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Need of non-operative caries treatment in 16-year-olds from Northern Norway

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Abstract

Purpose: To assess the prevalence of proximal enamel lesions, the need for non-operative caries treatment and the quality of dental restorations in 869 16-year-olds from Northern Norway.

Methods: All first year upper secondary school students in Tromsø and Balsfjord municipalities were invited to participate in an oral- and general health project (Fit Futures). The attendance rate was 90%, and all subjects born in 1994 (449 males and 420 females) were included in the present study. Dental caries was registered according to a 5-graded scale (1-2 = enamel lesions; 3-5 = dentinal lesions). Scores from 1 to 4 were used to register the quality of restorations (1 = good; 2 = acceptable; 3 = poor; 4 = unacceptable)

Results: Only 6 % of the 16-year-olds were completely caries-free. Eighty-four per cent of the participants presented with proximal enamel lesions. A majority of them had either previously restored teeth (35%) or both restored teeth and untreated dentinal caries lesions (34%). When using the D-value of the DMFS-index as a diagnostic criterion, 39% of the participants were in need of restorative treatment. When proximal enamel lesions were included in the diagnosis, the number of participants in need of restorative and/or non-operative caries treatment was 85%. Over 1/3 of the participants presented with at least one restoration below acceptable quality level.

Conclusions: Dental caries is still a major health problem affecting the total teenage population. A non-operative treatment strategy should be considered relevant in order to reduce the need for restorative treatment.

Key words: proximal enamel caries, dental caries, non-operative treatment, adolescents, oral health.

Introduction

Epidemiological data have shown a considerable reduction in caries prevalence among children and adolescents in Scandinavian and other Western countries over the last decades (Petersen 2003; Norderyd et al. 2015). A concomitant decrease in the need for operative treatment of caries has also been extensively documented (Mjor et al. 2008). This decrease is, however, in part due to a change in operative, diagnostic and treatment criteria (Gimmestad et al. 2003; Gabre et al. 2006; Vidnes-Kopperud et al. 2011).

Epidemiological caries data are based on the registration of DMFT/DMFS index values where the D-component represents caries lesions with progression into dentin. However, lesions limited to the enamel constitute a considerable part of all carious lesions (Martignon et al. 2010; Skeie, Klock 2014). As a consequence, valid caries diagnosis in populations with low caries prevalence and slow caries progression may need more sensitive diagnostic criteria including enamel lesions (Nyvad et al. 1999; Pitts 2004). Alm and co-workers (2007) claim that over 80% of proximal caries lesions diagnosed in adolescents are in the enamel only. This indicates that the reduction in caries prevalence is overestimated and that the burden of and the need for treatment of the caries disease is underestimated (Amarante et al. 1998; Nyvad et al. 1999; Alm et al. 2007; Schwendicke et al. 2014).

Treatment objectives for enamel lesions are to slow down, arrest or reverse the progression of the lesions by non-operative treatment procedures and thereby reduce the need for restorative treatment (Ekstrand, Christiansen 2005; Hausen et al. 2007). In this context, it is important to focus on early detection of caries lesions and include enamel lesions in the clinical diagnosis and epidemiological surveys, in order to adopt a non-operative treatment approach in clinical praxis (Raadal et al. 2011).

In the Nordic countries, the documented improvement in dental health among children and adolescents is to a large extent maintained into adulthood (Hugoson et al. 2005; Crossner, Unell 2007; Skudutyte-Rysstad, Eriksen 2007; Norderyd et al. 2015). However, a recently performed extensive analysis of age, period and cohort trends of caries in permanent teeth in four developed countries (USA, UK, Sweden and Japan) showed that there is still a gradual increase in DMFT/S-scores in the adult population due to untreated caries and neglect of oral health promotion in adult life (Bernabé, Sheiham 2014).

Quality and longevity of dental restorations are important issues regarding adult dental health. Secondary caries is reported to be the main reason for restoration failure and replacement (Qvist et al. 1990; Opdam et al. 2010; Pallesen et al. 2014), and preventive and non-operative interventions will thus have an impact on problems related to longevity of

restorations. Newly placed composite Class II restorations might also represent a threat against sound enamel on neighboring tooth surfaces, possibly due to iatrogenic damage of adjacent enamel surface or differences in plaque retention and bacterial colonization on dental restoration surface compared with enamel (Skudutyte-Rysstad et al. 2016).

Individually targeted caries preventive and non-operative treatment procedures have many similarities. However, the concept “non-operative treatment” includes a more conscious clinical examination and diagnosis, including evaluation of the activity of the individual lesions as a basis for proper selection of appropriate non-operative treatment modalities. Such modalities may, besides dietary recommendations and individually tailored information and instruction in dental hygiene, include use of flossing, fluoride varnish and fissure sealants (Ekstrand, Christiansen 2005; Hausen et al. 2007).

Based on data from a sample of 16-year-olds from Troms County, Northern Norway, the aims of the present investigation were to document the prevalence of proximal enamel lesions, to estimate the need for non-operative caries treatment and to record the quality of dental restorations.

Material and Methods

The present paper is based on cross-sectional data from the oral part of the “Fit Futures” project among adolescents in Troms county, Northern Norway (Winther et al. 2014). The study was carried out from September 2010 to May 2011 (Jacobsen et al. 2016) as part of a larger repetitive epidemiological general health project, “The Tromsø Study” (Jacobsen et al. 2012). All first year upper secondary school students in Tromsø (urban) and Balsfjord (rural) municipalities, were invited. Out of 1301 eligible students, 1117 were available for invitation. The remaining 184 were, due to illness, relocation and exchange student programs not attending the schools at the time of investigation and were excluded from the study. Out of the invited 1117 students, 1010 (aged 15-19) volunteered to participate in the oral part. The attendance rate among the invited students was 90%, and all subjects born in 1994 (449 males and 420 females) were included in the present study. In this material 13 % was of immigrant ethnicity. All participants had received regular dental care free of charge, within the Norwegian Public Dental Health System. The fluoride levels of the drinking water were low in both municipalities.

The participants were examined clinically and radiographically. Proximal caries lesions, from the mesial surface of the first premolar to the mesial surface of the second permanent molar, were scored according to a grading system from 1 – 5 based on depth of penetration

(Espelid et al. 1990; Amarante et al. 1998). Enamel lesions were graded 1-2 (corresponding to ICDAS level 1-3), and lesions penetrating in to dentin were graded 3-5 (ICDAS level 4-6) and included in the DMF-registrations. Detailed information on material and methods used in the oral part of the "Fit Futures" project are given in a recently published article (Jacobsen et al. 2016). In the present investigation the need for non-operative caries treatment was estimated by using proximal enamel lesions only (score 1- 2, corresponding ICDAS code 1-3) registered on bitewing radiographs from the mesial surface of the first premolar to the mesial surface of the second molar in each quadrant.

The principal examiner (IDJ) was calibrated with two experienced dentists. For calculation of inter-observer agreement regarding radiographic examination, bitewing radiographs from 88 patients (10% of the study sample) were randomly selected. The three dentists independently examined 28 surfaces per patient, making a total of 2464 surfaces, and scored them according to the 5 graded scale. The weighted kappa value between recordings of the three examiners was 0.71.

The quality of restorations was registered clinically and, when applicable, radiographically for each participant by the principal examiner (IDJ) according to a modified version of the clinical and radiographic criteria described by Hickel et al. (2010). Scores from 1 to 4 were used, 1 – good, 2 – acceptable (with minor defects), 3 – poor (filling with defects in need for repair/replacement but not immediately), 4 – unacceptable (filling needing immediate repair/replacement). A score was assigned to each participant corresponding to the assessed quality of the poorest filling.

Descriptive analyses and cross-tabulations were performed using SPSS 22.0. statistical packet.

The project was approved by the Regional Committee for Medical Research Ethics (2012/1197 REK Nord) and the Norwegian Data Protection Authority (07/00886-11).

Results

In the present sample of 16-year-olds, the prevalence of dentinal caries has been reported to be 82.7% with a mean DMFS-index of 6.1 ± 6.9 (range 0 – 48) and a mean DMFT-index of 4.2 ± 3.8 (range 0-19) (Jacobsen et al. 2016). The present investigation disclosed a prevalence of proximal enamel lesions of 83.9%, with a mean of 5.8 ± 5.0 (range 0 – 24). The distribution of subjects with or without proximal enamel lesions in relation to sound (DFS = 0), decayed (DS > 0) and filled (FS> 0) surfaces is presented in Table 1.

In this sample, 16.1% did not have any proximal enamel lesion. However, a majority of these subjects (9.1%) had previously placed restorations and only 50 subjects (5.8%) were totally caries-free. A major part of the participants with proximal enamel lesions had either previously restored teeth (34.6%) or both restored teeth and untreated dentinal caries lesions (34.4%). One hundred and one subjects (11.6%) presented with proximal enamel lesions without any caries experience according to the DMFS-scores (Table 1). The estimated odds not to have any proximal enamel lesions (PEL=0) was 0.16 for a student with previous caries experience (DFS>0), compared to 0.56 for a student without previous experience (DFS=0), (OR = 3.45; 95% CI 2.31 - 5.18).

According to the distribution of proximal enamel lesions, a total of 729 subjects (83.9%) were in need of non-operative caries treatment, either as the only treatment modality (46.2%) or in combination with restorative treatment (37.6%) (Table 1). When using the D-value of the DMFS-index as diagnostic criterion, 338 (38.8%) of the participants were in need of operative dental treatment. When proximal enamel lesions were included in the diagnosis, the number of participants in need of individual operative and/or non-operative caries treatment was 740 (85.1%) (Table 1). In this material, 706 (81.2%) of the 16-year-olds had experienced restorative care (Table 2). The individual quality distribution according to the poorest restoration is presented in Table 2. More than one-third of the participants with fillings (35.0%) had at least one restoration below acceptable quality levels (poor/unacceptable).

Discussion

The inclusion of enamel caries lesions in epidemiological studies among young people appears to be an important issue, in particular in populations with low caries prevalence as seen in the Nordic countries (Amarante et al. 1998; Mejàre et al. 1999; David et al. 2006; Alm et al. 2007; Poutanen et al. 2007; Norderyd et al. 2015). However, there is no systematic registration of enamel lesions for monitoring oral health at national levels. The present study including all 16-year-olds in one urban and one rural municipality offered a unique opportunity to study the need for non-operative caries treatment in a large and representative sample. When diagnosing caries according to the traditional DMFS-index, 39 % of the participants were in need of treatment. However, by including proximal enamel lesions in the diagnosis, the treatment need more than doubled (85 %).

In the present investigation, only enamel lesions limited to the proximal surfaces were registered, as they allow calibration and calculation of inter-observer agreement on bitewing radiographs. The kappa index showed acceptable value. Furthermore, as buccal and lingual decay is a minor problem among Nordic teenagers (Crossner, Unell 2007; Norderyd et al.

2015), and in order to eliminate uncertainties in visual discrimination between hypomineralizations and enamel lesions, smooth and occlusal surfaces were not included.

Even if a substantial reduction in caries prevalence is reported from many parts of the world (Petersen 2003; Marthaler 2004; Hugoson et al. 2008), a large majority (84%) of the present group of 16-year-olds was diagnosed with enamel proximal lesions. This is in agreement with earlier findings in Swedish 15-year-olds (Alm et al. 2007; Norderyd et al. 2015), indicating that the caries decline might be overestimated and the distribution of the caries disease is still substantial.

Caries is a preventable and curable disease. When early signs of disease activity appear, the implementation of non-operative treatment measures is a crucial requirement for successful reduction of restorative need. The generally accepted Nordic philosophy concerning caries treatment for children and adolescents is that the overall progression is rather slow and that a minor part of the population demands the majority of the resources (Crossner, Unell 2007; Schwendicke et al. 2015). This way of thinking leads to an approach trying to identify risk-groups and prolonging the recall interval for the rest of the population (Tan et al. 2006). This is, however, a strategy focusing on the need for operative treatment, and not the cure of the caries disease. In the present study, 94% of these 16-year-olds showed clinical and/or radiographic signs of caries experience. Adolescents from Northern Norway have historically had poorer dental condition than the rest of the country. According to the “Fit Future” study, however, the current caries status seems to approach that of the rest of the country. The participants with immigrant ethnicity did not seem to have influenced the caries prevalence (Jacobsen et al. 2016). The findings of this study indicate that although traditional epidemiological data show a considerable reduction in prevalence, dental caries still is a disease affecting the total teenage population and not a minor risk-group. This is in agreement with previous findings (Hugoson et al. 2008).

In this study a large majority of the participants with enamel proximal lesions also presented with either previously restored teeth (FS, 35 %), or both restored teeth and untreated dentinal caries lesions (DFS, 34 %) (Table 1). The odds of having proximal enamel lesions was more than three times higher for subjects with earlier caries experience indicating that non-operative treatment of enamel lesions should have been an integral part of traditional caries treatment earlier in life.

Non-operative caries treatment is a modality including clinical examination and early diagnosis of caries lesions, as well as assessment of the activity for the individual lesion, thereby applying the principles of preventive treatment on the individual enamel lesion level (Ekstrand et al. 2003; Selwitz et al. 2007; Raadal et al. 2011; Pretty, Ekstrand 2015). The

scientific evidence for the effectiveness and efficiency of non-operative interventions might be considered insufficient (Bader et al. 2001a; Bader et al. 2001b; Källestål et al. 2003; Källestål 2005; Mejare et al. 2015). On the other hand, fluoride-based interventions (varnish, gel and toothpaste) have a beneficial effect in reducing incidence and progression of non-cavitated lesions (Tellez et al. 2013; Mejare et al. 2015; Twetman 2015). A positive outcome of non-operative caries treatment with indications of long lasting effect, and a promising cost-effectiveness of such treatment, are supported by Ekstrand and collaborators (Ekstrand et al. 2003; Ekstrand, Christiansen 2005; Ekstrand et al. 2010; Ekstrand, Qvist 2014; Kuzmina, Ekstrand 2015), as well as by other investigators (Hausen et al. 2007; Hietasalo et al. 2009; Fejerskov et al. 2013).

A limitation regarding the current cross-sectional design was that it rendered impossible to discriminate between active and arrested lesions, obviously resulting in a certain amount of over-registration. In order to avoid this problem, longitudinal studies are required. However, the results of the present study clearly indicated the magnitude of the clinical problem related to enamel caries lesions. There is an obvious need for further studies regarding the efficiency of non-operative interventions on enamel caries lesions including the utility of auxiliary personnel (Baelum et al. 2012; Fejerskov et al. 2013; Widström et al. 2015).

Already at 16 years of age, 81% of the adolescents had experienced restorative care. At this young age, 35% of the participants with restorations had at least one restoration below acceptable quality level. The main reason for replacement of restorations is secondary caries (Mjor, Gordan 2002; Kopperud et al. 2012; Brown et al. 2015) and this is related both to restoration quality and caries activity. It has been shown in a longitudinal study that 90 % of the DMFT-score at the age of 41 is present already at 19 years of age (Crossner, Unell 2007) clearly supporting that the main focus of dental treatment after the teens involves repair and re-treatment. Consequently, the benefit of preventing enamel lesions from progressing into dentin and thereby avoiding restorations is obvious, further indicating the importance of early detection and proper handling of such lesions by applying a non-operative approach (Pitts 2004).

The present investigation clearly indicates that the caries disease still is widespread within the teenage population. Instead of trying to identify risk-groups and to prolong recall intervals, a relevant and successful treatment strategy for teenagers ought to be general prevention and shorter recall intervals in order to diagnose any active disease in time for non-operative treatment. This imply an individually adjusted treatment cost effectually performed by auxiliary dental personnel during a period when many permanent tooth surfaces are newly erupted. The teen years are a vulnerable time in life needing support

passing puberty, leaving parental guidance, family routines and food habits on the way to an adult life. The DMFS-score and the high number of 16-year-olds with restorations in need of repair or replacement further indicates the importance of a “non-operative” caries treatment strategy in order to reduce the need of traditional restorative care aiming at minimizing the vicious operative re-treatment circle throughout life (Brantley et al. 1995).

Compliance with Ethical Standards

There are no conflicts of interest for any of the authors.

Ethical approval

The project was in accordance with the ethical standards of the national research committee and with the 1964 Helsinki declaration and its later amendments.

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Legends

Table 1. The distribution of subjects with or without proximal enamel lesions (PEL), in relation to dentinal caries experience, based on DMFS-values. DS, FS, DFS are correspondingly decayed, filled and decayed-and-filled surfaces.

Table 2. Distribution of subjects according to the quality of the poorest dental restoration.

Tables

Table 1.

Proximal enamel lesions (PEL) = 0		**140 (16.1%)**
PEL = 0, DFS = 0		50 (5.8%)
PEL = 0, DFS> 0	DS = 0, FS> 0	79 (9.1%)
	DS > 0, FS = 0	3 (0.3%)
	DS> 0, FS> 0	8 (0.9%)
Proximal enamel lesions (PEL) > 0		**729 (83.9%)**
PEL> 0, DFS = 0		101 (11.6%)
PEL> 0, DFS> 0	DS= 0, FS> 0	301 (34.6%)
	DS> 0, FS = 0	28 (3.2%)
	DS> 0, FS> 0	299 (34.4%)

Table 2.

Individuals with restorations	706[1] (81.2%)
Quality of poorest filling	
Good	37 (5.3%)
Acceptable	421 (59.8%)
Poor	159 (22.6%)
Unacceptable	87 (12.4%)

[1]The quality of restorations in two subjects was not possible to assess due to orthodontic braces.