nenets: Their language is related to the northern division of the Samoyedic language group (Ackerman and Salminen, 2006). They were indigenous peoples in northern arctic area, for more details in the lower reaches of the Taz River and its tributaries (Slepchenko et al., 2016). These Siberian Tundra Nenets, together with the Forest and European Nenets, form a large single ethnic family in Northern Eurasia. The ancestors of Nenets began to leave the Sayano-Altay mountain area and moved to the Arctic Circle and Near Arctic in the 3rd century AD. The migration maintained almost a thousand years. The Nenets settled in the Taz River Basin and had expanded from there further to the northeast, expelling and assimilating the Enets tribe, another Samoyedic peoples, in the 17th century. The Taz Nenets belongs to the Northeast Asian affinity, anthropological group of the Yenisei (Bagashev and Slepchenko, 2015). The subsistence of Taz and Tundra Nenets is satisfied by reindeer herding and farming, along with fishing and hunting (Slepchenko et al., 2016).

(3) Selkups: They were a one of the small ethnic group in West Siberia, possibly the posterity of the Narym Selkups who migrated from the Tomsk-Narym area of the Ob River basin in the 17th to 18th centuries family (Kazakevich and Budyanskaya, 2010; Poshekhonova et al., 2018). They belong to the peoples of the Samoyedic-speaking group (Levin and Potapov, 1956). The Upper Taz Selkup's settlement area is located in the northern taiga zone that ranges from the Ratta River to the Tolka River. The Upper Taz Selkup keeps a semi-nomadic way of life based on hunting, fishing, herding reindeer, and gathering. Despite the long-standing relationships with the Russians, the Upper Taz Selkup have managed to preserve their cultural identity. Their subsistence strategy was based on all-year-round fishing, hunting, deer farming, and gathering (Slepchenko and Ivanov, 2015; Poshekhonova et al., 2018).

(4) Tatars: They belong to Turkic speaking ethnic groups of the West Siberia. Tatars populate mostly around the Irtysh River and its inflows. This area includes forest, forest-steppe, and partially steppe climatic zones. Ethnographers described several subethnic groups among Tobol-Irtysh Tatars: Ayaly, Kaurdak-Sargat, Tobol, Tura and Tyumen (Tomilov, 1981). Since anthropological analysis could not reveal any substantial differences between the above-mentioned groups, they could be considered as one unified complex of mixed Caucasoid-Mongoloid populations (Bagashev, 1993). In the past, the Ayaly group of Tobol-Irtysh Tatars was anthropologically studied based on samples from the cemeteries such as Okunevo VII (16^{th}–17^{th}), Bergamak II (17^{th}), Chertaly I (18^{th}–19^{th}), Toksay I (18^{th}–19^{th}) (Melnikov, 1991; Bagashev, 1993; Tikhonov and Tataurov, 1996; Mogilnikov, 1997; Zdor et al., 2000; Matyushchenko, 2003). The buried individuals were pastoralists, fishermen, and hunters living in the Irtysh River basin (Slepchenko, 2017).

Russian Settlers

The Russian settlers' village of Izyuk was founded in year 1,648 on the bank of the Irtysh River. Archaeological excavation was performed at the Izyuk site, and a cemetery was found next to the settlement. Based on anthropological studies of the skeletons, the settlers buried at the cemetery could have originated from Northern and Central Russia or Eastern Europe (Tataurova, 2010). The collection is currently curated at the Institute of the Problems of Northern Development Center (Tyumen Oblast, Russia).

The Teeth

The samples analyzed in this study belong to the Institute of the Problems of Northern Development Center in Tyumen (Russia). A total of 154 individuals (teeth number=2,709) acquired from the West Siberian excavation sites (Table 2) were examined in this study. They can be discriminated into two different peoples who lived in West Siberia during 16^{th} to 19^{th} century: Russian settlers and Siberian natives. The respective geographic locations of the archaeological sites are marked in Fig. 1.

Of them, the Siberian natives (n=75; 35 males, 40 females) were hunter-gatherers. They were originated from Khanty (n=7), Nenet (n=12), Selkup (n=22) and Tatar (n=34) groups (Fig. 1; Table 2). Total number of teeth was 1,404 (Table 3). The Russian settler skeletons investigated in this study were consisted of 79 individuals (47 males and 32 females), with 1,305 in total (Fig 1; Table 3).

Table 2. Archaeological information of Siberian Peoples and their subsistence strategies

Group		Site	Date	N	Activity & Subsistence
Siberian Natives	Tatar	Omsk	17th to 20th C	34	Fishers-hunters, cattle breeder, farmers to a lesser extent
	Selkup	Tomsk Oblast	17th to 19th C	22	Fishers-hunters
	Khanty	Khanty-Mansi Autonomous Okrug	17th to 18th C	7	Fishers-hunters
	Nenet	Yamalo-Nenets Autonomous Okrug	19th to 20th C	12	Fishers, reindeer herders
Russian settlers	Russian	Omsk (Izyuk)	16th to 18th C	76	Agricultural farmers

* N=number of individuals in each groups; C, Century

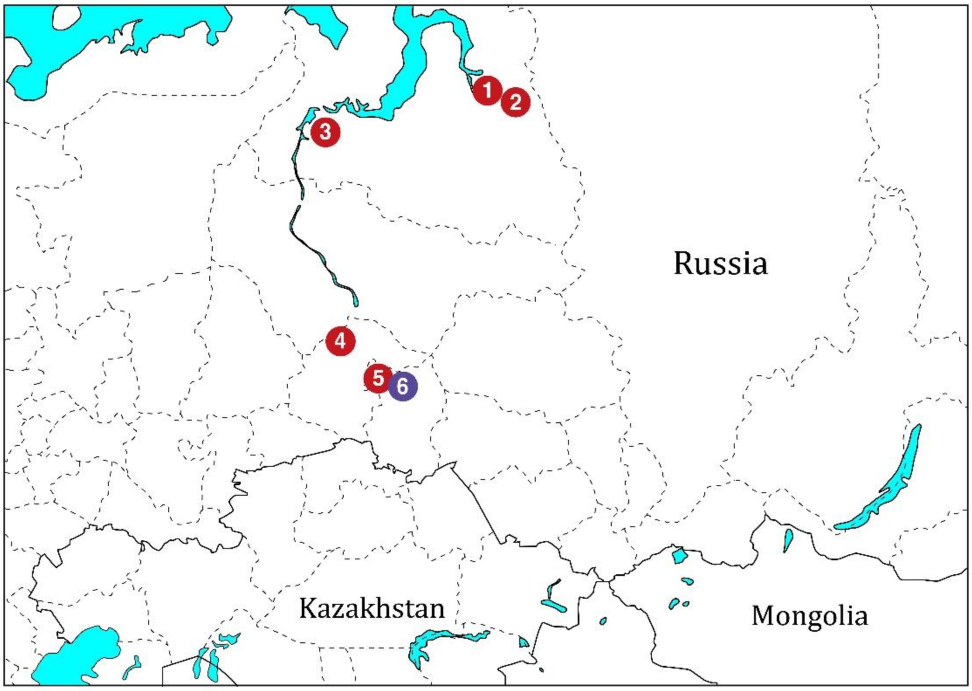

Figure 1. The geographic location of archaeological sites for each group. Numbers 1~5 indicate the excavation sites for Siberian natives (1 and 2, Nenet; 3, Selkup; 4, Khanty; 5, Tatar). Number 6 indicates the excavation site (Izyuk, Omsk) for Russian settlers.

Methods

Age and Sex Estimation

The biological profiles (age and sex) of the skeletons were estimated using standard anthropological methods by Buikstra and Ubelaker (1994). Age estimation was based on anthropological analyses of auricular surface, pubic symphysis, ectocranial suture closure, and dental attrition. The ages of immature ones were estimated using dental eruption and formation, and epiphyseal closure of long bones. All individuals were grouped into four age categories for more detailed analysis: adolescents (15-19 yrs), young (20-34 yrs), middle (35-49 yrs), and old adults (over 50 yrs) (Table 3). The number of permanent teeth by sex and age is summarized in Table 3. The teeth were also enumerated by tooth component (Table 4).

Sex was determined based on the sexually dimorphic skeletal features of the pelvis and skull. Sexually dimorphic features of the skull considered in this study include the frontal and gonial shapes, zygomatic root, supraorbital ridge, mastoid process, nuchal crest, and inion protuberance following standards of Ferembach et al. (1980), Brothwell (1981), and Bass (1995). Sexually dimorphic features of the pelvis considered in this study include the preaurciular sulcus, greater sciatic notch, ventral arc, medial portion of the pubis, subpubic angle, subpubic concavity, and median ischiopubic ridge, in accordance with the standards outlined by Phenice (1969).

Preparation for Examination

Every tooth was cleaned with soft brush and then examined under a bright light with the aid of a magnifying glass when necessary. All dentitions and/or alveoli were recorded with the two-digit system established by Fédération Dentaire Internationale (1971), in which the first digit stands for the quadrant and the second digit the tooth's position within that quadrant. Observations for every tooth and socket was based on its generation, preservation and individual age at death.

All teeth were macroscopically examined for any signs of dental diseases. Because no pathological signs were observed on deciduous teeth, the documentation of dental health data was only confined to permanent dentitions and their tooth sockets (Whittaker et al., 1981; Kerr et al., 1988, 1990; Whittaker and Molleson, 1996). Two analysis methods were used in this study: the methods of individual count (number of affected individual / number of observable individuals) and tooth count (number of affected teeth / number of observable teeth). The individual count method is useful for demonstrating the population prevalence of a given dental disease. Meanwhile, the tooth count method could be used for large sample size group, making the comparison of their disease frequencies easier (Beckett and Lovell, 1994).

Analyses of dental diseases were conducted by taking into account of each individual's sex and age information. Table 3 summarizes the age and sex distributions for the Russian settlers and Siberian natives. For documentation of dental diseases, standardized scoring system, written descriptions, and photography of uncommon and/or extreme cases were adopted in this study.

Table 3. Number of teeth and individuals in Siberian natives and Russian settler groups

Age group	Siberian natives		Russian settlers	
	Female	Male	Female	Male
Adolescent: <19 yrs	152 (8)	56 (2)	148 (9)	73 (5)
YA: 20~35 yrs	332 (20)	296 (14)	304 (16)	230 (9)
MA: 36~50 yrs	116 (9)	341 (16)	214 (15)	186 (11)
OA: 50+ yrs	57 (3)	54 (3)	73 (7)	77 (7)
Total	657 (40)	747 (35)	739 (47)	566 (32)
Group Total	1,404 (75)		1,305 (79)	

* Number of Individuals are presented in parenthesis
YA, young adult; MA, middle adult; OA, old adult

Table 4. Number of teeth by tooth component

Tooth	Siberian natives Number of teeth (of individuals)		Russian settlers Number of teeth (of individuals)	
	Female	Male	Female	Male
I1	59	59	50	57
I2	61	78	82	60
C	83	92	96	72
P1	82	98	104	70
P2	91	108	112	85
M1	115	120	117	83
M2	98	110	110	79
M3	68	82	68	60
Total	657	747	739	566
Group Total	1,404		1,305	

* I1, 1st incisor; I2, 2nd incisor; C, canine; P1, 1st premolar; P2, 2nd premolar; M1, 1st molar; M2, 2nd molar; M3, 3rd molar

Dental Examination

(1) Tooth wear

Tooth wear process continues after eruption. Some researchers differentiated this process as attrition (due to tooth-to-tooth contact), abrasion (due to tooth-on-food contact), and erosion (due to chemical dissolution) (Boyes, 1959; Allan, 1967; Eccles and Jenkins, 1974; Skogedal et al., 1977; Smith and Knight, 1984; Tuominen et al., 1989). However, since it is difficult to identify the actual etiology or pattern (Eccles and Jenkins, 1974; Tuominen et al., 1989; Imfeld, 1996; Bell et al., 1998), *tooth wear* in this thesis includes the processes below: abrasion, attrition and erosion.

Tooth wear (Figure 4A and 4B) for anterior teeth, premolars, and molars were scored according to Scott's method (1979). Tooth wears in anterior teeth (incisors, canines), and premolars were scored on a range of 1 (unworn tooth) to 8 (whole loss of crown). Molar occlusal surface was split into quadrants and the amount of identifiable enamel was calculated on a scale from 1 to 10. The final grade documented for each tooth was the sum of the scores of all quadrants, with minimum grade being 4 and maximum grade being 40 (Scott, 1979). Molar wear was considered mild for score 4 to 16, moderate for 17 to 29, and severe for more than 30.

(2) AMTL

Tooth loss can be classified as ante- or postmortem. Of them, the AMTL (Figure 5A and 5B) was scored as positive in cases when the remodeling traces were observable in the alveolar sockets. If socket was empty without evidence of healing, the tooth was considered to be lost post-mortem. The AMTL prevalence was represented as the number of AMTL incidences divided by the total number of tooth socket positions observed.

(3) Calculus

Calculus, mineralized plaque adhering to the tooth surface (Hillson 1996), is recorded on an individual tooth level, with its location and severity according to the standards of Buikstra and Ubelaker (1994) and Brothwell (1981). The location is recorded as supra- or sub-gingivally on the crown or the root. Supragingival calculus is localized on the dental enamel above the gingival margin, generally as a band at the enamel border itself (Friskopp, 1983; Hillson, 1996). It is the most abundant on the buccal surfaces of the maxillary first molars and the lingual surfaces of the mandibular incisors (Friskopp, 1983). Meanwhile, subgingival calculus is situated within the gingival pocket, deposited on the root surface (Friskopp, 1983; Hillson,1996). Of them, in this study, only supragingival calculus (Figure 6A and 6B) was examined. It was scored as trace, grade A (small amount), grade B (moderate amount), and grade C (large amount). The prevalence of calculus was represented as the number of teeth with calculus deposition, either supragingival, or subgingival divided by the total number of observable teeth. The calculus was observed only in the supragingival region in this study.

(4) Caries

Carious lesions (Figure 7A and 7B) were scored as positive when the each cavities showed on the teeth crown and/or root (Hillson, 2001). And the lesions were also regarded as carious when enamel demineralization was observed (Hillson, 2001). Carious lesions at the crown enamel are classified as *coronal caries*. The original enamel lesion may be initiated in a variety of locations on the crown. As the lesions develop, they involve the dentine; finally, when the pulp chamber is penetrated, that induces an inflammatory response inside the pulp, which may in turn lead to periapical inflammation (Hillson, 2001).

Meanwhile, *Root surface caries* ordinarily occur later in life. Carious lesions may initiate from the cement of the root surface either along the cement–enamel junction or further down the root upon the margin of the gingivae. Root surface caries progress slowly in general, but the thin layer of cement is penetrated to expose the underlying dentine before long (Hillson, 2001). The prevalence of caries was represented as the number of carious teeth divided by the total number of observed teeth. Caries prevalence for anterior (incisors and canines) and posterior (premolars and molars) teeth was estimated.

Statistical analysis

Package R (R Core Team, 2017) was used for statistical inferences in this study. The comparison of the age or sex proportions (homogeneity) across two groups (Siberian natives and Russian settlers) was performed by Pearson's Chi-squared test. As for homogeneity in the age proportions across Siberian natives and Russian settlers, significant evidence (Pearson's Chi-squared test, P-value=0.3312) could be obtained to conclude that the distribution is similar between two groups. As for the proportions of sex across two groups, the pattern was also similar between them (Pearson's Chi-squared test, P-value=0.5431).

The calculus, caries and AMTL incidences for each group were statistically compared using the Pearson Chi-square test. To compare the prevalence when the total sample number was less than 10, Fisher's exact test was used. Differences in tooth wear were evaluated using the simple t-test. Finally, the package ggplot2 implemented in package R version 3.4.0 (R Foundation for Statistical Computing, Vienna, Austria) with the implemented geom_polygon function was used to draw a radar chart for displaying the calculus prevalence data of each group and the above-described caries prevalence by tooth location. The caries prevalence of each Siberian native subgroup (Khanty, Nenet, Selkup and Tatar) was plotted in the radar chart (Wickham, 2009).

Results

Tooth wear

Table 5 shows the difference of dental wear grade between Siberian natives and Russian settlers. In all age groups, except age group 4, the Russian settlers (5.39) had a higher degree of tooth wear than the Siberian natives (4.76) (t-test, p=0.0175).

Khanty (6.28) had the most severe degree of tooth wear pattern, followed by Selkups (5.26) and Nenets (5.09) (Table 6). Tatars (3.95) showed very low tooth wear degree compared to other groups.

Table 5. Dental wear grade in Siberian natives and Russian settlers

Age group	Sum of dental wear grade/total number of teeth		
	Siberian native	Russian Settler	P valuea
Adolescent	2.77	4.9	0.0005276***
YA	4.09	4.62	0.06295
MA	5.85	5.88	0.9263
OA	7.03	6.52	0.4199
Total	4.76	5.39	0.0175*

* T test
YA, young adult; MA, middle adult; OA, old adult

Table 6. Dental wear grade in each Siberian native sub-group and Russian settlers

Tribe	Sum of dental wear grade/total number of teeth
Khanty	6.28
Nenet	5.09
Selkup	5.26
Tatar	3.95
Russian	5.39
Total	5.07

AMTL

In the current study, the Russian settlers' AMTL prevalence (19.3%) was higher than that of the indigenous Siberians (2.8%), regardless of age (Table 7). This result was expected, given that the Russian settlers were farmers and the Siberian natives were hunter-gatherers. In terms of AMTL prevalence by sex (Table 8), Russian settler females showed higher prevalence of AMTL than males did (Chi-squared, p= 0.002543). As for the indigenous Siberians, however, the male and female AMTL prevalences were almost identical (Chi-squared, p=0.1209). To control for the potential adverse e□ect of AMTL on caries prevalence, the combined prevalence of caries and AMTL (Table 9 and Table 10) was also calculated. In the Russian settlers, combined caries/AMTL prevalence increased with age. Siberian natives also showed an increasing pattern in combined results, specifically in age classes 1 to 3. Meanwhile, the combined prevalence of caries and AMTL was very low in age class 4 among the native Siberians (Table 9).

The analysis of AMTL prevalence among Siberian native groups were as follow. The Selkups (4.09%) showed the highest prevalence, followed by Tatar (2.37%) and Nenets (1.99%). In the case of Khanty, the prevalence was 1.94%, which was the lowest among the groups (Table 11).

Table 7. AMTL prevalence in Siberian natives and Russian settlers

Age group	Siberian natives N AMTL (prevalence)	Russian settlers N AMTL (prevalence)	P value
Adolescent	0/137 (0.000)	6/201 (2.9851)	[a]0.105
YA	5/970 (0.5155)	40/780 (5.1282)	[b]3.47e-09***
MA	45/616 (7.3052)	158/551 (28.6751)	[b]< 2.2e-16***
OA	2/134 (1.4925)	128/192 (66.6667)	[b]< 2.2e-16***
Total	52/1,857(2.8002)	332/1,724(19.2575)	[b]< 2.2e-16***

* [a]Fisher's exact test; [b]Pearson's Chi-squared test
YA, young adult; MA, middle adult; OA, old adult

Table 8. Comparison of AMTL prevalence between females and males

		Sex		**P value between sex (Chi-square test)**
		Female	**Male**	
Group	Siberian natives	32/928 (3.448 %)	20/929 (2.153 %)	0.1209
	Russian settlers	212/971 (21.833 %)	120/753 (15.936 %)	0.002543**
P value between groups (Chi-square test)		< 2.2e-16***	< 2.2e-16***	

* Pearson's Chi-squared test

Table 9. Comparison of combined caries & AMTL prevalence in Siberian natives and Russian settlers

Age group	Caries & AMTL combined prevalence (%)		
	Siberian natives N	Russian settlers N	P value
Adolescent	0/137 (0.000)	20/201 (9.950)	0.0003547***
YA	47/970 (4.845)	98/780 (12.564)	9.76E-09***
MA	56/616 (9.091)	220/551 (39.927)	< 2.2e-16***
OA	3/134 (2.239)	149/192 (77.604)	< 2.2e-16***
Total	106/1857	487/1724	< 2.2e-16***

* Pearson's Chi-squared test
YA, young adult; MA, middle adult; OA, old adult

Table 10. Statistical analysis in caries and AMTL of Siberian natives and Russian settlers

	Siberian natives	Russian settlers
Only caries	19	17
caries with AMTL	4	38
Only AMTL	7	11
Without both	45	13
Total	75	79
P value	0.00000003042***	0.3079

* Pearson's Chi-squared test

Table 11. AMTL prevalence in each Siberian native tribes and Russian settlers

Tribe	AMTL prevalence
Khanty	1.94
Nenet	1.99
Selkup	4.09
Tatar	2.37
Russian	19.26
Total	5.93

Calculus

In this study, the prevalence of calculus deposition was significantly higher in Russian settlers (22.6%) than Siberian natives (10.8%) (Chi-squared, p=< 2.2e-16) (Table 12; Figure 8). Also, the prevalence of individuals with calculus was higher in Russian settlers (60.8%) compared to Siberian natives (30.7%) with statistical differences. (Chi-squared, p= 0.0003399) (Table 13).

The prevalence of calculus deposition in males was noteworthy in both groups. In Siberian natives (n=1,404), calculus was found in 112 out of 745 male teeth (15.0%) while 39 out of 659 female teeth (5.9%). The calculus prevalence was statistically different between both sexes (Fisher exact test, p= 6.105e-08) (Table 14). In case of Russian settler's teeth (n=1,305), I found 141 calculus out of 565 male teeth (25.0%) and 154 calculus out of 739 female teeth (20.8%). This difference was not statistically significant (Fisher exact test, p= 0.09028) (Table 14).

Among the native Siberians, the calculus prevalence was lowest in the Khanty (3.85%) and the highest in the Selkup (13.36%) (Table 15).

Table 12. Statistical analysis of calculus per teeth prevalence among Siberian natives and Russian settlers

Age group	Siberian native				Russian settler				P value
	Total (n)	Affected (n)	Non-affected (n)	Prevalence (%)	Total (n)	Affected (n)	Non-affected (n)	Prevalence (%)	
Adolescent	208	2	206	1	221	27	194	12.2	8.649e-06***
YA	628	54	574	8.6	534	147	387	27.5	< 2.2e-16***
MA	457	64	393	14	400	106	294	26.5	7.101e-06***
OA	111	31	80	27.9	149	15	134	10.1	0.0003587***
Total	1,404	151	1,253	10.8	1,304	295	1,009	22.6	< 2.2e-16***

* Pearson's Chi-squared test
YA, young adult; MA, middle adult; OA, old adult

Table 13. Statistical analysis of calculus per individual prevalence among Siberian natives and Russian settlers

Age group	Siberian native				Russian settler				P value
	Total (n)	Affected (n)	Non-affected (n)	Prevalence (%)	Total (n)	Affected (n)	Non-affected (n)	Prevalence (%)	
Adolescent	10	1	9	10	9	7	2	77.8	[a]0.005477**
YA	34	10	24	29.4	30	20	10	66.7	[b]0.006345*
MA	25	10	15	40	26	16	10	61.5	[b]0.2084
OA	6	2	4	33.3	14	5	9	35.7	[a]1
Total	75	23	52	30.7	79	48	31	60.8	[b]0.0003399***

* [a]Fisher exact test; [b]Pearson's Chi-squared test
YA, young adult; MA. middle adult; OA, old adult

Table 14. Comparison of calculus prevalence between females and males

Population	Age group	Male				Female				P value
		Total (n)	Affected (n)	Non Affected (n)	Prevalence (%)	Total (n)	Affected (n)	Non Affected (n)	Prevalence (%)	
Siberian natives	Adolescent	56	2	54	3.6	152	0	152	0	[a]0.07153
	YA	294	42	252	14.3	334	12	322	3.6	[b]3.713e-06***
	MA	341	64	277	20.4	116	0	116	0	[b]1.079e-06***
	OA	54	4	50	7.4	57	27	30	47.4	[b]7.509e-06***
	Total	745	112	633	15	659	39	620	5.9	[b]6.105e-08***
Russian settlers	Adolescent	73	8	65	11	148	19	129	12.8	[b]0.855
	YA	230	84	146	36.5	304	63	241	20.7	[b]7.834e-05***
	MA	186	40	146	21.5	214	66	148	30.8	[b]0.04587*
	OA	76	9	67	11.8	73	6	67	8.2	[b]0.6438
	Total	565	141	424	25	739	154	585	20.8	[b]0.09028

* [a] Fisher exact test; [b] Pearson's Chi-squared test
YA, young adult; MA, middle adult; OA, old adult

Table 15. Calculus prevalence in each Siberian native sub-group and Russian settlers

Tribe	Individual Number	Calculus prevalence (%)
Khanty	7	5/130 (3.85)
Nenet	12	19/157 (12.10)
Selkup	22	80/599 (13.36)
Tatar	34	30/518 (5.79)
Russian	79	295/1305 (22.61)
Total	154	429/2709 (15.84)

Caries

Indeed, in this study, whereas the rate of dental caries among the agriculturalist Russian settlers was 11.88%, it was only 3.85% in non-agriculturalist Siberian natives (Table 16).

The Russian settlers also showed increased dental caries prevalence as age increased (Table 16). However, this tendency was not observed in Siberian natives, as caries prevalence declined in age classes 3 and 4. I assumed that this might have been caused by the effect of AMTL on dental caries prevalence. As AMTL is mainly caused by dental caries (Nelson et al., 1999; Lukacs, 2008; Walter et al., 2016), caries prevalence will be underestimated if AMTL is not considered. To control for the potential adverse effect of AMTL on caries prevalence, I also calculated the combined prevalence of caries and AMTL (Table 11). In the Russian settlers, combined caries/AMTL prevalence increased with age. Siberian natives also showed a increasing pattern in combined results, specifically in age classes 1 to 3. Meanwhile, the combined prevalence of caries and AMTL was very low in age class 4 among the Siberian natives (Table 9).

Among the indigenous skeletons examined in the current study, caries in female (6.1%) was more commonly observed than in males (1.9%) (Chi-squared, p=7.559e-05), indicating that Siberian native women were at greater risk of caries (Table 17). Interestingly, in the current case of the Russian settlers did not showed, the inter-sex difference with statistical significance (Chi-squared, p=0.52) (Table 17).

In this study, caries prevalence was much higher in the posterior teeth than in the anterior. The posterior teeth also showed a much higher caries prevalence among the Russian settlers (16.2%) than among the indigenous Siberian peoples (5.3%) (Table 18; Fig. 9A). Among the native Siberians, all known to have been pastoralists or hunter-gatherers, the caries prevalence was the lowest in the Selkup (0.5%) and the highest in the Tatars (8.1%) (Table 19; Fig. 9B).

Table 16. Comparison of caries prevalence between Siberian natives and Russian settlers

Age group	Carious prevalence (%)		
	Siberian natives	**Russian Settler**	**P value**
Adolescent	0/105 (0.000)	14/160 (8.750)	0.004601**
YA	42/731 (5.746)	58/611 (9.493)	0.01246*
MA	11/457 (2.407)	62/400 (15.500)	1.73E-11***
OA	1/111 (0.901)	21/134 (15.672)	0.000144***
Total	54/1,404 (3.846)	155/1,305 (11.877)	8.79E-15***

* Pearson's Chi-squared test

Table 17. Comparison of caries prevalence between females and males

Group	Carious prevalence in both sexes (%)		
	Female	Male	P value
Siberian Native	40/657 (6.088)	14/747 (1.874)	7.56E-05***
Russian Settler	92/739 (12.449)	63/566 (11.131)	0.52
P valuea	7.41E-05***	3.63E-12***	

* Chi-square test

Table 18. Prevalence of dental caries between Siberian natives and Russian settlers (by tooth component)

Age group	Carious prevalence in anterior teeth (%)			Carious prevalence in posterior teeth (%)		
	Siberian natives	Russian settlers	P value	Siberian natives	Russian settlers	P value
Adolescent	0/34 (0.000)	4/50 (8.000)	[a]0.1434	0/71 (0.000)	10/110 (9.091)	[a]0.00688**
YA	2/215 (0.930)	1/186 (0.538)	[a]1	40/516 (7.752)	57/425 (13.412)	[b]0.00626**
MA	0/154 (0.000)	4/142 (2.817)	[a]0.0518	11/303 (3.630)	58/258 (22.481)	[b]3.007e-11***
OA	0/29 (0.000)	2/39 (5.128)	[a]0.5035	1/82 (1.220)	19/95 (20.000)	[b]0.0002178***

* [a]Fisher's exact test; [b]Pearson's Chi-squared test
YA, young adult; MA, middle adult; OA, old adult

Table 19. Caries prevalence in each Siberian native sub-group and Russian settlers

Tribe	Individual Number	Caries prevalence (%)
Khanty	7	3/130 (2.31)
Nenet	12	6/157 (3.82)
Selkup	22	3/599 (0.50)
Tatar	34	42/518 (8.11)
Russian	79	155/1305 (11.88)
Total	154	209/2709 (7.72)

Figure 2. The teeth of Siberian natives. Example of a maxilla (A), and a mandible (B).

Figure 3. The teeth of Russian settlers. Example of a maxilla (A), and a mandible (B).

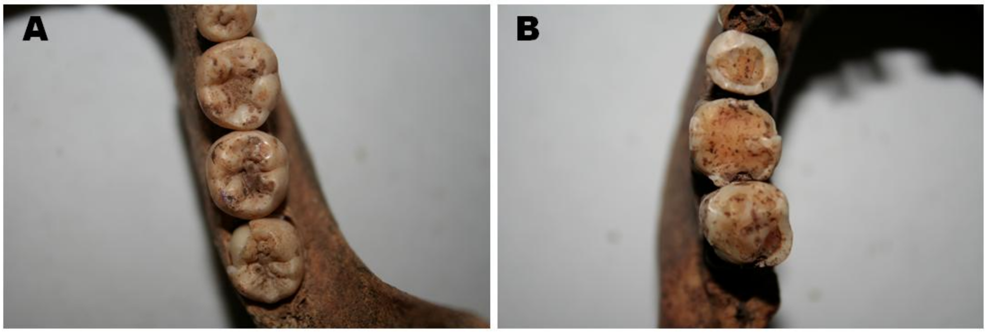

Figure 4. Examples of tooth wear in Siberian natives (A), and Russian settlers (B).

Figure 5. Examples of AMTL in Siberian natives (A), and Russian settlers (B).

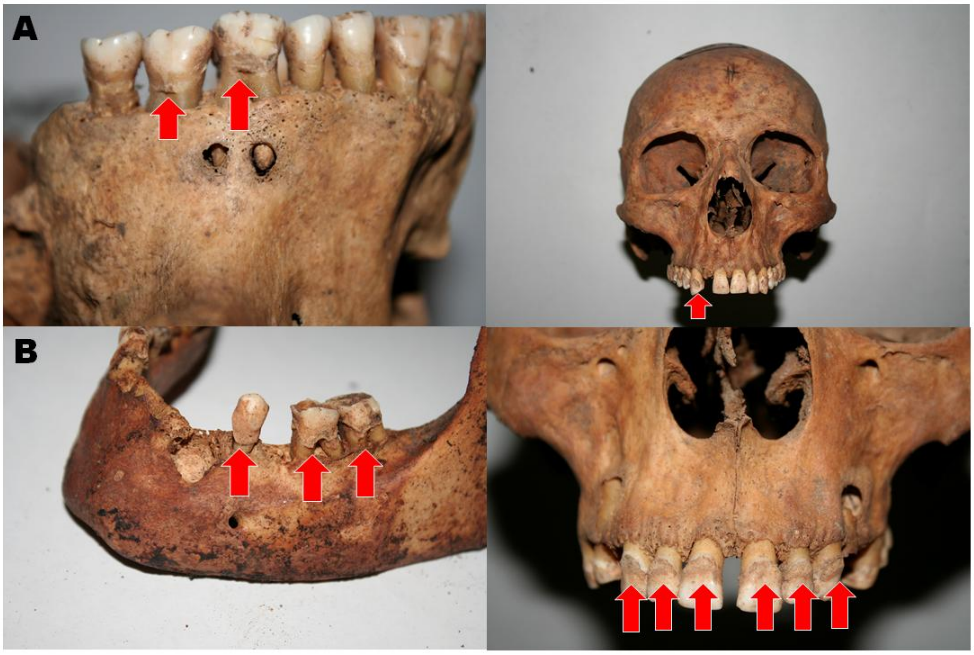

Figure 6. Examples of dental calculus in Siberian natives (A), and Russian settlers (B).

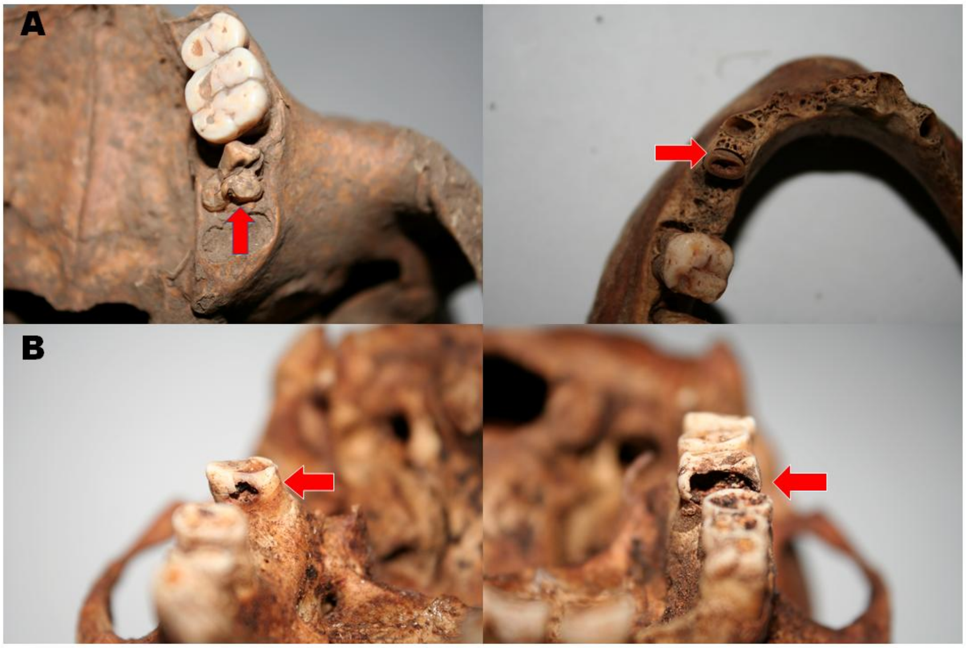

Figure 7. Examples of dental caries in Siberian natives (A), and Russian settlers (B).

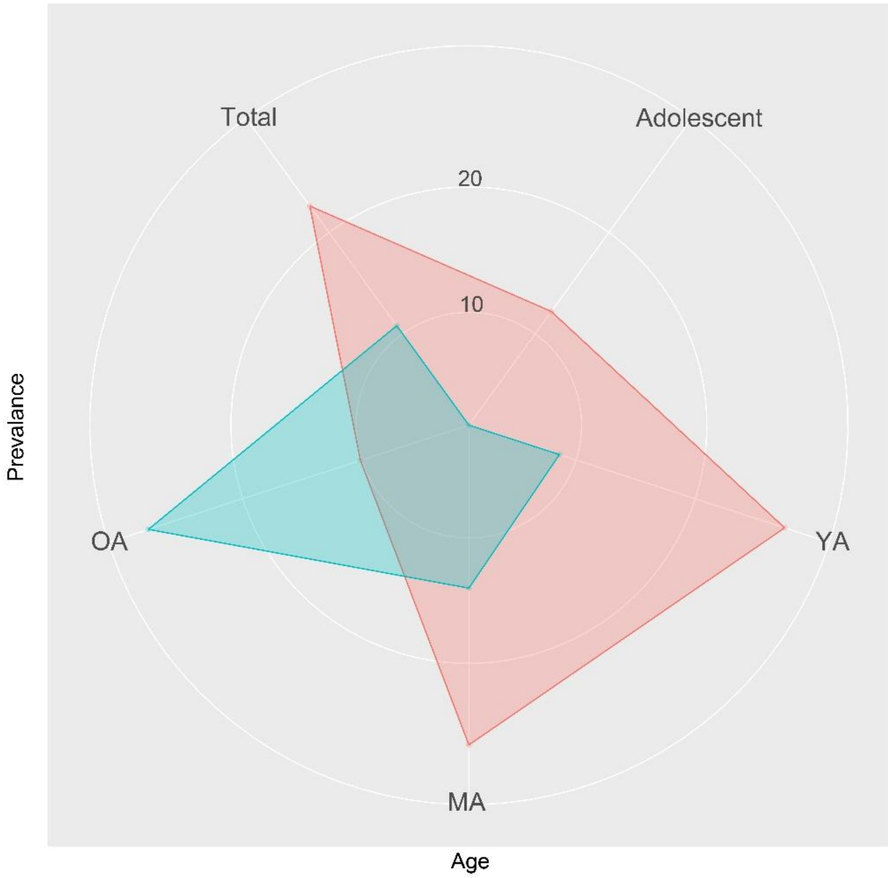

Figure 8. The radar charts displaying calculus prevalence. Prevalence of dental calculus in Siberian natives (blue) and Russian settlers (red) by tooth numbers.

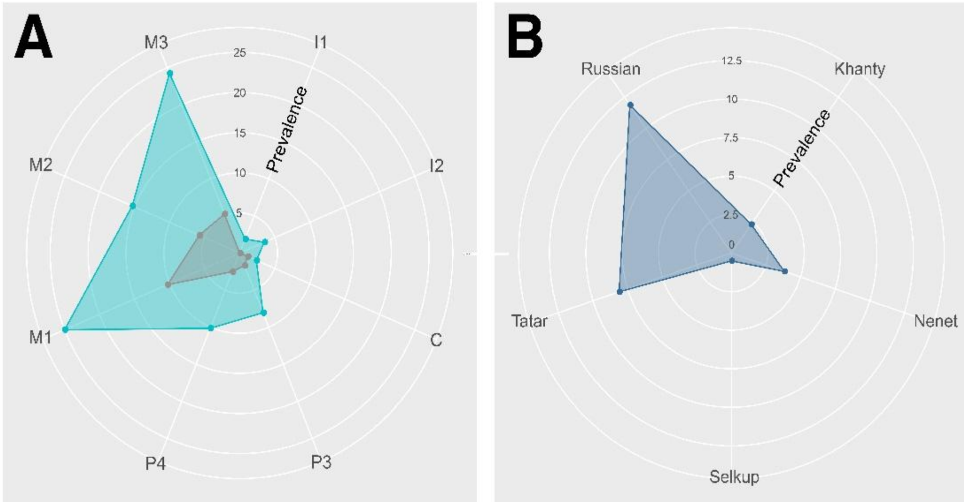

Figure 9. The radar charts displaying caries prevalence. (A) Prevalence of dental caries in Siberian natives (red) and Russian settlers (blue) by tooth location (I1, Central Incisor; I2, Lateral Incisor; C, Canine; P3, 1st Premolar; P4, 2nd Premolar; M1, 1st Molar; M2, 2nd Molar; M3, 3rd Molar). (B) Caries prevalence of Russian settlers and each Siberian native group (Khanty, Nenet, Tatar, Selkup).

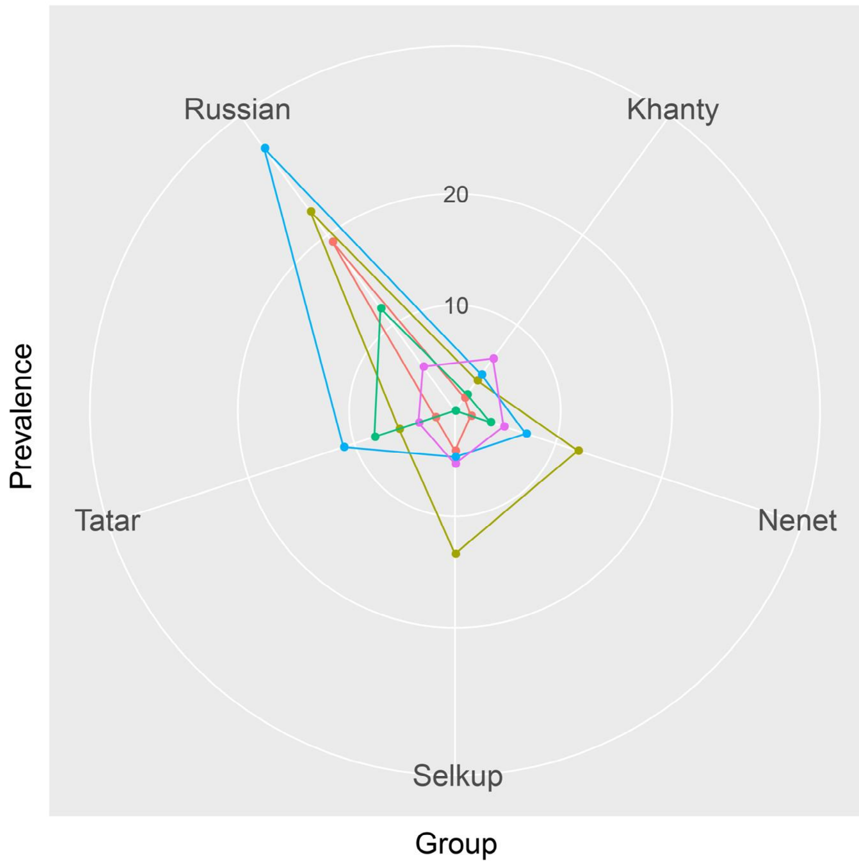

Figure 10. The radar charts displaying prevalence of dental diseases and tooth wear degree in Russian settlers and Siberian native sub-groups. AMTL prevalence (red), calculus prevalence (olive green), caries prevalence (green), caries & AMTL combined (blue) prevalence and tooth wear degree (pink).

Discussion

On the basis of the cause-effect relationship between carbohydrate intake and dental caries formation, carious lesions are often used as a marker to reconstruct the populations' subsistence in the past. Data obtained by the current study of dental pathologies thus serve as important resources for evaluating life conditions of the historical peoples in the 16th to 19th century West Siberia. Of these two groups that simultaneously inhabited in West Siberia (Siberian natives and Russian settlers), one group was composed mainly of hunters and fishermen who supplemented terrestrial resources with fishing and hunting while Russian settlers subsisted mainly on agricultural products.

Actually, previous anthropological studies generally reported that the health status of prehistoric hunter-gatherers might have been better than agriculturalists' (Goodman et al., 1980; Latham, 2013). Most of these studies assumed that agricultural populations faced an increasing risk of different diseases as well as a decline in nutritional intake due to restrictive diets. These effects were due to the reliance on a limited array of crops compared to the diverse diets consumed by hunter-gatherers (Cohen and Armelagos, 1984). The difference of tooth wear, AMTL, calculus, and caries between the two groups and other related topics are thus discussed as follows (Figure 10).

Tooth wear

The prevalence of tooth wear is known to be related to diet (Roberts, 1970; Molnar, 1971; Perzigan, 1977; Grine and Kay, 1988; Kerr, 1988; Ungar, 2004). In general, hunter-gatherer's foods generally contained coarser ingredients (Whittaker et al., 1982, 1985, 1987, 1990; Gordon, 1984; Grine and Kay, 1988; Puech, 1992; Teaford and Lyle, 1996). Therefore, tooth wear has been more commonly observed among hunter-gatherers than among agriculturalists.

In the present study, however, in most age groups (except of age group 4), the Russian settlers showed a higher degree of tooth wear than the Siberian natives did (Table 5). For this, it is notable that indigenous peoples in Siberia are less dependent on vegetable foods than hunter-gatherers in other regions. In other words, harsh weather condition of Siberia with a short vegetation period made it difficult to collect enough vegetables; but only fish or deer could be available for their diets (Levin and Potapov, 1956; Savchenko et al., 2015). In addition, the Siberian native peoples ate fish and meat raw without cooking, which is likely to be associated further with low prevalence of tooth wear (Levin and Potapov, 1956).

AMTL

Regardless of the exact cause of teeth loss, AMTL provides important indications about the human population's dental health (Lukacs 1989; Kelley et al., 1991; Langsjöen, 1996). In addition, it is also used to infer historical subsistence strategies or as a proxy for determination of carbohydrates proportions in diets (Turner, 1978, 1979; Powell, 1985; Hillson, 1996, 2001). In the current study, the Russian settlers' AMTL prevalence was higher than that of the indigenous Siberians. Given that the Russian settlers were farmers and the Siberian natives were hunter-gatherers, the results could be easily predictable (Lanfranco and Eggers, 2012). In terms of AMTL prevalence by sex, Russian settler females showed higher prevalence of AMTL than males did. As for the indigenous Siberians, however, the male and female AMTL prevalence were almost same

(Table 8). The exact cause of this difference of AMTL by sex in two groups should be studied further in the future.

Calculus

Calculus deposits are generally covered by non-mineralized bacterial plaque. It is this plaque that plays a major pathological role in periodontitis and alveolar abscess (Lukacs, 1989; Mandel, 1990; Hillson, 1996). In fact, a number of factors are known to affect the prevalence and extent of calculus formation (Forshaw, 2014). While there are many factors involved in the generation of calculus, diet has long been a part of major interest in research (Lieverse, 1999; Flensborg, 2016). It is generally accepted that calculus deposition is facilitated by an alkaline oral pH which is induced by high protein diets. Plaque forming is also known to be facilitated by high carbohydrate consumption and severe dental attrition (Dawes, 1970; Mandel, 1973, 1974; Damen and ten Cate, 1989; Rolla et al., 1989; Flensborg, 2013).

As for the relationship between calculus formation and diets, there are several contradictory theories. Some claimed that calculus deposition might be related to the consumption of protein-rich foods (Lillie, 1996; Lieverse, 1999). Others argued that carbohydrate rich diets might promote calculus deposition (Littleton and Frohlich, 1989). Hillson (1979) asserted that dental caries and calculus tended to be mutually exclusive. Other studies also demonstrated a correlation between high calculus rates and farm products (Evans, 1973; Homan, 1977; Brothwell, 1981; Cassidy, 1984; Lukacs, 1989; Eshed et al., 2006).

In this study, the prevalence of calculus deposition *by teeth* was significantly higher in Russian settlers than Siberian natives. Also, the prevalence of calculus *by individual* was statistically higher in Russian settlers (60.8%) compared to Siberian natives (30.7%) (Table 13). Russian settlers in this study seem to have consumed agricultural crops (mainly wheat) while Siberian natives mostly relied on animal products for their diets. This result thus suggests that an increase in carbohydrate intake might play more important role in dental calculus formation in this study.

As seen in Table 12, the Siberian natives showed an increase in calculus prevalence as age increased. However, the same pattern was not observed in Russian settlers. Like Siberian natives, the calculus prevalence of Russian settlers increased as age increased, but declined in age class 4 (Table 12). This might be explained by AMTL increase in age class 4. The prevalence of calculus deposition by sex was also noteworthy. In Siberian natives, calculus was found more frequently in males than in females, which could be statistically evidenced. On the other hand, in case of Russian settlers, the difference between sexes was not statistically significant (Table 14). Higher prevalence of calculus in males could be explained by the males' poorer oral hygiene or doing more practices relating with an oral alkaline pH etc. (Bongfiglioli and Belcastro, 2003; Flensborg, 2013).

Caries

In dental paleopathology, caries is one of the diseases easily observable in human skeletons recovered from archaeological excavations. It starts at the enamel surface of the tooth or at the exposed parts of the tooth neck. Caries extends further through the dentine into the pulp cavity; and other periodontal diseases may follow (as pulpoalveolar and periodontal). Finally, the affected tooth falls out and subsequently the alveolus is closed naturally (Caselitz, 1998). Caries is thus a good proxy for overall dental health and dietary changes in historical populations (Larsen et al., 1991; Sciulli, 1997; Temple and Larsen, 2007; Šlaus et al., 2011).

The cause-effect relationship between carbohydrate-rich foods and dental caries has been discussed (Hillson, 1979; Costa, 1980; Sreebny, 1983; Goodman et al., 1984; Kashket et al., 1994; Larsen, 1995; Katzenberg, 1997; Herskovitz, 1998; Lingström and Borrman, 1999; Nelson, Lukacs and ö Yule, 1999; Saunders et al., 2007; Han et al., 2010). Carious lesions have also been studied in attempts to infer each groups' subsistence strategies (Lanfranco and Eggers, 2010).

Many literatures about the influence of diets on overall dental health has dealt with the beginning of agriculture. Briefly, Turner's review (1979) indicated that the reported caries rates of hunter-gatherer populations ranged between 0.0% and 5.3% while the peoples with a mixed subsistence or agriculturalists' lifestyle were much higher: 0.44–10.3% or 2.3–26.9%, respectively. In short, a transition from hunting/gathering to an agriculture-based strategy seems to have caused an increase of caries prevalence in history (Larsen et al., 1991; Lukacs, 1992; Temple and Larsen, 2007; Watson, 2008; Cucina et al., 2011; Halcrow et al., 2013).

In this study, Russian settlers were agriculturalists who consumed high-carbohydrate foods whereas native Siberians ingested more meats and fishes than cereals (Slepchenko, 2017). Therefore, it could be easily presumed that the latter showed a lower prevalence of dental caries due to less intake of carbohydrate-rich foods. Indeed, the prevalence of dental caries among the agriculturalist Russian settlers was far higher than non-agriculturalist Siberian natives in this study.

Dental Caries as Age Increased

Russian settlers showed increase in dental caries prevalence as age increased in this study. However, this tendency was not observed in Siberian natives, as caries prevalence declined in age classes 3 and 4 (Table 16). In my opinion, this might have been caused by the effect of AMTL on dental caries prevalence. As AMTL is mainly caused by dental caries (Nelson et al., 1999; Lukacs, 2008; Walter et al., 2016), the caries prevalence could be underestimated if AMTL will not be given in due consideration. In fact, the reports of dental caries prevalence generally employ *the observed caries rate* or *caries index*, obtained by dividing the number of teeth with one or more carious lesions by the total number of teeth observed (Lukacs, 2011). However, this index also has a practical limitation that teeth lost during lifetime is not considered (Lukacs, 2011). Since some AMTLs were commonly occurring due to caries, the prevalence of caries estimated by *caries index* might underestimate the caries actually experienced by the group.

Instead, a method that attempts to rectify this problem is *the decayed-and-missing index*, in which the sum of all carious teeth and all teeth lost antemortem is divided by the total number of teeth observed plus those lost antemortem (Powell, 1985; Kelly et al., 1991). Since this index could reduce the potential adverse effect of AMTL on caries prevalence in archaeological specimens, the combined prevalence of caries and AMTL (the decayed-and-missing index) was estimated in this study. In the Russian settlers, combined caries/AMTL prevalence increased with age. Siberian natives also showed an increasing pattern in combined results, specifically in age classes 1 to 3. As for the Siberian natives' combined prevalence very low in age class 4 (Table 9), it could be assumed that native individuals who suffered from caries or AMTL might have died earlier than those who did not.

Difference in Caries between Sex

In previous studies, the reports on difference in caries between sex were not the same. Briefly, some authors (Lukacs and Largaespada, 2006; Temple and Larsen, 2007; Lukacs, 2011b,) argued that increased estrogen level might have related to decrease in salivary-flow rates, which further promotes bacterial fermentation of carbohydrate, finally causing higher caries prevalence rates in females. Also, the others suggested that hunting behavior might have afforded men more opportunities to ingest less cariogenic meat products, while the plant-gathering behavior of women might have consumed more cariogenic plant foods (Temple and Larsen, 2007). Despite these presumptions, there is also an anthropological report with a different result on this subject: a higher prevalence of caries in males than in females in 12th to 14th century medieval French skeletons (Esclassan et al., 2009).

In the present study, among the indigenous skeletons examined, caries in females was more commonly observed than in males, indicating that Siberian native women were at greater risk of caries than men were (not statistically significant) (Table 17). This tendency is presumed to be associated with the AMTL prevalence. As for the difference between the sexes not remarkable in the Russian settlers, it must be considered that the AMTL difference between both sexes was more apparently observed in Russian settlers, which means that observable caries rates might have become low due to the AMTL.

Difference in Caries between Anterior and Posterior Teeth

In this study, caries prevalence was generally higher in the posterior teeth than in the anterior teeth. The posterior teeth also showed a much higher caries prevalence among the Russian settlers than among the indigenous Siberian peoples (Table 18). Likewise, previous studies reported that posterior teeth were much more frequently affected by caries. The highest prevalence of caries was mainly observed in molars (4.3–57.6%) while incisors and canines showed the lowest prevalence of caries (0.0–4.7%) (Kerr et al., 1988; Hillson, 2001; Vodanović et al., 2005; Esclassan et al., 2009; Meng et al., 2011; Novak, 2015). This is due to the fact that posterior teeth have more complex morphology (Hillson, 2001). Bacterial plaque could accumulate more easily on surfaces with teeth pits and cracks, which could not be removed easily (Powell, 1985).

The Pattern between Siberian Natives

In the present study, among the Siberian natives, the caries prevalence was the lowest for the Selkup and the highest for the Tatars. The Tatar people’s higher prevalence of caries raised the possibility that they might have consumed more carbohydrates than did the other native peoples.

In previous ethnological studies, some of Siberian native tribes (Nenets, Khanty, and Selkup) sustained nomadic life and engaged in reindeer herding. They were less influenced by immigrant Russian culture in history (Golovnev and Osherenko, 1999). On the other hand, Tatar people showed relatively little resistance to imported Russian culture. They were living in the place geographically very close to the Russian settlers, subsisting on primitive form of agriculture in part (Levin and Potapov, 1956). Since they run the agricultural as well as traditional hunting and fishing lives together, the Tatars has a cultural heritage distinct with the other Siberian tribes, an interim identity between Siberian natives and Russian settlers (Levin and Potapov, 1956). Their contact with the Russian settlers resulted in the acquisition of abundant agricultural products and the resultant intake of sufficient carbohydrates (Slepchenko, 2016). They had easier access to immigrant Russian agriculturalists' products such as flour and sugar than did their indigenous counterparts. Actually, in the process of global colonization, similar tendency, native peoples' traditional diets replaced by western foods, is commonly reported worldwide (Holloway et al., 1963; Mayhall, 1970). Taken together, in the present study, dental caries differently affected each sub-group of Siberian native peoples according to their dietary patterns and subsistence strategies.

Conclusion

Dental-pathological indicators yield important clues regarding the diets and lifestyles of human populations in history. Comparing peoples living at the same places during similar period is very informative in anthropological perspective (Lanfranco and Eggers, 2012). The aim of this study was thus to consider dento-pathological indicators in the 16th to 19th century West Siberian human groups (native peoples and Russian settlers) with different subsistence strategies.

The current study demonstrated a significant difference of several dental pathologies between the two groups co-existed in the 16th and 19th century West Siberia. Briefly, statistically significant differences were observed in the prevalence of dental calculus, AMTL and caries among them. In inter-observer error minimized way, the current study reconfirms the extant anthropological hypothesis that several dental diseases increased in agriculturalists than in hunter-gatherers in history.

Meanwhile, in the present study, the difference of tooth wear was not observed between the two populations. Considering the previous reports that tooth wear was observed at a higher prevalence in hunter-gatherers, the result of the current study looks exceptional. However, it is notable that the foods consumed by the Siberian natives were mainly composed of raw fish and meat. The foods might not have been so tough as to cause severe tooth wear, commonly seen in the other hunter-gatherer peoples.

In summary, by a complex array of pathological manifestations that indicates differential access to food and divergent lifestyles in Siberia, the present thesis could support or modify the previous theories and hypothesis on dental pathologies of hunter-gatherers and agriculturalists in history. My thesis on dental pathologies of the 16th to 19th century Russian settlers and Siberian native peoples in West Siberia was successful in revealing the followings. First, the differences in dental health of these populations could be successfully assessed. Next, their health status could be examined within the circumstances of their subsistence and environment. And finally, a fundamental hypothesis of the correlation between diet and dental health that could be applied to the future related studies in historical Siberia could be proposed in the present thesis.

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Appendix 1. Ethnicity and life style of Siberian natives and Russian settlers

	Siberian Native Peoples				Russians
	Khanty	**Nenets**	**Selkups**	**Tatars**	
General Information	▪ Except for some small peripheral groups, they lived in the Ob' Basin. ▪ In many of the places where they settled, the Khanty also lived in close contact with the Russian. ▪ In the north they are neighbors of the Nenet and Komi, and in the east of the Selkup. ▪ In culture, Khanty and Mansi were very close to one another, particularly in the field of graphic art, religious	▪ The Nenets are the largest of the Samoyedic-speaking peoples. ▪ The territory settled by the Nenet was very extensive and almost entirely covered the European tundra and forest tundra from the river Mezen' in the west to the left tributaries of the river Pyasina-the Pur and Agapa-to the east in Siberia.	▪ Belongs to the peoples of the Samoyedic-speaking group. ▪ During the migrations of the Samoyedic groups in the taiga belt, there emerged as the Selkup people, similar in economy and culture to their neighbors, the Khanty and Kets. ▪ Some of the Selkups migrated in the 17^{th} century from the Ob' Basin to the river Taz, and then to the river Turukhan.	▪ The West-Siberian Tatars live chiefly in rural localities, and their settlements are interspersed among the Russian settlements. ▪ To a lesser extent they live in the towns of Western Siberia, such as Tyumen, Tobol'sk, Tomsk, Tara, Barabinsk, Novosibirsk, Omsk and other places.	▪ It was the Russians who opened up Siberia to the European world. The chief inducement to geographical exploration among the Russians was economic interest, that is to say, the desire to expand their spheres of economic activity by discovering new territories, to expand relations with neighboring lands, and to develop trade by incorporating the newly discovered regions.

	belief, folklore, and social organization. ▪ The extensive settlement of Khanty in territories with a variety of different terrains, and the different cultural influences of neighboring peoples, brought about a rather variegated picture of their economy.				▪ Siberia was discovered by the Russian many centuries before it was finally incorporated into the Russian State, and the name "Siberian land" is found Russian chronicles dating from 1407. It was one of the most important discoveries in world geography. ▪ Siberia was incorporated into Russia at the end of the 16th and beginning of the 17th century, during the formation of the Russian multinational state. ▪ The Russian State, growing economically and strengthening politically, required the

					expansion and fortification of its frontiers. ▪ The incorporation of Siberia, discovered by Russians, completely accorded with this aim. In Siberia, which was the natural continuation of the territory of the Russian State beyond the Urals, which had great natural wealth and was so sparsely populated, the Moscow government saw a major source of territorial and economic development of Russia. ▪ The great majority of the Russian population of Siberia consisted of peasants living in rural

					localities.
Subsistence	▪ The economy of the bulk of Khanty combined fishing and hunting with reindeer-herding or pastoralism, as subsidiary occupations. ▪ Fishing, hunting, or reindeer-herding took prominence according to local conditions. ▪ Among the Khanty living on the Ob' and on the lower reaches of its tributaries, fishing was the chief occupation. ▪ The inhabitants of the upper reached of these rivers, Khanty engaged	▪ The Nenet engaged in reindeer-breeding, fishing and hunting (on land at sea). ▪ Characteristic features of tundra Nennish reindeer-breeding were pasturing of all year round under the supervision of herdsmen, herding the reindeer by means of herd-dogs and the exclusive use of reindeer -drawn sleighs. ▪ Long-distance seasonal migration was typical of the tundra form of reindeer-breeding. ▪ In winter, the herds	▪ On the Taz the Selkups acquired reindeer-breeding. ▪ That is how the group of northern Selkups, separated from the Ob' group by the Khanty population on the river Vakh and the Ket population on the river Yeloguy came into being. ▪ A considerable number of Narym Selkups, particularly those living on the Ob', developed close relations with the Russian peasants and fishermen settling the	▪ The commonest occupation among the Siberian Tatars was agriculture, which they had practiced since the end of 16th century. The chief form of agriculture was the long-term-fallow system. ▪ The fields were worked with wooden ploughs and wooden harrows with iron teeth. ▪ They sowed barley, rye and oats. From beginning of the 20th century, wheat became common. ▪ Fishing was common	▪ Agriculture was the main occupation of the Russian peasants. ▪ The farming condition in Siberia was quite different from farming in the central regions. ▪ Only a small area of the lessee's land (peasant holding) was cultivated, and the remainder lay fallow. After several harvests, the land was left fallow for as long as 15 years. ▪ The basic crops were wheat, winter and spring rye, oats and

	chiefly in hunting, while fishing was of secondary importance. ▪ The techniques and fishing tackle varied among local groups. The Khanty from the lower reaches used to leave their settlements and go to the Ob' for the fishing season. ▪ Over the whole period of the catch they lived with their families in summer dwellings, catching the fish and preserving it. ▪ As soon as the fishing ended, just before the rivers froze over, they returned to their winter residence.	were grazed in the forests, in the forest-tundra or in the scrub-type tundra where the snow was softer, and the reindeer could find food without difficulty. ▪ Nor was there any lack of fuel, so essential during the cold months, in those parts. ▪ In the spring, the Nenet began migrating back to the north and on the way sometimes went as far as Artic coast. ▪ The ever-present winds drove off the mosquitoes that pestered the animals and there were also good fishing waters there. In the fall they	Ob' in the 16th century. ▪ By the 17th century the Narym Selkups had assimilated the Russian language and by the beginning of the 20th century the Ob' Selkups were all bilingual, many having completely lost their native language. ▪ The age-old basic occupations of the Selkups were hunting and fishing, Reindeer-breeding was known only to the Northern Selkup, among whom it was used for purposes of transportation. ▪ The main hunting weapon among the Selkups from the second half of the 19th	among the Marsh Tatars, and they also engaged in hunting. In the lakes and large rivers their fishing tackle consisted of small nets and large cast seines. ▪ The hunting of fur animals was ▪ The first Siberian Tatar collective farms were set up in 1928, but it was not until 1930-31 that people began joining the collective farms on a wide scale. ▪ Most of these Tatar collective farms concentrated on agriculture, and to a lesser extent on fishing. ▪ Apart from these	barley; millet, buckwheat, peas and other crops were also grown. ▪ The increase in the amount of wheat sown through a reduction in rye was observed at the earlier stages of Russian agriculture in Siberia (particularly in the west). ▪ Dairy farming was the most advanced side of animal husbandry in western Siberia, while in the east it was mainly meat production. ▪ In western Siberia, dairy farming was mainly in the hands of private

	▪ Among these groups the stocks of fish far exceeded their personal needs, and most of it was sold.	began to return. ▪ In certain parts, the households with fewer reindeer remained in the tundra the whole year round, only making short trip.	century was the gun.	branched of agriculture, the Tatars also keep bees on their farms and breed fowl (duck and geese). ▪ In the forest regions with cedar plantations, the collective farms collect the cedar nuts. ▪ Hunting is not a main occupation of the Tatar collective farms. ▪ The procurement offices sign contracts for the hunting season with individual hunters and farms. ▪ The hunter hand over animal skins to the authorized representative of the procurement organization.	entrepreneurs who used improved machinery for making butter, and was therefore of commercial importance. ▪ On the peasant farms, butter was made largely in homemade wooden churns.

Diets	▪ Meat of the wild reindeer, elk, and other game and fish were the staple diet of the Khants. ▪ It was only the wealthier reindeer-herders who slaughtered domestic reindeer. ▪ Kidney, liver, marrow, the eyes, ears, lips and other parts of the carcass were eaten raw. The remaining meat was cooked. ▪ Fresh blood was drunk immediately after the slaughter, while the rest of it was collected and used for flour pancakes or added to broth. The	▪ The staple diet of the Nenets was domestic reindeer, which comprised 85% of the whole diet, and among those possessing few reindeer it was fish, which was usually eaten raw (fresh and frozen), sometimes boiled. ▪ The fish was rarely salted and preserved, and did not, therefore, keep very well. ▪ A common dish was fat boiled down from the inside of the fish and mixed with roe, pieces of fish and berries; seal-fat (melted) and deer-fat were also eaten.	▪ Before the Revolution, the staple diet of the Selkups was fish. ▪ The fish was salted and made into porsu (dried fishmeal) and yukola (dried pressed fish). ▪ Most of the preserving of the fish was done in summner during the “big catch.” ▪ In order to make the porsu, the fish was divided into parts, fried, dried and ground in mortars. ▪ The leftovers from the yukola and porsu were also boiled down and made into oil. ▪ Bile was extracted from the gallbladders and	▪ The main diet of Siberian Tatars was cereals and fish, and to a lesser extent milk products and meat (horsemeat, mutton and game). ▪ The staple diet of the Tatars living along the Irtysh and the Tobol and their tributaries was fish and fish oil. ▪ The food was cooked by the women and in summer always out of doors. ▪ Bread was also baked in street ovens. ▪ The favorite national dish was noodles cooked in broth or water.	▪ In the agricultural belt of Siberia the staple diet of the rural population was composed of bread and various dishes made with flour. ▪ Rye bread was baked with leavening in the form of small round rolls. ▪ Wheat bread predominated in certain places (particularly in Western Siberia). Sour wheat bread was made in Siberia in the form of ring-rolls. ▪ Unleavened dough was made into dumpling and meat or sour-cream

	soft horns of young reindeer were also used as food. ▪ In autumn, when the catch of wild reindeer was extensive, the meat was preserved; it was cut into thin strips and laid out for drying on special structures raised high above the ground. ▪ Sometimes the meat was slightly smoked. The reindeer fat was smoked and considered a delicacy. ▪ In winter, the venison was eaten in the frozen form, cut with a knife into thin strips. ▪ Fish was eaten raw,	▪ The meat was usually boiled (but not broiled). It was sometimes eaten raw (fresh or frozen). ▪ Meat was preserved by smoking it. Apart from venison and fowl, polar-fox meat and seal meat were sometimes eaten. Berries (cloudberry, blueberry and blackberry), and other vegetation such as angelica, were eaten. ▪ Bread, which became universally adopted by the Nenets after the arrival of the Russians, was eaten in small quantities and then only by the wealthy. ▪ Food was usually eaten 3 times a day. In the	livers of the fish and used to work suede; the sturgeon bladders were used to make glue for joining bow and lining skies.	▪ Other common farinaceous dished were unleavened cakes, fritters, square pies containing curds, meat, and later potatoes. Meat-rolls. ▪ Pancakes and large pies with fish baked inside were always consumed on national festivals. ▪ The Tatar often cooked alyuva from wheat flour, boiled with milk and seasoned with melted butter. ▪ Another dish, zaturan, was made from flour fried in butter, boiled in tea water and served with milk. ▪ The usual fare on holidaya was baursak,	turnovers, which had evidently been brought by the immigrants from the north of European Russia. ▪ Pigori were the fare for family festivities. They were made of leavened or unleavened dough, were either sweet or plain, and had different kinds of stuffing such as cabbage, sour cream, cheese, potato, onion, carrot, grape, berries, ground or devilled meat and so on; each type was called by a different term. ▪ Wild-cherry pies and also fish pies were particularly widespread

	boiled or dried. In summer the fish was dried on hanger set up on the spot near the summer camp, or smoked over a fire lit beneath the hangers. ▪ The fish oil was extracted from the innards in large pots and was a very important product for the Khants. It was eaten in the pure form or mixed with crushed bird-cherries; it was used to make fried flour pancakes and "boiling" for which crushed dried fish was boiled in it. ▪ These "boiling" were always taken along on	morning and afternoon they drank tea with bread and fat, and in the evening, after the tea, they ate meat or fish bouillon and boiled meat or fish. ▪ From the age of 2, children were given the same food as adults. During the transition period after suckling, boiled meat and boiled brain were chewed.		pieces of dough cooked in boiling butter. When served, they were smeared with honey and sprinkled with sugar. ▪ These dished were usually found in the wealthier households, while the poor people had to simpler and more monotonous food.	in Siberia; in the fish pies the fish was cooked whole (as in the Urals). ▪ Russian dished made with wheat flour, such as pancakes and fritters, and also oatmeal and porridge were also known Siberia. Pel'meni (a kind of dumpling with meat or fish) was known as Siberian food, and was also common in the Urals. ▪ During the winter the Pel'mini used to be frozen (before being cooked) and put into boxes or sacks; they were taken on journeys

	hunting expeditions in winter they used to eat frozen fish. Fishheads, or sometimes the whole of a small fish, were dried and crushed into flour, which was then boiled to make a porridge. ▪ Among the uncultivated vegetation the Khants ate berried(blackberries, black currants.				as well. ▪ Russian meat dished known throughout the country, such as aspic, roast meat, cabbage and grain soup, etc., were also found in Siberia.
Dwellings	▪ In the past the Khanty settlements consisted of 1 to 10 houses with extra structures, arranged without any special plan. ▪ The settlements were a long way away from one another.	▪ The principal type of old nenet dwelling was the conical tent. ▪ It was constructed from 30-50 poles (depending on its size) covered in winter with two layers of reindeer-skin sections with clipped	▪ Selkup settlements were usually located on high river banks, at the mouths of estuaries, channels and dry riverbeds, and were small, ranging from 2 to 10 dugouts, houses or tent.	▪ Their dwellings were of Russian type, made of logs and covered with planks, although the Baraba Tatars covered their houses with turf. ▪ Stone houses were found among the rich people, chiefly in the	▪ Plots of land with nuclear villages of one or two houses were typical of the first Russian migrants to settle in the vast empty spaces of Siberia. ▪ These little groups of

	▪ The Khanty had nomadic-type or settled-type dwellings according to the nature of their economy. ▪ For example, the Khanty reindeer-herders lived in the tent borrowed from the Nenets. ▪ In structure the tent was no different from the Nenets chum. ▪ The permanent winter and sometimes summer dwelling of most of the Khanty was the hut made of thin beams or thick boards.	fur. ▪ The inner layer was put with the fur inside and the outer layer with the fur outside. ▪ In the summer the tent was sometimes covered with sections of boiled birchbark sewn together.	▪ The dwellings were set up without any plan and scattered about. ▪ On the lower reaches of the Tym, there were constructions of the Russian type; on the lower reached of the Ket' and on the Taz it was also possible to find a variety of dwellings-Russian cottages, dugouts, half-dugouts, tents made of wooden laths, and so on.	Bukharan settlements near Tyumen' and Tobol'sk. ▪ The Baraba dwellings were quite different; these were wattle houses, smeared with clay similar to the Ukrainiam huts, but with a flat turf roof. ▪ The older Tatar houses had a large, high, open porchway, which was approached by a stairway or notched beam. ▪ Old-fashioned, two-stories houses were retained until recently.	houses grew into large settlements. ▪ They emerged chiefly along the banks of rivers and lakes, which were the normal ways of communication, on water divides, and near highways or major trade routes. ▪ Their settlements may be divided by their layout into the following groups: 1) a free, disorderly layout; 2) the single row settlement stretching along a river or lake with the houses facing the water; and 3) settlements of the two rows of houses with a

					street between, mostly lying along highways and roads. ▪ A typical feature of the Siberian settlement is the cattle enclosure, which was described earlier.
Social Structure	▪ In the past the phratries were strictly exogamous, since it was considered that everybody within the same phratry was a blood relative or "brother" and "sister." ▪ The social structure of the Ob' Ugrians at the turn of the 20th century retained principally the traditions of the patrilineal clan.	▪ The Nenets families varied in size. Some contained 10 to 15 or more people in one household with one head. ▪ The clan (yerkar) was patrilineal, i.e., it consisted of a group of blood relatives on the male side. ▪ The clans were united into phratries. Marriage was strictly exogamous.	▪ Even in the 19th century, the basic unit of the Selkups was the territorial neighborhood commune, consisting of a number of related and nonrelated households, but it still retained traces of the previous clan organization to a great extent. ▪ The Selkup clan consisted of a group of relatives on the male	▪ Women used to eat separately from the men, usually after them. ▪ At weddings and festivals, men and women feasted separately, in different houses. ▪ A peasant family usually consisted of five to seven people, and the members of the family obeyed the head, the father, in every respect.	▪ The fishing was carried out by the men, but at tomes women and boys took an extensive part in it by seine-handling. ▪ Female labor was particularly important in processing the fisg (for example, in making yukola and also for subsidiary jobs. ▪ The living conditions of the Siberian peasantry

	▪ Although certain survivals of matriarchal forms did exist, generally speaking, the position of women among the Khanty was an inferior one up to the Revolution. ▪ The girl's consent was not asked for marriage. After she had been selected, the parents of the groom sent matchmakers of else the groom went himself, accompanied by friends, to the parents of the bride. ▪ The matchmaker or a comrade of the groom discussed the size of the bride-price with the	Marriages were not concluded within the phratries. ▪ The clan group possessed a particular area of territory consisting of winter and summer reindeer pastures and various hunting and fishing grounds. ▪ It was only the summer fisheries located at the sites of the summer camps which were possessed by individual households on a separate basis. ▪ Woman had no right to inheritance; the property passed to the sons and brothers. ▪ Separation at the wish	line. ▪ The clans were united in two exogamous phratries. ▪ Although the woman in the Selkup family was subordinate to the man, her status was not an inferior one; in many respects the Selkup woman had the same rights as the man. ▪ For example, she was able to take part in the hunting and fishing, whereas among some peoples of the Far North women not only unable to take part in the occupations, but were forbidden to touch fishing tackle, so as not to bring bad luck during	▪ According to Moslem custom, the rich Tatars kept as four wives who lived in different houses. ▪ The wife was subordinate to her husband in everything. She was not only restricted in her right, but also bound by a whole series of religious taboos. ▪ Girls did not go to school and were only taught the bare essentials in schools attached to the mosque where they were taught by the wife of the mulla. ▪ Women had no access to any further education.	were different from those of the Russian peasants in central Russia. ▪ Russian peasants were exploited and oppressed by the ruling classes, like tithes payable in money or kind, compulsory labor, and so on. ▪ There was class distinctions among the peasantry typical of the post-Reform period. Before Reform, the peasantry in Siberia was a comparatively homogeneous group. ▪ The Siberian peasants began using manure as

	girl's parents. ▪ The amount of bride-price was large. It was sometimes paid in live reindeer, clothing, or household utensils. ▪ The bride's mother played an important part in the negotiations. ▪ Another form of matrimony was marriage by abduction, which naturally was very popular among the young people who had little possessions of their own. ▪ A vestigial form of the ancient matrilocal marriage was a system of working in return for	of the wife was made difficult, although for men it was made easy. ▪ There was also polygamy. In most cases these were rich men who could pay quite a large amount of money for each wife. ▪ The permanent obligations of the Nenets woman included all household duties- setting up and taking down the tent, procuring water and fuel, cooking food, dressing skins, making clothing and looking after the children. ▪ She took some part in the reindeer-raising (guarding the herd) and	hunting and fishing.	▪ Girls were married off at the age of 13, though not always. The bride was not supposed to see the groom before the wedding. The groom sent two matchmakers to the bride's father, who agreed on the bride-price,and then the groom moved into his father-in-law's house and live there until the bride-price was paid. ▪ When a mean died, property was divided equally among his sons and the daughters were given half the share received by the sons. If there were no sons, the daughters	a fertilizer more and more. There was no consistency in the rotation of crops, which may largely have been due to prevalence of squatter land-tenure, for the cultivator was hardly dependent at all on his fellow farmers. And ran his farm as he wished.

	the wife, instead of the bride-price, by which the husband entered the wife's house and remained there 3 or 4 years in a fairly inferior position, after which he was allowed to move with his wife to a separate house. However, it often happened, particularly when the wife had no brothers, that he just stayed there in his mother-in-law's house.	in fishing (dressing the fish, and sometimes helping with nets). ▪ All domestic matters were almost entirely run by the woman, and customary law recognized the ownership by the wife of her dowry and all property acquired through her personal labor.		received half the property, while the rest went to relatives. ▪ The mother and father had different rights of inheritance, the mother qualifying for one-third and the rest going to the father.	

국문 초록

서론: 기존 인류학 연구에서는 농경민과 수렵-채집민 간 치아 병리 상태에 대해 상당한 차이가 보고되었지만 관찰자 간 오류를 완전히 배제한 결론을 제시한 경우는 드물었다. 본 연구에서는 16-19 세기 서시베리아지역에서 공존한 수렵-채집민 (원주민)과 농경민 (러시아 이주민) 간 치아 상태의 병리 양상을 분석하여 이 문제에 관해 신뢰성 높은 결론을 제시하고자 하였다.

방법: 16-19 세기 서시베리아 무덤에서 출토된 러시아 이주민 인골 79 개체와 시베리아 원주민 (타타르, 네네츠, 셀쿱, 칸티) 인골 75 개체를 조사하였다. 법의인류학적 방법을 이용하여 성별, 나이 등 인류학적 기초 정보를 추정하였다. 농경민과 수렵-채집민으로 구분되는 두 집단의 치아 상태를 비교하기 위해 치아 마모도, 생전치아 결실, 치석, 충치 등 4 가지 요소를 분석하였다. 분석 결과는 R 패키지를 이용하여 통계처리 하였다.

결과 및 고찰: 치아 마모는 거칠고 섬유질이 많은 음식을 주로 섭취하는 수렵-채집민 집단에서 더 높은 빈도로 관찰된다고 알려졌지만 본 연구에서는 이주민 집단과 원주민 사이의 치아 마모 빈도의 차이를 뚜렷이 관찰하기 어려웠다. 이는 원주민 집단이 섭취한 음식물이 주로 익히지 않은 생선과 고기 등으로 이루어져 있어 치아 마모를 심하게 유발할 정도로 거칠지 않았기 때문이라고 추측된다. 반면, 치석, 충치 및 생전 치아 결실의 경우는 수렵-채집민인 원주민에 비해 농경민인

이주민 집단에서 높은 빈도로 관찰되었는데 이는 단백질 위주의 식습관을 유지한 원주민 집단에 비해 이주민의 경우 탄수화물과 단백질을 혼합한 식습관을 유지한 것이 그 이유라고 판단하였다.

결론: 이 연구를 통해 필자는 16-19세기 서시베리아지역에 공존하던 수렵-채집민과 농경민 간에 치석, 충치 및 생전 치아 결실의 빈도가 통계적으로 유의한 차이가 있음을 확인하였으며 이는 두 집단의 식생활과 밀접한 관련이 있다고 추정하였다. 이 결과는 농경이 도입된 이후 그 이전보다 치아 질병이 더 증가하였다고 본 기존 인류학적 통설을 관찰자 간 오류를 가능한 한 배제한 상태에서 입증하는데 성공한 보고이다.

키워드: 서시베리아, 충치, 치석, 생전 치아 결실, 치아 마모, 시베리아 원주민, 러시아 이주민

학번: 2013-30600