Acta Odontologica Scandinavica, 2006; 64: 55–58

ORIGINAL ARTICLE

Tooth wear in maxillary anterior teeth from 14 to 23 years of age

MAUNO KÖNÖNEN[1,3], ESA KLEMETTI[2], ANTTI WALTIMO[1], JARI AHLBERG[1], MARJUT EVÄLAHTI[1], EIJA KLEEMOLA-KUJALA[1] & MARJATTA NYSTRÖM[1]

[1]*Institute of Dentistry, University of Helsinki, Helsinki, Finland,* [2]*Faculty of Dentistry, Kuwait University, Kuwait City, Kuwait and* [3]*Department of Oral and Maxillofacial Diseases, Helsinki University Central Hospital, Helsinki, Finland*

Abstract
Using a planimetric method, the size of horizontal wear facets on maxillary anterior teeth was studied longitudinally in the permanent dentition of 35 subjects at ages 14, 18, and 23 years. The study subjects had not previously undergone any orthodontic treatment and had Class I occlusion. We studied the association between the amount of wear and reported parafunctions and maximal bite force. Total wear areas in age groups 14, 18, and 23 years were 29.5 mm^2 (SD 11.4), 39.1 mm^2 (SD 12.7), and 45.0 mm^2 (SD 13.0), respectively. The total wear area increased significantly both from 14 to 18 years of age and from 18 to 23 years of age ($p < 0.0001$). Between 18 and 23 years of age, the maxillary canines showed strongest wear, although the central incisors had largest wear facets. It can be concluded that wear of permanent anterior teeth is a continuous phenomenon in adolescence and young adulthood.

Key Words: *Canine, follow-up, incisor, planimetry, young adulthood*

Introduction

Incisal and occlusal tooth wear is a continuous process that occurs throughout life [1], and, characteristically, in the modern man, anterior teeth show the most extensive wear [2,3]. In the anterior teeth, horizontal wear facets are found on the incisal edges and cusp tips, whereas vertical facets appear on the palatal surfaces in maxillary and on the labial surfaces in mandibular anterior teeth. As the horizontal facets occlude relatively far from the maximal intercuspidation position, and the vertical facets occlude close to that, it has been suggested [4] that the vertical facets are predominantly related to normal function, whereas horizontal facets are typical for parafunction [5].

Among present-day Western populations, most studies of tooth wear have been cross-sectional [3,4,6–10]. Longitudinal studies on tooth wear in Western man are fewer [1,2,11–14]. Since tooth wear is slow in contemporary industrialized populations, a categorical scale (e.g. rating the amount of wear on a scale from 1 to 4) is not sensitive enough for studying tooth wear especially in a healthy young permanent dentition. We used planimetric methods [11,15], where the area of wear facets is given in square millimeters, as numeric data are more usable for making comparisons and for discovering trends.

The aim of the present work was to monitor the development of horizontal wear in the anterior teeth of subjects from 14 to 23 years of age who, according to anamnestic data, had no bad dietary habits, no dental or medical conditions, and had Angle I occlusion. In the oldest group, we also studied the association between the amount of wear and reported parafunctions and maximal bite forces.

Material and methods

Approval for the study was received from the Ethics Board of the Faculty of Medicine, University of Helsinki, Finland. The study subjects were participants in a longitudinal study on dental development [16]. We qualified only the 35 subjects [17 M and 18 F] who according to the anamnestic data had no medical disorders, and, according to dental examination, had good oral health, Class I occlusion, no congenitally missing teeth, no previous extractions or orthodontic treatment, and had dental

Correspondence: Dr. Mauno Könönen, Institute of Dentistry, Faculty of Medicine, P.O. Box 41 (Mannerheimintie 172), FIN-00014 University of Helsinki, Helsinki, Finland. Tel: +358 9 19127280. Fax: +358 9 19127509. E-mail: mauno.kononen@helsinki.fi

(Received 5 April 2005; accepted 17 October 2005)
ISSN 0001-6357 print/ISSN 1502-3850 online
DOI: 10.1080/00016350500419933

casts of both jaws taken at ages of 14, 18, and 23 years.

The wear of anterior teeth was studied only on the casts of the maxillary dentition, since wear of the mandibular teeth was difficult to define because of numerous rounded edges of the labial facets. The casts were carefully examined using a strong spotlight and a magnifying glass. The outlines of the wear facets, which were parallel or approximately parallel to the occlusal plane, were traced lightly with a sharp pencil. Where the facet was angulated and had both horizontal and vertical components, only the horizontal part was selected [11]. For testing reproducibility, two authors [M.K. and M.N.] studied five casts from each age group, but only one author made the final tracings. Each dental cast was then photographed with a camera fixed on a stand, perpendicular to the occlusal plane, from a distance of 10 cm (film: Ilford Pan F 50 ASA, black and white). A thin plastic plate resting on the incisal edges of central incisors and on the disto-palatal cusps of the permanent first molars was used to determine the occlusal plane. When needed, the cast was tilted by means of a piece of soft wax under the cast. For facilitating the planimetric tracing, the photographs were enlarged to five times their actual size. The areas of the facets were calculated from the photographs using a drawing tablet and a microcomputer. Wolf et al. [17] have described the technique in detail. The sum of the horizontal wear areas of the six anterior teeth was called the total wear area.

Tracing of the casts and the photography were performed once. Double planimetric measurements of the areas were performed on 30 randomly selected teeth representing the three age groups. The error of the measurements [SE] was calculated using the formula $\mathrm{SE} = \sqrt{\Sigma d^2/2N}$, where d is the difference between the first and second measurements and N is the number of double determinations. The error of the planimetric measurements was less than 0.1 mm^2.

When the subjects were 23 years old, and the last casts were obtained, a thorough clinical oral examination, including a questionnaire related to parafunctions, and some dietary factors was performed. None of the subjects reported habitual regurgitation or recurrent vomiting. Daily use of one or several foods and drinks with low pH-value like apples, citrus fruits, fruit juices, or cola-type beverages was common, but no extreme dietary patterns were reported. In a previous report, covering the ages between 5 and 18 years of the same subjects, also salivary buffer capacity, salivary flow rate, and some cephalometric variables were included at the age of 18, but no significant associations were recovered [11].

Maximal bite force was measured in the molar and incisal areas using a specially designed apparatus with a sensor unit having a piezoelectric crystal that generates electric charge in proportion to force applied. The metallic housing of the bite force sensor was 10 mm thick and covered on both sides with 2 mm thick rubber plates mounted with double-sided adhesive tape. To prevent moisture from reaching the piezoelectric sensory unit, the housing was covered with latex finger cot. This "bite-comfortable" design of the housing/sensor system delivered the bite force to a large supportive tissue area. The bite force recorder has been described in detail previously [18].

In the statistical analysis [JA], the paired t-test was used for differences between continuous variables. Pearson's correlation coefficient was used for expressing the degree of association between continuous variables. Differences and correlations were considered significant when $p < 0.05$.

Results

All age groups

The areas of wear facets of individual teeth are presented in Table I. Total wear areas in age groups 14, 18, and 23 years were 29.5 mm^2 (SD 11.4), 39.1 mm^2 (SD 12.7), and 45.0 mm^2 (SD 13.0), respectively. The total wear area increased significantly both from 14 to 18 years of age and from 18 to 23 years of age ($p < 0.0001$). Pooled values were used for males and females since, regarding the sizes of horizontal wear facets, no differences ($p > 0.05$) existed between them in any age group. Also the wear of individual teeth, excluding lateral incisors from 18 to 23 years of age, increased significantly during the respective investigation periods (Table I).

Table I. The areas [mm^2] of wear facets of individual teeth [mean [SD] range], and p-values in paired t-test between groups

Tooth/age	14 years	p	18 years	p	23 years
#13	3.6 [2.7] 0–8.6	0.0001	6.2 [3.7] 0–13.7	0.0001	7.6 [3.5] 0–14.8
#12	4.0 [2.8] 0–9.9	0.0001	5.0 [2.8] 0–12.3	p = NS	5.0 [3.0] 0–12.7
#11	7.5 [2.1] 2.8–12.9	0.0001	9.4 [2.8] 2.8–14.5	0.01	10.2 [2.7] 4.1–15.4
#21	7.8 [2.2] 0–11.8	0.0001	9.2 [2.1] 5.5–14.0	0.001	10.4 [2.5] 5.9–16.3
#22	3.6 [2.8] 0–9.9	0.0001	5.1 [2.8] 0–11.4	p = NS	5.4 [2.9] 0–12.0
#23	3.3 [2.1] 0–8.7	0.0001	5.4 [2.4] 0–10.3	0.0002	6.3 [2.7] 0.5–12.7

#13 = maxillary right canine, #12 = maxillary right lateral, #11 = maxillary right central, #21 = maxillary left central, #22 = maxillary left lateral, #23 = maxillary left canine.

The 23-year group

The average vertical overbite was 3.2 mm (SD 1.5, range 0–5) and horizontal overbite (overjet) 2.3 mm (SD = 1.2, range 0–6). Mean maximal bite force in the molar region was 853 N (SD = 167). These are combined values for right and left sides for the boys and girls, since maximal bite forces did not differ significantly ($p > 0.05$) by side or gender. In the incisor region the mean maximal bite force was 360 N (SD = 132). No significant difference was found between studied males and females. Total wear area correlated significantly with maximal incisal bite force ($r = 0.4$, $p < 0.05$). Pearson's correlation coefficient between the total horizontal wear area and the wear of individual maxillary anterior teeth was significant ($r = 0.7$–0.8; $p < 0.001$). Reported grinding of teeth correlated with total wear area ($r = 0.36$; $p < 0.05$).

Discussion

Originally, we also planned to register tooth wear in molars. However, our preliminary study showed that the wear facets of permanent molars were small [11]. This finding is in accordance with a study by Magnusson et al. [19]. Maxillary anterior teeth were chosen for this study because they are bigger than mandibular anteriors, and the differences in the size and form are clearer.

The used planimetric method provides data on a continuous scale. Double measurements suggested good reproducibility. There are, however, some sources of error. The studied facets were not always exactly parallel with the occlusal plane, which may produce a projection error. Tracing outlines of the facets on the casts could become a source of subjective error. Horizontal and vertical facets were usually well defined, but in some cases rounded edges made tracing difficult. The method of assessing tooth wear as areas of wear facets also has its limitations. The form of the facets or size of the teeth is not considered. On the other hand, the present study focused more on changes during the time from adolescence to young adulthood than on the absolute size of the facets. Since only one examiner made all the assessments, and all models of the same subjects could be compared and traced successively, the accuracy of the tracings can be considered adequate for discovering eventual trends.

In this study, the maxillary canines showed strongest wear between 18 and 23 years of age, as the lateral incisors showed least wear, but the central incisors had largest wear facets. This may have been due to their chisel-like appearance and better suitability for mastication than the canines. In subjects with Class I tooth position, the tapered cusp tip of the maxillary canine is in contact with mandibular teeth mainly in non-functional jaw movements [5]. However, once the pointed cusp tip of the canine starts wearing, the increase in the size of the wear facet is more rapid than in chisel-shaped teeth, in which the size of the facet does not grow much once the whole incisal edge is involved.

Wear of teeth is irreversible and lost tooth substance cannot be regained. Thus the wear of permanent teeth is cumulative, but its rate may vary during life. It has been suggested that extensive tooth wear is caused by parafunctions [20], unbalanced morphological occlusion [21], unfavorable dentofacial morphology [18], foods and drinks with low pH [22], digestive disturbances [23], or combinations of these [2,24]. However, some recent reports indicate that the bruxists do not necessarily have more tooth wear [25] or temporomandibular dysfunction syndromes [25–28] than non-bruxers. Given this array of possible causes, it is not surprising that the results of this study present a complicated picture for interpreting etiological factors.

Horizontal facets are mainly caused by grinding [5], and tooth wear progresses faster in bruxers than in non-bruxers [20], but the etiology of bruxism is multifactorial [29]. In this sample, it is possible that bruxism has occurred in the past and then ceased [6], but it is also possible that the subjects were unaware of the current grinding of teeth [19]. The subjects in the present study had no medical disorders, had good oral health, Class I occlusion, and no previous orthodontic treatment. At 23 years of age, they filled questionnaires related to parafunctions, dietary factors, habitual regurgitation or vomiting, and daily use of soft drinks or citrus fruits. As bruxism most likely exists to some extent in all populations, this sample of young adults should be seen in most aspects very neutral, and tooth wear in this sample should be considered normal.

Carlsson et al. [2] found a positive association between extensive tooth wear and high maximal anterior bite force, while Dahl et al. [30] did not find such an association. In the present sample, the total wear area of anterior teeth and maximal incisal bite force were significantly related. Since tooth wear is cumulative, its causes should be easier to determine in young people than in the old, although the multifactorial etiology [2] makes it complicated also at young age. As the tooth wear has reached a stage where the whole occlusal surface is involved, measurements of wear facets on incisors no longer accurately depict the rate of wear because the size of the facet does not significantly increase even though the height of the tooth decreases.

It can be concluded that horizontal tooth wear of maxillary anterior teeth is a continuous phenomenon in adolescence and young adulthood.

References

[1] Carlsson GE, Egermark I, Magnusson T. Predictors of bruxism, other oral parafunctions, and tooth wear over a 20-year follow-up period. J Orofac Pain 2003;17:50–7.

[2] Carlsson GE, Johansson A, Lundqvist S. Occlusal wear. A follow-up study of 18 subjects with extensively worn dentitions. Acta Odontol Scand 1985;43:83–90.

[3] Dahl BL, Krogstad BS, Gaard B, Eckersberg T. Differences in functional variables, fillings, and tooth wear in two groups of 19-year-old individuals. Acta Odontol Scand 1989;47:35–40.

[4] Woda A, Gourdon AM, Faraj M. Occlusal contacts and tooth wear. J Prosthet Dent 1987;57:85–93.

[5] Jankelson B. Physiology of human dental occlusion. J Am Dent Assoc 1955;50:664–80.

[6] Nilner M. Prevalence of functional disturbances and diseases of the stomatognathic system in 15–18 year olds. Swed Dent J 1981;5:189–97.

[7] Kampe T, Hannertz H, Ström P. Facet pattern in intact and restored dentitions of young adults. A comparative study. Acta Odontol Scand 1984;44:225–33.

[8] Hugoson A, Bergendahl T, Ekfeldt A, Helkimo M. Prevalence and severity of incisal and occlusal tooth wear in an adult Swedish population. Acta Odontol Scand 1988; 46:255–65.

[9] Lambrechts P, Braem M, Vuylsteke-Wauters M, Vanherle G. Quantitative in vivo wear in human enamel. J Dent Res 1989;68:1752–4.

[10] Oginni O, Olusile AO. The prevalence, aetiology and clinical appearance of tooth wear: the Nigerian experience. Int Dent J 2002;52:268–72.

[11] Nyström M, Könönen M, Alaluusua S, Evälahti M, Vartiovaara J. Development of horizontal tooth wear in maxillary anterior teeth from five to 18 years of age. J Dent Res 1990;69:1765–70.

[12] Silness J, Johannessen G, Rynstrand T. Longitudinal relationship between incisal occlusion and incisal tooth wear. Acta Odontol Scand 1993;31:15–21.

[13] Johansson A, Haraldson T, Omar R, Kiliaridis S, Carlsson GE. A system for assessing the severity and progression of occlusal tooth wear. J Oral Rehabil 1993;20:125–31.

[14] Bartlett DW. Retrospective long term monitoring of tooth wear using study models. Br Dent J 2003;194:211–13.

[15] Russell MD, Grant AA. The relationship of occlusal wear to occlusal contact area. J Oral Rehabil 1983;10:383–91.

[16] Nyström M, Kleemola-Kujala E, Evälahti M, Peck L, Kataja M. Emergency of permanent teeth and dental age in a series of Finns. Acta Odontol Scand 2001;59:49–56.

[17] Wolf J, Mattila K, Hietanen J, Vartiovaara J. A radiological study of degenerative vascular changes in the external carotid region and carotid bifurcation. Br J Oral Maxillofac Surg 1989;27:362–70.

[18] Waltimo A, Nyström M, Könönen M. Bite force and dentofacial morphology in men with severe dental attrition. Scand J Dent Res 1994;102:92–6.

[19] Magnusson T, Carlsson GE, Egermark I. Changes in clinical signs of craniomandibular disorders from the age of 15 to 25 years. J Orofac Pain 1994;8:207–15.

[20] Xhonga FA. Bruxism and its effect on the teeth. J Oral Rehabil 1977;4:65–76.

[21] Ricketts RM. Occlusion – the medium of dentistry. J Prosthet Dent 1969;21:39–60.

[22] Eccles JD. Tooth surface loss from abrasion, attrition and erosion. Dent Update 1982;9:373–81.

[23] Smith BGN. Toothwear: aetiology and diagnosis. Dent Update 1989;16:204–12.

[24] Phelan J, Rees J. The erosive potential of some herbal teas. J Dent 2003;31:241–6.

[25] Pergamalian A, Rudy TE, Zaki HS, Greco CM. The association between wear facets, bruxism, and severity of facial pain in patients with temporomandibular disorders. J Prosthet Dent 2003;90:194–200.

[26] Hirsch C, John MT, Lobbezoo F, Setz JM, Schaller HG. Incisal tooth wear and self-reported TMD pain in children and adolescents. Int J Prosthodont 2004;17:205–10.

[27] John MT, Frank H, Lobbezoo F, Drangsholt M, Dette KE. No association between incisal tooth wear and temporomandibular disorders. J Prosthet Dent 2002;87:197–203.

[28] Egermark-Eriksson I, Carlsson GE, Magnusson T. A long-term epidemiologic study of the relationship between occlusal factors and mandibular dysfunction in children and adolescents. J Dent Res 1987;66:67–71.

[29] Lavigne GJ, Kato T, Kolta A, Sassle BJ. Neurobiological mechanisms involved in sleep bruxism. Crit Rev Oral Biol Med 2003;14:30–46.

[30] Dahl BL, Fløystrand F, Karlsen K. Pathologic attrition and maximal bite force. J Oral Rehabil 1985;12:337–42.