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Tooth wear with an erosive component in a Mediaeval Iceland population

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ABSTRACT

Objectives: Dental erosion is generally thought of as a modern phenomenon, but there is emerging evidence that the condition has always been present in the human dentition to some degree. The aim of this study was to quantitatively evaluate the severity of tooth wear observed in skeletal material from a mediaeval population of the farm at Hofstaðir, Mývatnssveit, in northeast Iceland.

Methods: The teeth were examined and tooth wear was quantified using the Smith and Knight Tooth Wear Index. All surfaces of the teeth were examined by a single trained examiner from 53 adult skulls available (24 males and 29 female). The majority of the skulls were examined at the stores of Þjóðminjasafn Íslands (The National Museum of Iceland) using good lighting and magnification.

Results: There were a total of 1696 possible teeth and 6784 surfaces, and from this 69.5% were scored. There was a higher overall rate of wear in the mandibular dentitions and that the highest wear rates were seen on the occlusal/incisal surfaces of the 1st and 2nd molars and the premolars. For the group, and from those surfaces available for scoring, dentine was exposed on 1464 surfaces (31%). There was no evidence of cervical wear.

Conclusion: High levels of tooth wear were observed in this Icelandic assemblage and the appearance was characteristic of both chemical and physical wear.

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1. Introduction

Few investigations have been focused on acid erosion in archaeological assemblages,^{1,2} despite it being frequently discussed in modern clinical dental research publications.³ Unlike previous archaeological studies that observed varied sources of nutrition within populations, the mediaeval Icelandic diet was limited and inescapable – largely consisting of milk and its derivatives, alongside meat and fish protein. There was small-scale and seasonal input from vegetal matter. Large-scale and year round storage of skyr (a soft yoghurt-like cheese) and its by-product whey, in the capacity

of thousands of litres, is known to have occurred based on the archaeological evidence of massive barrel pits, as well as documentary and ethnographic information.^{4,5} Mýsa and the by-product sýra were primarily utilised to pickle and store a variety of domestic and wild foodstuffs, and was also drunk as beverage called *blanda* (to mix – a watered down form of sýra). The lactic acid content in sour whey (*sýra*) was due to a long fermentation process. Lactic acid has a relatively high dissociation constant, and its by-product lactate can actively bind to calcium present in enamel.⁶ These limited items made up significant portions of the daily repast.

Archaeological work on the cemetery at the farm Hofstaðir in Mývatnssveit, Northeast Iceland was first undertaken in

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1999 during excavations being conducted on the Viking Age *skáli* (long-hall) and its associated structures.⁵ Further periodic excavations over the following years and leading up to the present time have revealed at least two, and possibly three, phases of a small chapel construction, and an associated Christian cemetery in an adjacent and later occupied area of the farm. A relative date for the cemetery's use can be estimated as slightly pre-1000 AD to until the end of the 13th century AD based on volcanic tephra sequencing, as well as radiocarbon dates from the earliest chapel phase.⁷

The aim of this research was to characterise the wear observed on skulls found at Hofstaðir. The hypothesis was that the Mediaeval population had no wear and was not similar in appearance to a modern wear pattern.

2. Methods

To date, there have been 121 individuals excavated from 118 separate grave cuts. There are 66 adults who range widely in their rates of preservation and completeness. The sex distribution is about equal between males and females, with only a few individuals that it has not been possible to assign a definite sex due to poor preservation.⁸ Of those adults that are in a condition that would allow for thorough osteological investigation, the average biological age is high, with the categories of 36–45 and 45+, being substantially larger than any other group.

The teeth from 53 skulls with adequately intact adult dentitions were available for examination. All skulls were cleaned and the teeth examined dry, and under good lighting conditions by the previously trained first author. Using the Smith and Knight Tooth Wear Index (TWI),⁹ four tooth surfaces (lingual, buccal/labial, occlusal/incisal, and cervical) were scored on a scale of 0 (no wear) to 4 (complete loss of enamel, secondary dentine exposure, or pulp exposure). For the purpose of this study the Smith and Knight TWI was modified to include information relevant to archaeological assemblages. The scores of M (missing) and R (restored) were replaced with more applicable scores. Where sockets showed little-to-no-evidence of remodelling and no corresponding tooth, a score of PM (lost post-mortem) was assigned. Teeth considered NP (not present) were those that were considered congenitally absent or non-erupted. This score was typically applied only to third molars. Scores of AM (lost ante-mortem) were used when there was obvious structural changes and evidence of healing to the alveolar socket.

The majority of the skulls were examined at the stores of Þjóðminjasafn Íslands (The National Museum of Iceland), except those that were excavated within the last 2 years, which were examined at Fornleifastofnun Íslands. All scores were recorded on TWI 'patient' sheets from a macroscopic examination. A 10× hand lens and a periodontal probe were used when determining very small patches of dentine exposure. In instances where scores were not possible due to obfuscating factors, such as post-mortem damage or dental calculus, a score of 9 (missing data) was assigned. At least 50% of the coronal surface had to be present and visible to score a tooth for wear. Taphonomic changes and damage varied between individuals, but the roots, cervix, and sometime the

dentine, displayed the most obvious alterations. These post-depositional associated changes made scoring the cervix problematic, but given the overall low rates of wear associated with this surface, it can be considered non-detrimental to the study.

Tooth wear was expressed at the subject and the group levels and using previously published protocols.¹⁰ Tooth wear variables were analysed as the percentage of surfaces, with each tooth wear score for each subject and for the group as a whole, and at the subject level as the percentage of surfaces with scores equal to or greater than score 1 and score 2 for enamel and dentine separately. Six skulls were randomly chosen for reproducibility and the tooth wear index repeated on a separate occasion.

3. Results

From the 53 skulls, 24 males and 29 females, there were a total of 1696 teeth and 6784 surfaces. Table 1 shows data analysed for the whole group with 4716 (69.5%) surfaces. From the remaining teeth, the majority of the surfaces were missing or non-scorable: 976 (14.38%). The age distribution estimated from standard osteological methods⁸ is shown in Fig. 1. Overall, there were 7.68% surfaces graded level 4 and the highest wear rates were seen on the occlusal/incisal surfaces of the 1st and 2nd molars and the premolars (Fig. 2). At the subject level (Table 2) a mean of 70.5% of subjects had evidence of tooth wear with 8.1% graded at level 4. For the group, and from those surfaces available for scoring, dentine was exposed on 1464 surfaces (31%). The data analysed for individual skulls showed the mean number of teeth with a score of 2 or above (dentine exposed) was 22.7%. The reproducibility for the repeated scores was a Kappa 0.81.

There were no wear lesions visible on the cervical surfaces of the teeth. Any changes to the cervical area were not classifiable and were consistent with taphonomic changes post-mortem. No tooth had evidence of cervical wear and there were no surfaces with cariogenic decay.

The appearance of the wear lesions was comparable to that observed in modern dentitions. There are no validated methods to characterise patterns of wear that adequately bring together modern clinical methods with archaeological studies of dental wear in terms of erosive types of injury, but the appearance of the lesions observed in the skulls was

Table 1 – The distribution of scored worn teeth for the whole group.

	Of worn teeth (0–4)	Of all teeth
% (Nos score 0)	20.45 (894)	14.56 (894)
% (Nos score 1)	53.95 (2353)	38.4 (2358)
% (Nos score 2)	14.7 (646)	10.5 (646)
% (Nos score 3)	7.9 (346)	5.63 (346)
% (Nos score 4)	10.8 (472)	7.68 (472)
% (Nos 6 score)		10.49 (644)
% (Nos score 7)		5.34 (328)
% (Nos score 8)		1.9 (120)
% (Nos score 9)		15.9 (976)

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