

SHORT REPORT

Dental health of Vikings from Kopparsvik on Gotland

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Abstract

The prevalence, distribution, and location of dental caries were studied in complete and partial human dentitions dating from the Viking Age dating (900–1050 AD) excavated in Kopparsvik on island of Gotland, Sweden. 18 individuals and a total of 370 teeth were examined, using a strong light source and dental probe. Carious lesions were found in a large number of the individuals, 14 out of 18. The percentage of teeth affected by caries (11,9%) corresponds well with studied skull materials from the same period. The surface most susceptible to caries was the occlusal surface, whereas only a few proximal lesions and one single carious root surface was found. The tooth most commonly affected by caries was the mandibular first molar. The tooth most commonly missing ante-mortem was also the mandibular molar, and the tooth most commonly missing post mortem was the mandibular incisor. Other findings included apical infections, which were detected clinically in 3% of the teeth.

KEYWORDS

caries, dental health, Gotland, Kopparsvik, tooth decay, Viking age

1 | INTRODUCTION

Of all the diseases found globally, untreated dental caries in permanent teeth currently constitutes the most prevalent condition, and in deciduous teeth, it is the 10th most prevalent condition (Kassebaum et al., 2015). Even if there is strong evidence of a decline in dental caries in many western countries since the middle of the last century, the disease is still prevalent, and a shift in the burden of caries from children to adults has been observed (Norderyd et al., 2015). Dental caries has been affecting mankind since time immemorial, but the caries prevalence has shifted in pattern and severity. In literature, historical data are often presented as case reports. Larger findings of skeletal remains from Scandinavian populations are more common from the Medieval period and onwards (Olsson & Sagne, 1976; Varrela, 1991) but more uncommon from earlier times.

Even if the caries distribution found in remains of early historical Scandinavian populations has varied, a frequently reported figure for

caries prevalence is around 10% of all examined teeth (Lingström & Borrmann, 1999; Olsson & Sagne, 1976; Varrela, 1991). However, a notable higher caries prevalence at individual level, of 40–60%, has been found in remains from medieval times (Varrela, 1991). Explanations of these differences could be related to technical aspects, such as the occurrence of post mortem defects, and number of missing teeth. The population itself may play a role, where factors such as heterogeneity of the studied individuals, general standard of living and variation in diet, are important factors (Vehkalahti, Rajala, Tuominen, & Paunio, 1983; Lingström & Borrmann, 1999). In an Icelandic study of dentitions from the Viking era, only “a few” caries lesions were found (Richter & Eliasson, 2008).

The island of Gotland in the Baltic Sea in Sweden is known for its old history and played a central role during the Viking Age as an important area for trading goods. On site Kopparsvik, archaeological excavations in 1964 and 1965 resulted in an assemblage that has been thoroughly examined, including some osteological examinations of the skeletons found (Petterson, 1966; Mälärstedt, 1979; Carlsson, 1983;

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Larje, 1985; Westholm, 1989; Thunmark-Nylén, 2000, 2004a, 2004b; Arcini, 2005, 2010; Sten & Mellström, 2011; Sten, 2015; Toplak, 2016; Margaryan, 2017, Ytterman, Brynnel, Sandström, & Sten, 2017; Ahlström Arcini, 2018; Mühlemann et al., 2018). The graves of the individuals examined in this work are dating back to the Viking Age (900–1150 AD). However, only limited attention has been paid to dental conditions in these prehistoric individuals.

Little is known about the dietary intake among the study population. The Swedish Vikings lived in farm communities, and their primary source of protein was meat from the farm animals; beef, pork, sheep, and horse. Fish and sea birds were a major part of the diet, explained by the proximity to water. Carbohydrates included grains, root crops, and bread. Mead was drunk, and the sweeteners used was honey or natural berries. Dried fruit, hazelnuts, and mushrooms were also consumed during this period (Wickerts, 2013).

In this article, dental health has been analysed from a number of individuals with special reference to dental caries. The dental examination of a selected number of individuals from the population was to be carried out before a research team from Centre for GeoGenetics at the Natural History Museum of Denmark, Copenhagen, took DNA samples of teeth in the project entitled *Population Genomics of Vikings*, which meant that analysed teeth would be destroyed (Margaryan, 2017; Mühlemann et al., 2018).

The aim of this study was to study the caries and dental health prevalence in a sample of dentitions from the Viking Age from a limited, but well-defined, region of Gotland.

2 | MATERIALS AND METHODS

2.1 | Study population

The study material comprised a total of 18 individuals from an assemblage consisting of a total of 342 individuals excavated in a graveyard dating back to 900–1050 AD. The examination was part of a larger study in which DNA is assessed in order to study the relationship between these individuals and subjects from other parts of Scandinavia living during the Viking period. The gender and age had previously been determined. The gender distribution was 15 men and 3 women. Age was expressed in intervals between 20 and 60 years.

The sample consisted of jaws and fragments of jaws, which explains why variation between complete or partial examination of the dentition was possible.

Prior to the dental examination gender (Bukistra & Ubelaker, 2010; Wescott, 2000), age (Lamendin et al., 1992; Lovejoy, 1985; Lovejoy, Meindl, Przbeck, & Mensforth, 1985) and stature (Sjøvold, 1990) were assessed.

2.2 | Dental examination

When necessary, fragments of alveolar bone and teeth were cleaned with soft brushes before examination. The dentitions were examined by visual inspection and use of a dental probe under a strong light

source. Photographs and X-rays were taken for illustrative purposes. All clinical examinations were carried out by one and the same person (dentist CB), who also photographically documented the findings. X-rays were performed by dentist BL and analysed by CB.

For each individual, the number of teeth, caries lesions, apical pathology, and other findings of interest were registered. To determine whether a missing tooth was lost post mortem or ante-mortem, the alveolar bone was examined. A tooth was determined to have been lost post mortem in cases where the alveolar socket was empty and without signs of healing. In case of root remains, these were recorded as remaining teeth. However, if the crown of a tooth was fractured post mortem, this tooth was recorded as lost post mortem.

2.3 | Carious lesions

A carious lesion was determined as a defect, explorable with dental probe, in crown and/or root. Only explorable cavitated lesions that extended into the dentine were recorded as caries; thus, superficial colour changes in the enamel were not registered as caries. To classify a carious lesion, the location in the dentition, the location by site, and number of surfaces involved were recorded. The location of the lesion was classified as one or more of the following: (a) occlusal, (b) mesial, (c) distal, (d) lingual/palatal, (e) buccal, and/or (f) root caries. When a lesion extended further than one surface, all the affected surfaces were recorded. Where only a carious root fragment was observed, all surfaces were recorded as affected.

2.4 | Other oral conditions

During the examination of the dentitions, any additional oral conditions were noted. These findings included apical pathology visible in the bone by inspection, supernumerary teeth, and variations in anatomy of teeth and jaws.

3 | RESULTS

In this material, the remains of a total of 18 adult individuals were examined, age ranging between 20 and 60 years at the time of death (Table 1). A total of 370 teeth were studied (Table 2).

3.1 | Lost teeth

Greater post mortem than ante-mortem tooth loss was found. The distribution according to location showed that a larger number of teeth from the upper jaw compared to the lower jaw were available for evaluation (Figure 1). The lower incisors were the teeth most commonly lost post mortem, and the mandibular molars were most commonly lost ante-mortem. Ante-mortem loss was more common in the lower jaw compared with the upper jaw ($n = 23/n = 3$).

TABLE 1 Number of teeth, distribution of caries, ante-mortem (AM) and post mortem (PM) tooth loss and age at time of death individual level

Individual #	No. of examined teeth	No. of carious teeth	No. of AM tooth loss	No. of PM tooth loss	Age (years)
3864	25	1	0	7	50-55
4564	29	6	0	3	40-50
7264	30	1	0	2	50-60
7464	32	0	0	0	20
7764	9	1	0	23	45-60
7864	21	4	0	11	45-50
8864	29	8	0	3	45-55
11864	28	5	2	6	40-50
16165	28	1	2	2	30-35
16765	16	2	11	5	45-55
18265	32	0	0	0	45
18765	30	1	0	2	25-35
20465	24	2	2	6	30-40
20865	32	0	0	0	30-40
21265	17	0	2	13	45-50
22865	32	4	0	2	35-50
24265	31	4	0	1	20-30
9365	29	4	0	3	40

TABLE 2 Number of teeth examined, number of carious teeth, and number of teeth lost, ante-mortem (AM) and post mortem (PM)

	No. of examined teeth	No. of teeth with caries	No. of lost teeth	No. of AM tooth lost	No. of PM tooth lost
Maxillary	246	20	40	3	37
Mandibular	124	24	68	23	45
Totally	370	44	108	26	82

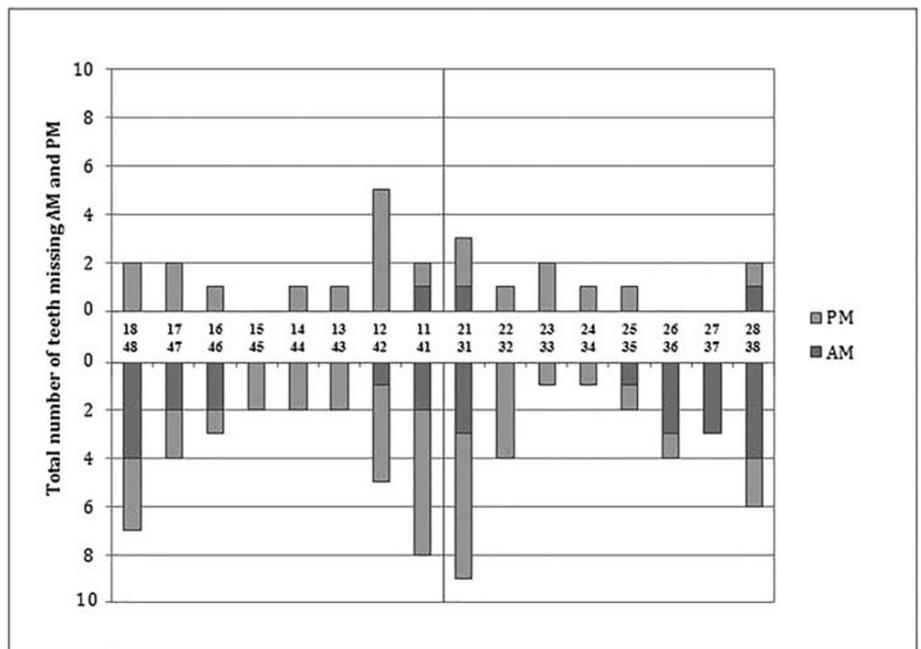


FIGURE 1 The prevalence and distribution of teeth lost ante-mortem (AM) and post mortem (PM) according to tooth position

3.2 | Caries

Only 4 out of 18 individuals did not display any carious lesions. The most common tooth affected by caries was the mandibular first molar followed by the mandibular second molar and the first and second maxillary molars (Figure 2). A total of 44 out of 370 (11.9%) teeth had at least one carious lesion. Similar numbers of lesions were found in the mandibular and the maxillary jaws (25 vs. 23 lesions). A majority ($n = 35$) of the lesions were classified as occlusal caries, whereas only a few lesions ($n = 9$) were classified as proximal caries (Figure 2). The

occlusal caries could in some cases be seen on surfaces that showed attrition into the dentine. Only one tooth had root caries. Examples of carious lesions can be seen in Figure 3a,b.

3.3 | Others

The number of teeth with apical periodontitis was 12 of 370 teeth (3.2%) with the mandibular first molars most commonly affected. In two mandibular molars, the roots had been separated and with only

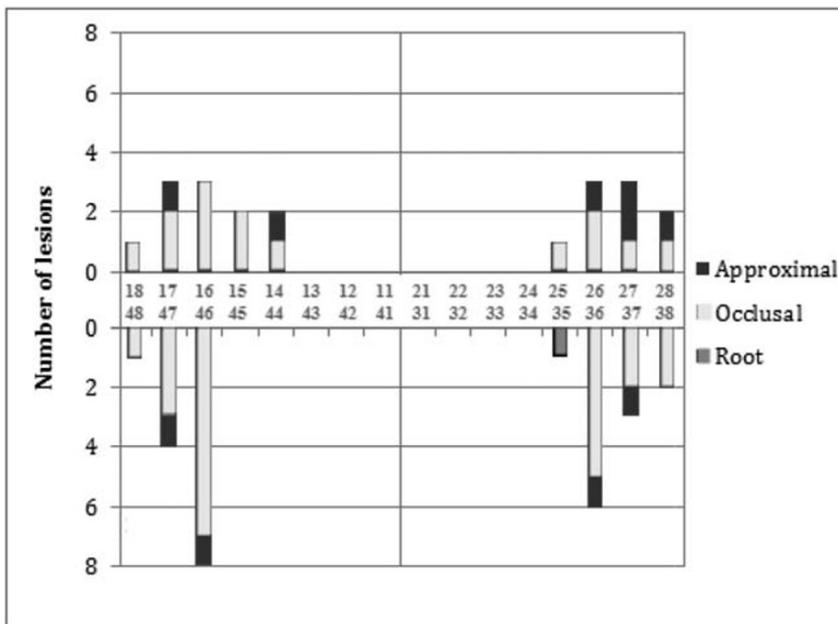


FIGURE 2 The prevalence and distribution of caries lesions according to tooth position and type of lesion

(a)



(b)

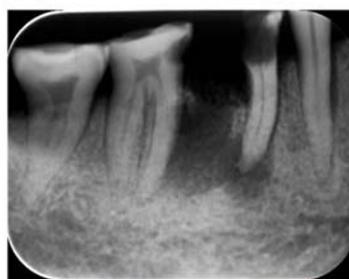


FIGURE 3 (a)–(b) Some examples of caries lesions; illustrated both by photos and radiographs [Colour figure can be viewed at wileyonlinelibrary.com]

one root remaining in the jaw. The alveolar sockets showed healing suggesting this had occurred ante-mortem. One individual had supernumerary teeth with six lower incisors.

Many teeth displayed severe attrition.

4 | DISCUSSION

In spite of the limited number of dentitions examined, the findings from these examinations are believed to provide unique information about historical population from the Viking period thereby offering an insight into the dental condition but also, to a certain extent, into the life of individuals from this time period. The Viking era was a period in which Gotland was one of the major areas for trading goods in Sweden and was thus in close contact with countries in the east and west. The possibility that the examined individuals have a non-Swedish origin cannot be excluded. However, historical excavations of the area have revealed around 1,000 different archaeological findings, indicating that this was also a well-established residential area.

A larger number of teeth had been lost post mortem compared to ante-mortem. Although it is difficult to give the reason for tooth loss ante-mortem (Bennike, 1985) it is believed that the missing teeth were exfoliated, even if the possibility of aplasia cannot be excluded. Caries is not believed to be the main reason for tooth loss: attrition, periodontitis, and trauma are instead regarded as main causes (Whittaker, Molleson, Bennet, & A.P. Edwards I, Jenkins PR, Llewelun JH., 1981). In this material, a high degree of tooth wear was found. This could be a contributing factor for caries and tooth loss. This indicates that a diet high in abrasive elements was consumed during this time period.

The findings of this work indicate that dental caries occurred in a high number of the examined dentitions. The prevalence in number of teeth affected, corresponded well with previous studies of historical European material (Olsson & Sagne, 1976; Varrela, 1991). The majority of carious lesions were found on the crown, with the lesions located almost exclusively on the occlusal surface, which differs in comparison to an examination of Swedish dentitions from the early 17th century (Lingström & Borrman, 1999). No conclusion about the number of carious lesions in relation to age could be drawn, due to the small number of individuals.

Speculations about the findings can be made, but it is difficult to come to hard conclusions. A low caries prevalence was found in comparison with modern man where a high intake of fermentable carbohydrates, in particular sugars, is found. However, the diet consumed in Sweden during this time period, 800–1150 AD, contained naturally occurring sugars, which, to the largest extent, are believed to come from fruits, berries, and honey (Wickerts, 2013). The diet might have differed somewhat, if individuals with a foreign background were among those studied.

Other findings included a number of apical lesions identified clinically and via radiographs. The clinical condition of these teeth varied and caries was not the only reason for the infections. The possibility that some of the individuals may have suffered from pain due to their dental status cannot be excluded.

The present findings indicate that caries was not an unknown condition in individuals living around 1,000 years ago, which suggests that a diet containing fermentable carbohydrates was consumed.

ACKNOWLEDGEMENT

Many thanks to Lena Idestrom, Curator/Collection Manager, Gotlands Museum, for all her help within the Viking Age osteological material Kopparsvik in the museum's collection.

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How to cite this article: Bertilsson C, Sten S, Andersson J, Lundberg B, Lingström P. Dental health of Vikings from Kopparsvik on Gotland. *Int J Osteoarchaeol*. 2020;30:551-556. <https://doi.org/10.1002/oa.2867>