

Swedish Dental Journal

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In 2010 Swedish Dental Society celebrates 150 years. The painting shows the constitutional meeting in 1860

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CONTENTS

Aesthetic evaluation in subjects treated due to congenitally missing maxillary laterals
Robertsson, Mohlin, Thilander **177**

Dental erosion and soft drink consumption in Swedish children and adolescents and the development of a simplified erosion partial recording system
Hasselkvist, Johansson, Johansson **187**

Influence of dietary supplementation with *Lactobacillus reuteri* on the oral flora of healthy subjects
Sinkiewicz, Kronholm, Ljunggren, Dahlén, Bratthall **197**

Self-perceived oral health and obesity among 65 years old in two Swedish counties
Ekbäck, Näslund, Montgomery, Ordell **207**

Dental care utilization in a Swedish county in 1993 and 2003
Sondell, Söderfeldt, Hugoson **217**

Abstracts of free communications and posters presented at the 46th Annual Congress of the Swedish Dental Society, Göteborg, November 18-20, 2010 **229**

Contents of Swedish Dental Journal
Volume 34, 2010 **coverpage 3**

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Introduction

Swedish Dental Journal, the scientific journal of The Swedish Dental Association and the Swedish Dental Society, is published 4 times a year to promote practice, education and research within odontology. Manuscripts containing original research are accepted for consideration if neither the article nor any part of its essential substance has been or will be published elsewhere. Reviews (after consultations with the editors), Case Reports and Short Communications will also be considered for publication. All manuscript will be exposed to a referee process.

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Aesthetic evaluation in subjects treated due to congenitally missing maxillary laterals. A comparison of perception in patients, parents and dentists

STEFAN ROBERTSSON^{1,2}, BENGT MOHLIN¹, BIRGIT THILANDER¹

Abstract

© The treatment of the congenitally missing maxillary lateral incisor is a challenge to the dental profession. The demand for optimal orthodontic and prosthetic treatment is high because the condition has an impact on facial aesthetic.

The aims of the present study were to determine how different outcome of treatment were perceived by professionals and laypeople and to identify situations that caused dissatisfaction or satisfaction after space closure or tooth replacement.

A panel of four groups (patients with missing laterals, parents to these subjects, patients with other malocclusion and general dental practitioners) were included. Sixteen cases with uni- or bilateral missing maxillary lateral incisors, treated with space closure or with prosthetic replacements were presented photographically to the panel. The prosthetic replacements included resin-bonded bridges, porcelain bonded to gold bridges and implants. The panel was asked to rate the overall appearance of the mouth, to rank up to three disturbing features and to rank the most important treatment goals in case of treatment need.

An obvious difference between the panel groups was found. The general practitioners were less critical than laypeople in rating the overall appearance. Amongst dentists the tooth colour, the tooth shape and asymmetry were the most disturbing factors whilst laypeople were disturbed by colour, spacing and tooth shape.

Half of the dentists did not find any treatment need whilst the corresponding figure amongst laypeople was 19 per cent. When a treatment need was confirmed the most common treatment goals amongst dentists were to change the colour or the shape of the teeth. The laypeople wanted to change the colour, the space condition or the shape of the teeth.

The study has shown that professionals and laypeople are of different opinion when rating treatment outcome in cases with missing maxillary laterals. Careful planning to achieve optimal aesthetics should be performed.

Key words

Congenitally missing maxillary laterals, orthodontics, prosthodontics, aesthetic evaluation

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Utvärdering av estetik hos individer med agenesi av överkäkslateral. En jämförelse av uppfattning hos patienter, föräldrar och tandläkare

STEFAN ROBERTSSON, BENGT MOHLIN, BIRGIT THILANDER

Sammanfattning

⊙ Behandling av patienter med agenesi av överkäkslateral är en utmaning för tandläkarkåren. Det ställs stora krav på en optimal ortodontisk eller protetisk behandling då bettavvikelsen starkt påverkar ansiktets estetik.

Målet för denna studie är att klargöra hur olika behandlingsresultat uppfattades av tandläkare och lekmän och att identifiera förhållanden som medförde positivt och negativt gensvar vid ortodontisk luckslutning eller protetisk ersättning för lateralen.

En panel bestående av fyra grupper (patienter med saknade lateraler, föräldrar till dessa patienter, patienter med annan bettavvikelse och allmäntandläkare) deltog i studien. Sexton fall med uni- eller bilateral agenesi av överkäkslateral, behandlade med ortodontisk luckslutning eller protetisk ersättning, presenterades med hjälp av fotografier för panelen. De protetiska ersättningarna bestod av compositretinerade onlay-broar, metallkeramiska konstruktioner och implantat. Panelen bedömde bettets utseende, rangordnade upp till tre störande avvikelser och rangordnade också behandlingsmålen om man ansåg att det fanns ett behandlingsbehov.

Resultatet visar att det finns en klar skillnad mellan grupperna. Allmäntandläkarna var mindre kritiska än lekmannagrupperna vid bedömningen av det allmänna estetiska intrycket. Bland tandläkarna var tandfärg, tandform och asymmetrier de mest störande avvikelserna medan lekmännen anmärkte på tandfärg, glesställningar och tandform.

Hälften av tandläkarna ansåg inte att det fanns något behandlingsbehov medan motsvarande siffra för lekmannagruppen var 19 procent. När tandläkargruppen ansåg att det fanns ett behandlingsbehov var de mest frekventa behandlingsmålen förändring av tandfärg eller tandform. Lekmannagruppen önskade förändra tandfärg, glesställningar och tandform.

Studien visar att en professionell grupp och lekmän har olika värdering av behandlingsresultaten vid agenesi av överkäkslateral. En noggrann behandlingsplanering för att uppnå ett optimalt estetiskt resultat är därför nödvändig.

Introduction

The reported prevalence of congenitally missing maxillary laterals is one to two per cent in Nordic populations (1, 4, 7, 16, 17, 19, 28, 29, 35, 38, 46). Problems in those subjects are commonly associated with an excess of space in the maxillary anterior segment or reduced size (peg shape) of the contralateral incisor.

Visible tooth irregularities seem to be the strongest motivating factor for orthodontics as well as orthognatic surgery (36, 43, 48, 50). Orthodontic treatment hence has more and more been focused on creating satisfaction with aesthetics. Creating ideal occlusions does not seem to be an effective prevention against development of periodontitis, speech disorders, chewing problems or temporomandibular disorders (TMD). (6, 32, 40). Malocclusions may sometimes cause adverse psychosocial reactions and could influence an individuals self esteem (10, 14, 18, 22, 42, 44, 45, 48,). Significant associations to psychological health have not been confirmed so far, however (2, 21).

Dental professionals are most often those who initiate orthodontic treatment (48). Children below 10-12 years of age rarely seem to be capable of making decisions on aesthetic improvement (12, 13). Individual differences in teenager's motivation for orthodontic treatment have been shown (18). It appeared that subjects showing great dependence in family and friends emphasized psychosocial motives for treatment contrary to more independent individuals who focused more on functional or oral health reasons for treatment.

In a study by *Mohlin et al* (32) a marked difference was found in the evaluation of oral aesthetics between 12-year old children and a group of dentists. A large number of children declared a wish to correct malposition of the teeth or overjet. The dental team thought that more than 60% of those who expressed a desire for treatment had a nicer than average dental appearance. Obviously dentists and the 12-year-old children had different references with regard to average or nicer than average appearance.

Influence on oral health and function by different kinds of treatment in cases with missing maxillary laterals must be taken into consideration in the treatment planning. In a retrospective study of space closure versus prosthetic treatment only small differences were found with regard to oral health and function (38). However, a significant difference was found concerning the subject's satisfaction with appearance.

When evaluating aesthetics, panels are often used. The panel composition, i.e. age, gender and professional background, seem to have an influence on aesthetic evaluation (24, 25, 26).

The aim of the present study hence was (1) to determine how different results after treatment of spacing due to congenitally missing maxillary laterals were perceived by professionals and non-professionals, (2) to compare the view of teen-agers, parents and dental professionals on different results after space closure or tooth replacement and (3) to identify situations that generally caused dissatisfaction or satisfaction.

Material and methods

Panel members

A panel of the following four groups of participants was included in the study:

- 1) Thirty patients (9 males, 21 females) with missing maxillary laterals and before orthodontic treatment, mean age 15.2 years (range 13-17 years), were randomly selected from the files of one of the authors (SR).
- 2) Twenty patients (8 males, 12 females) with no congenitally missing maxillary lateral but treated with fixed appliance due to other malocclusions were randomly selected from the same files (SR). Their mean age was 15.8 years (range 14-18 years).
- 3) Twenty parents (8 males, 12 females) to the subjects with missing laterals. Their mean age was 44.8 years (range 33-54 years).
- 4) Twenty general dentists (6 males, 14 females) in five nearby situated Public Dental Clinics were asked to participate in the study. Their mean age was 44.6 years (range 33-58 years) and had been in practice on average 17 years (range 2-34 years).

Those 90 panel members had to evaluate the treatment outcome of cases with congenitally missing maxillary lateral. The patient's opinions of treatment outcome were not considered in the present study. This aspect will be addressed in another study, in progress.

Cases

From the files of one of the authors (SR) sixteen previously treated cases (4 males, 12 females) with different types of treatment of congenitally missing lateral(s) were selected due to the following criteria: (1) type of treatment (space closure, resin-retained restoration, porcelain bonded to gold restoration and implants) and (2) outcome of treatment (Table



© Figure 1. Case presentation

1). The treatment outcomes were regarded to be representative of subjects treated due to missing maxillary laterals.

To be included, the cases had to be documented with a complete set of intra-oral photos taken with the same camera system, equipped with a 100 mm macro lens with ring-flash illumination and colour slide film. Three photos were used, one frontal view of the dentition and two fronto-lateral views, left and right, exposed at angles of 90 degrees to the teeth in the position of the maxillary laterals. Lip retractors were used in these photographs. The colour slides were enlarged four times and a lip line were outlined in a similar fashion on all photos (Figure 1). In the Result section, by reason of lack of space, only the frontal views are shown.

Aesthetic evaluation

A structured interview composed of questions using Visual Analog Scale (VAS) and distinct alternatives was used. All panel members were individually interviewed by the same person (SR). Each case was presented consecutively and the panel member was asked to rate the cases during the structured interview. The interviewer guided the panel members through the interview, using neutral expressions and making notes of any comments during the session. The panel members were not made aware of the fact that the focus of the study was on missing maxillary laterals.

The participants were asked to rate the overall appearance of the mouth using VAS. The ends of the scale were described “totally unacceptable” on the

© Table 1. Case presentation. Osc = Orthodontic space closure, Pr = Prosthetic replacement, + and - indicate the treatment result.

Case	Missing tooth	Osc/Pr	Space cond.	Symmetry	Upper midline	Colour	Shape	Comments
1	12,22	Osc	-	+	+	+	-	Spacing. Pointed 13, 23
2	12,22	Osc	+	+	+	+	-	Reshaped 13, 23 with composite
3	12,22	Osc	+	+	+	-	-	Pointed and yellow 13, 23
4	12,22	Osc	+	+	+	+	+	Rounded 13, 23
5	22	Osc	+	-	+	+	-	No reshaping 23
6	12,22	Pr	+	+	+	+	+	Implants
7	12,23	Osc	+	+	+	+	+	Reshaped 13, 23 with grinding
8	12,22	Ocs	-	+	+	+	+	Reshaped 13, 23 with composite
9	12,22	Pr	+	+	+	+	-	Resin-bonded bridge. Short pontics 12, 22
10	12,22	Osc	-	+	+	-	-	Reshaped 13,23 with composite
11	12,22	Pr	-	+	+	-	+	Resin-bonded bridge. Greyish 11, 21
12	12	Osc	+	-	-	+	-	Pointed 13
13	12,22	Pr	+	+	+	+	+	Porcelain bonded to gold 13..12, 22..23.
14	12	Osc	+	+	+	+	+	Reshaped 13 with grinding
15	12,22	Osc	+	+	+	-	+	Reshaped 13,23 with composite. Yellowish
16	12,22	Pr	+	+	+	+	+	Porcelain bonded to gold. 12..22

left and “perfect” on the right end. They were then asked to rank the three most disturbing features in the maxillary anterior region. The distinct alternatives were: no disturbing feature, tooth colour, tooth shape, tooth position, space condition, symmetry/midline, and other alternatives. Finally, they were asked to rank the most important treatment goals in case of treatment need with the distinct alternatives: no treatment need, change of shape, the colour, the space condition, the position of teeth, symmetry/midline, or other things.

Statistical method

Two-way ANOVA completed with Student-Newman-Kuels tests were used to evaluate the VAS-variables. The Chi-square and Fisher’s exact test were used to determine differences in categorical variables for the whole material and individual cases respectively. Due to the large number of tests performed the level of significance was set to $p < 0.001$.

Results

Overall findings

When comparing the whole material, i.e. sixteen cases, there seems to be an obvious difference in rating between the panel groups (Tables 2, 3, 4).

Overall appearance (Table 2):

To visualize the results the scale is divided into three sections, designated poor, average and good. The dentist rated the appearance as good in 38%. In the laypeople groups the corresponding figure was 18% on average. However, the patients with other malocclusions were more positive than the two other laypeople groups. These differences were significant ($p < 0.001$).

Disturbing features (Table 3):

Amongst dentists the colour of the teeth (40%), the shape (26%) and asymmetry/midline shift (13%) were the three most disturbing features. The laypeople groups, taken together, mostly made remarks of the colour (44%), spacing (19%) and the shape of the teeth (16%). The differences between professionals and laypeople were significant ($p < 0.001$).

Treatment need and treatment goal (Table 4):

Almost 51 percent of the dentists didn’t think that there was a treatment need. The corresponding figure in the laypeople group was 19 percent. The most common treatment goals among dentists were to change the colour (23%) and the shape (14%) of the teeth. In

© **Table 2.** Distribution of aesthetic evaluation (%). Total observations=1440. I=subjects with missing lateral, II=subjects with other malocclusion, III=parents, IV=dentists.

	I n=30	II n=20	III n=20	IV n=20
Poor	29.6	23.8	28.1	20
Average	54.6	51.6	56.6	42.2
Good	15.8	24.7	15.3	37.8

The Chi-square and Fisher’s exact test were used to determine differences in categorical variables. $P < 0.001$.

© **Table 3.** Disturbing features (%). Total observations=1440. I=subjects with missing lateral, II=subjects with other malocclusion, III=parents, IV=dentists.

	I n=30	II n=20	III n=20	IV n=20
No disturbing feature	4.2	4.7	5.3	4.4
tooth shape	17.7	13.4	17.2	25.6
tooth colour	42.3	47.8	41.3	40.3
space condition	19.2	20.9	16.9	7.8
symmetry/midline	11.9	10.0	10.6	12.8
tooth position	3.8	2.8	7.8	3.1
Others	1.0	0.3	0.9	5.9

The Chi-square and Fisher’s exact test were used to determine differences in categorical variables. $P < 0.001$.

© **Table 4.** Treatment need and treatment goals (%). Total observations=1440. I=subjects with missing lateral, II=subjects with other malocclusion, III=parent, IV=dentists.

	I n=30	II n=20	III n=20	IV n=20
No treatment need	16.7	22.5	18.1	50.6
Change of shape	12.7	9.7	17.2	14.1
Change of colour	41.0	43.8	39.7	23.4
Change of space condition	16.5	15.0	12.2	3.8
Change of symmetry/midline	10.6	8.1	9.1	6.3
Change of tooth position	2.3	0.9	3.6	0.9
Change of other features	0.2	0.0	0.0	0.9

The Chi-square and Fisher’s exact test were used to determine differences in categorical variables. $P < 0.001$.

© **Figures 2, 3, 4, 5** Cases representative of treatment outcome of orthodontic space closure



© **Figure 2.** Case 1.



© **Figure 3.** Case 2.



© **Figure 4.** Case 4.



© **Figure 5.** Case 5.

© **Figures 6, 7, 8, 9** Cases representative of treatment outcome of prosthodontic replacement



© **Figure 6.** Case 6.



© **Figure 7.** Case 9.



© **Figure 8.** Case 11.



© **Figure 9.** Case 13.

the laypeople groups the main goals were to change the colour (41%), the space condition (15%) and the shape (13%) of the teeth. The differences between professionals and laypeople were significant ($p < 0.001$).

Case presentations

The treatment outcomes are presented in eight cases. Cases 1,2,4,5 represent typical outcome of orthodontic space closure and cases 6,9,11,13 represent typical outcome of prosthodontic replacements.

Case 1 (Figure 2)

Bilateral missing lateral incisors. Space closure. Spacing. Pointed cuspids.

Overall appearance: Among dentists the appearance was rated as acceptable (50%), or good (40%). Amongst the three groups of laypeople none rated the appearance as good. Instead, 37% found the appearance unacceptable ($P < 0.001$).

Disturbing features: The most disturbing attribute recorded was spacing (72%). The second most disturbing feature was the shape of the cuspids (21%).

Treatment need and goals: The majority of the dentists (55%) were of the opinion that there was no need for treatment. Amongst laypeople 67% judged that there was a treatment need related to spacing ($p < 0.001$).

Case 2 (Figure 3)

Bilateral missing lateral incisors. Space closure. Reshaped cuspids with composite.

Overall appearance: The appearance the dentition was rated as good (45%) or acceptable (50%) by the dentists. In the laypeople-group only 7% rated the appearance as good and 17% rated it as unacceptable ($p < 0.001$).

Disturbing features: The most disturbing feature in the dentition was the colour (cuspids) (60%) followed by toothshape (21%).

Treatment need and goals: Amongst dentist 65% were of the opinion that there was no treatment need and 25% expressed the opinion that there was a need to change the colour of the cuspids. In the laypeople groups only 16% thought that there was no treatment need. The majority (59%) thought that there was a need to change the colour of the cuspids and 14% that there was a need to change the shape of these teeth ($p < 0.001$).

Case 4 (Figure 4)

Bilateral missing lateral incisors. Space closure.

Overall appearance: The overall appearance of the dentition was ranked as acceptable (30%) or good

(70%) by all the participants.

Disturbing features: Amongst all participants 24% did not find any disturbing feature in the dentition while 32% complained of the shape of the cuspids and 26% noticed the spacing.

Treatment need and goals: In total, 81% expressed the opinion that there was no treatment need.

Case 5 (Figure 5)

Unilateral missing lateral incisor (22). Space closure. Asymmetry.

Overall appearance: The overall appearance of the dentition was ranked as acceptable (66%) or good (29%) of the participants.

Disturbing features: The most disturbing feature was the lack of symmetry noticed by 54% in the four groups followed by tooth colour (cuspid) (30%).

Treatment need and goals: Amongst dentists 75% didn't think that there was a treatment need. In the laypeople groups the corresponding figure was 24%. In the latter groups, 43% stated that there was a need to correct the asymmetry and 27% were of the opinion that there was a need for tooth colour correction ($p < 0.001$).

Case 6 (Figure 6)

Bilateral missing lateral incisors. Prosthetic replacements with implants.

Overall appearance: The overall appearance of the dentition was rated as acceptable (44%) or good (56%) by the participants.

Disturbing features: When ranking disturbing features 30% of the laypeople mentioned space condition (missing papillas) while none in the professional group made a remark of this feature ($p < 0.001$).

Treatment need and goals: The majority (56%) of the participants thought that there was no treatment need in this case.

Case 9 (Figure 7)

Bilateral missing lateral incisors. Prosthetic replacement with resin-bonded bridge
12 11 21 22.

Overall appearance: The overall appearance of the dentition was rated as poor by 22% and acceptable by 68% of the participants.

Disturbing features: The most disturbing feature was the shape of the teeth (63%). The main complaint was that the lateral incisors were too short.

Treatment need and goals: The majority of the participants (63%) thought that there was a need to change the shape of the teeth (lateral incisors).

Case 11 (Figure 8)

Bilateral missing lateral incisors. Prosthetic replacement with resin-bonded bridge

¹² ¹¹ ²¹ ²². Greyish 11,21.

Overall appearance: In all, 87% ranked the overall appearance as unacceptable.

Disturbing features: The disturbing feature was the colour of the central incisors (99%).

Treatment need and goals: The most important treatment goal was to change the colour of the central incisors (94%).

Case 13 (Figure 9)

Bilateral missing lateral incisors. Prosthetic replacement with porcelain bonded to gold bridges ¹³ ¹² and ²² ²³.

Overall appearance: The overall appearance of the dentition was rated as unacceptable by 33% and acceptable by 61%.

Disturbing features: The most disturbing feature was the colour of the teeth (76%). Several of the participants mention the dark colour of the crown margins as a disturbing factor.

Treatment need and goals: In all, 68% thought that there was a need to correct the colour.

Discussion

The present study has clearly shown that professionals and laypeople are of different opinion concerning treatment outcomes in cases with missing maxillary lateral incisors.

Kiekens et al (24, 25, 26) have analysed the use of panels in evaluating facial aesthetic. According to their studies, age, gender and professional background have an influence on aesthetic evaluation which must be a major concern when comparing different studies. As regards gender the present study shows an equal majority of females in all panel groups (in total 59 females and 31 males). Regarding age, the two teenage groups and the two adults groups of participants didn't differ between themselves. In previous studies (27, 28) it has been found that the years of professional experience had no effect on aesthetic perception. In the present study the professional group is represented by general practitioners as they are those referring patients to orthodontic and/or prosthetic treatment. It has been indicated that orthodontists, in detecting dental aesthetic discrepancies, are more discriminating than general practitioners (3, 27, 28). In ongoing studies aesthetic evaluations by orthodontists will be included.

In the present study the cases were evaluated during individual interviews. A thorough understanding and

confirmation of the subject's perception was possible. To test the aesthetic perception of different dental features various methods can be utilized. In the present study, photos of treatments outcome in genuine patients were used. The use of photos of real subjects is in accordance with other relevant studies (11, 50). In other studies photos were digitally altered to represent aesthetic variations (3, 8, 27, 28, 51). The focus in our study was of the importance of dental features and therefore the lip lines were outlined in a similar fashion on all photos. Lip coverage of the upper central incisors was around zero mm and coverage of the lower incisors was one to three mm. The chosen lip coverage is supposed to be the most attractive smile image according to Geron & Atalia (15). To laypeople, intraoral photos and the use of lip retractors are highly unusual. In this type of study, the use of photos, showing only the smile of the subjects would result in different surrounding soft tissue because of variance of lip coverage. The method used made the photos more recognizable for this group and the attention of the test persons were focused on the arrangement of the teeth.

As regards treatment alternatives, the evaluated cases included orthodontic space closure, conventional prosthodontics and implants. All the selected cases had been treated by specialists in orthodontics or prosthodontics. There was only one case with implants in this study. Further studies, in preparation, will focus on implants as a replacement in cases with missing maxillary laterals.

In all three aspects analysed, i.e. overall appearance, disturbing feature and treatment need and goal, there was a significant difference between dentists and laypeople. In accordance with some earlier studies (48, 42), our professional group was more positive in their estimation of appearance, contrary to other studies which show that the professionals are more discriminating (9, 21, 27, 28, 35). According to *Birkeland et al* (5) children were more satisfied with their dental appearance than their parents. In the present study there was no difference between the children and parents in this aspect.

In all four groups the most commonly disturbing feature was the colour of the teeth. This is in accordance with numerous papers where it has been shown that dissatisfaction with dental appearance mostly is influenced by tooth colour (11, 34, 38, 40, 50). One important goal, when replacing or restoring maxillary anterior teeth, is to create harmonious proportion between the widths of these teeth. In common theories, the maxillary lateral incisor is proposed to

be 60-70% of the width of the central incisor (31, 51). In the present study *the shape of the teeth* was the second most disturbing feature among professionals and the third among laypeople. However, the width of the tooth in the lateral position seemed to be far less important than a pointed cuspid in this position. Spacing was the second most disturbing feature amongst laypeople and of minor importance in the professional group. In general, asymmetric aesthetic discrepancies seem to be more perceptible than symmetric discrepancies (28, 38). In the present study *asymmetry/midline shift* was the third most commonly disturbing feature in the professional group, despite the fact that there was only three cases with unilateral missing lateral included.

When comparing *treatment need and treatment goal*, fully 50 percent of the dentists where of the opinion that a treatment need didn't exist. In the groups of laypeople, without knowledge of dental treatment, a vast majority (81%) expressed the opinion that a treatment need existed. When proposing a treatment, their primary goal was to change the colour or shape of the teeth. General dentists, teen-aged patients and parents share, in some aspects, the same opinion on treatment outcome in cases with missing maxillary lateral incisors. The professional knowledge of treatment alternatives, prognosis of treatment and cost/benefit of treatment seem to have an influence on the opinion of dentists. There is a risk that this knowledge will be predominant over the layman's opinion of treatment expectation.

Thus, it is important, whenever possible, to plan the treatment according to lay peoples aesthetic preferences.

To conclude

- General dentists were less critical than laypeople concerning overall appearance, disturbing features and treatment goals.
- Comparing professionals and lay people the greatest difference was found in the estimation of treatment need.
- The most prevalent disturbing factor and the most mentioned treatment goal were the colour of the cuspid in the position of the lateral incisor. In the laypeople groups spacing was considered a major disturbing feature. Asymmetry and/or midline shift was considered a disturbing feature in all groups. If a unilateral space closure is the treatment choice, no midline shift and acceptable colour and shape of the cuspid are of outmost importance.

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Dental erosion and soft drink consumption in Swedish children and adolescents and the development of a simplified erosion partial recording system

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Abstract

© The aims of this study were to investigate the prevalence of dental erosion among Swedish children and adolescents and to examine its relation to soft drink consumption. It was hypothesized that the prevalence of dental erosion would be higher in boys than girls, that it would show a correlation with soft drink consumption and that a further simplification of a previously-used partial recording screening system for dental erosion would have an acceptable sensitivity and specificity.

801 individuals were invited to participate, of whom 609 (75%) accepted. 135 were 5-6 years, 227 were 13-14 years, and 247 were 18-19 years old. A questionnaire survey of each individual's soft drink consumption habits, in addition to a clinical examination, were performed.

Severe erosion extending into dentine on one or more maxillary anterior teeth/ molars was found to be 13.3% in the 5-6 group, 11.9% in 13-14 group and 22.3% in 18-19 group. The total prevalence for all age groups was 16.4%. The severity of erosion was highest among 18-19 year-old boys, 34.4 % of whom exhibited one or more teeth with severe erosive damage while none of the girls did so. Soft drink consumption was significantly correlated with severity of dental erosion in the 18-19 and 13-14 groups but not in the 5-6 years old group. A simplified erosion partial recording system (SEPRS) using 4 (permanent) or 6 (primary) surfaces as markers showed excellent sensitivity (100%/100%, respectively) and specificity (98%/100%, respectively) in relation to scoring of all maxillary canines/incisors and first permanent/all primary molars.

In view of the high prevalence of dental erosion and soft drink consumption among Swedish children and adolescents reported here, there is clearly a need for a national epidemiological registration system as well as for community-based preventive programs to be implemented. The hypothesis that dental erosion would be higher in boys than girls and that it would show a correlation with soft drink intake was confirmed.

Key words

Adolescents, beverages, child, index, partial recording, prevalence, tooth erosion

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Dental erosion och dryckeskonsumtion hos svenska barn och ungdomar samt utveckling av ett förenklat partiellt screening-system för erosion

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Sammanfattning

◎ Syftet med denna studie var att undersöka förekomsten av dental erosion hos svenska barn och ungdomar samt att relatera denna till dryckeskonsumtion. Hypotesen var att förekomsten av erosion var högre hos pojkar än hos flickor, att den var korrelerad till dryckeskonsumtion och att en ytterligare förenkling av ett tidigare utvecklat partiellt screening-system för dental erosion skulle uppvisa en godtagbar sensitivitet och specificitet.

801 individer erbjöds medverka i studien, av vilka 609 (75%) accepterade. 135 var 5-6 år, 227 var 13-14 år, och 247 var 18-19 år. Den kliniska undersökningen kompletterades med en intervju om varje individs konsumtionsvanor av drycker.

Hos 13,3% av 5-6 åringar, 11,9% av 13-14 åringar och 22,3% av 18-19 åringar registrerades grav erosion in i dentin på minst en tand i överkäksfronten eller på sexårständer/mjölkmolarer. Förekomsten för hela gruppen var 16,4%. Förekomsten var högst hos 18-19-åriga pojkar där 34,4% uppvisade minst en gravt erosionsskadad tand, vilket ingen av flickorna gjorde. Dryckeskonsumtionen var signifikant korrelerad till svårighetsgraden av erosion i 18-19 års gruppen och i 13-14 års gruppen men inte i 5-6 års gruppen. Det förenklade screeningsystemet för erosion (SEPRS), där 4 (permanent) eller 6 (primära) tandytor användes som markörer, uppvisade en utmärkt sensitivitet (100%/100%) och specificitet (98%/100%) i jämförelse med en fullständig registrering av alla tänder i överkäksfronten och alla sexårständer/mjölkmolarer.

Mot bakgrund av den höga prevalensen av dental erosion och dryckeskonsumtion hos svenska barn och ungdomar, finns ett uppenbart behov av att införa nationella epidemiologiska registreringar, liksom av att införa landsomfattande preventionsprogram. Hypotesen att dental erosion var vanligare hos pojkar än hos flickor och att förekomsten av erosion var korrelerad till dryckeskonsumtion uppfylldes

Introduction

The terms erosion, attrition, and abrasion have widespread acceptance as descriptors of tooth wear. In short, dental erosion implies acid-induced wear of dental hard tissue, attrition wear by tooth-to-tooth contact and abrasion wear by foreign objects (eg. toothbrush). Recent studies in different countries have shown that dental erosion is common among children and adolescents but that its prevalence varies. Since studies vary in cohort composition such as socioeconomic background and age, investigation methods, investigators and indices, their results are difficult to compare. Among children aged 5-6 years, prevalence figures of dental erosion with dentine involvement ranges from 21-34% (3, 9, 10, 14) and in 13-14 years from 13-53% (3, 6, 11, 13, 23). There are no reports on adolescents aged 18-19 years, but among 20 year-old Saudi men, the prevalence of dental erosion with dentine involvement was 16% while the corresponding figure for 15-17 year old Danish boys and girls was 1.6% (20, 22). In 15 year old Dutch children, 24% exhibited deep enamel or dentin erosion (1). In one study, no significant difference in prevalence between 11-14 year-old male and female children was found (7), but other studies have reported gender differences in the prevalence of dental erosion as well as in soft drink consumption. In this regard, it has been reported that boys had significantly more dental erosion than girls, and that male gender, white children and social deprivation were significantly associated with erosion (1, 11, 25).

Several reports have shown that the consumption of carbonated drinks is higher among teenage boys compared to girls (2, 5, 24). It has also been reported that dental erosion has a clear association with consumption of soft drinks. In a group of young Saudi men it was found that a higher intake of cola-type drinks was more common in a high- than in a low-erosion group (253 l/yr and 140 l/yr, respectively) (19). In Icelandic adolescents (19-22 years) significantly higher erosion scores were found in the molars of subjects drinking more than 1 l of carbonated drinks per week than those who did not (16). In a group of 1149 British 12 year-olds, it was found that high consumption of carbonated drinks increased the odds for erosion being present by more than two-and-a-half times (11).

In the clinical situation grading of erosion is often overlooked and difficult to perform, especially at an early stage, and many scales and systems available for scoring dental erosion are time consuming and complicated to use. In epidemiological studies there

is a need for a simple screening system with a high degree of accuracy.

The aim of the present study was to investigate the prevalence of dental erosion among Swedish children and adolescents and to examine its relation to soft drink consumption. It was hypothesised that the prevalence of dental erosion would be higher in boys than girls and that it would show a correlation with soft drink consumption. A further hypothesis was that a reduced number of dental marker surfaces would be representative of an individual's severity of dental erosion.

Material and methods

Patient selection

A total of 1580 children and adolescents aged 5-6, 13-14 and 18-19 years at the Public Dental Health Service in Nora and Storå, County Council of Örebro, Sweden were enrolled in the study. Due to time constraints at the clinic, only a limited number of appointments could be allocated for the study and a total of 801 patients were given appointments in consecutive order from the computerised recall system at the Public Dental Health Service during the study period in 2005-2007. All data collection took place during their regular dental health examinations. 609 children (75%) accepted to participate in the study, of whom 135 were aged 5-6 years, 227 were 13-14 years, and 247 were 18-19 years old. 51% were males.

The regular dental health examination followed a routine protocol and radiographs were taken on individual indications. In addition, the severity of dental erosion was recorded on maxillary canines, lateral and central incisors and the presence of cuppings were recorded on first permanent molars/all primary molars.

Clinical examination

The grading of dental erosion on maxillary anterior teeth was performed according to a scale and a system developed by *Johansson et al.* (17) (Table 1) and a separate scale was constructed and used for recording molar cuppings (Table 2). Before the study, calibration on the grading of dental erosion was performed between the investigator (AH) and a more experienced researcher in terms of clinical recording of dental erosion (AKJ). Intra-examiner concordance in the use of the scales for grading erosion and cuppings was tested by the examiner (AH) performing two successive blind assessments after an interval of 2-6 weeks in 10 patients aged 5-6 years

© **Table 1.** Ordinal scale used for grading severity of dental erosion on buccal and lingual surfaces of maxillary anterior teeth (17).

Grade	Criteria
0	No visible changes, developmental structures remain, macro-morphology intact.
1	Smoothened enamel, developmental structures have totally or partially vanished. Enamel surface is shiny, matt, irregular, "melted", rounded or flat, macro-morphology generally intact.
2	Enamel surface as described in grade 1. Macro-morphology clearly changed, facetting or concavity formation within the enamel, no dentinal exposure.
3	Enamel surface as described in grades 1 and 2. Macro-morphology greatly changed (close to dentinal exposure of large surfaces) or dentin surface exposed by $\leq 1/3$.
4	Enamel surface as described in grades 1, 2 and 3. Dentin surface exposed by $>1/3$ or pulp visible through the dentin.

Note: Approximal erosion and presence of "shoulder" should be recorded.

© **Table 2.** Ordinal scale used for grading cuppings on occlusal surfaces of first permanent molars and primary molars.

Grade	Criteria
0	No cupping/intact cusp tip
1	Rounded cusp tip*
2	Cupping ≤ 1 mm
3	Cupping > 1 mm
4	Fused cuppings: at least two cuppings are fused together on the same tooth

*Changed morphology compared to the assumed original anatomy at the time of eruption

(primary teeth) and in 24 patient aged 13-14 years/18-19 years (permanent teeth). All 6 maxillary anterior teeth (buccal and palatal surfaces) were graded for severity of erosion and all first permanent and all primary molars were graded for cuppings.

The highest scores from the recordings of maxillary anterior tooth erosion (Table 1) and cuppings on first molars/primary molars (Table 2) were used to determine the total prevalence of erosion and transformed to the scale: i) No erosion (score 0); ii) mild erosion (score 1); iii) moderate erosion (score 2); iv) severe erosion (score 3); v) very severe erosion (score 4). This means that to qualify for a score 1 (mild erosion), 2 (moderate erosion) or 3 (severe

erosion), maximum score from the grading of all the maxillary anterior teeth (Table 1) and from grading molar cuppings (Table 2) had to be 1, 2 or 3 respectively, with no exceeding score on any tooth surface. Qualifying for score 4 (very severe erosion) indicates that there was at least one tooth surface on the maxillary anterior teeth graded with 4 (Table 1) or a molar occlusal surface with cupping score 4 (Table 2).

In addition, buccal cervical defects were recorded for all teeth according to Johansson (17) and only defects showing clear demarcation were recorded. One examiner (AH) performed all the clinical examinations.

Questionnaire

During the clinic visit, a questionnaire was completed through an interview by a specially trained dental assistant. The questionnaire enquired in detail drinking habits, type of drinks and amount and frequency of consumption. Carbonated soft drinks were recorded separately from all soft drinks which also included juice, still drinks and sport drinks. The additional time needed for the extended examination and interview was approximately 15 minutes.

If there was a diagnosis of erosion, the patient was informed about the condition and preventive and/or restorative measures were carried out when indicated. The clinical examiner was blinded to all information obtained from the questionnaire.

Approval from the Regional Ethical Review Board, Uppsala, Sweden was obtained prior to the start of the study.

Statistical analysis

A simplified erosion partial recording system (SEPRS) using different marker surfaces was developed and evaluated. The final model comprised highest erosion scores from the palatal surfaces of central maxillary incisors (according to Table 1) (tooth numbers 11/21) and from cupping scores (according to Table 2) of mandibular first permanent molars (tooth numbers 36/46) (4 surfaces in all). The final selection from the primary teeth comprised the highest scores from the palatal surfaces on maxillary central incisors (tooth numbers 51/61) and all 4 primary first molars (totally 6 surfaces). The sensitivity and specificity for the 4 and 6 selected surfaces from the permanent and primary teeth, respectively, were calculated in relation to the scores on all the graded permanent (16 surfaces) and primary (20 surfaces) maxillary anterior (buccal and palatal surfaces) and molar (occlusal surfaces) teeth.

Differences between the groups were tested by the Mann-Whitney U-Test. Pearson correlation analysis was used for assessing the association between soft drink intake and severity of dental erosion as well as between buccal cervical defects/cupplings and erosion scores. $P < 0.05$ were considered statistically significant. Sensitivity and specificity was calculated by cross-tabulation and standard statistical procedures. All analyses were performed on a Personal Computer using the Statistical Product and Service Solutions (SPSS, Release 15).

Results

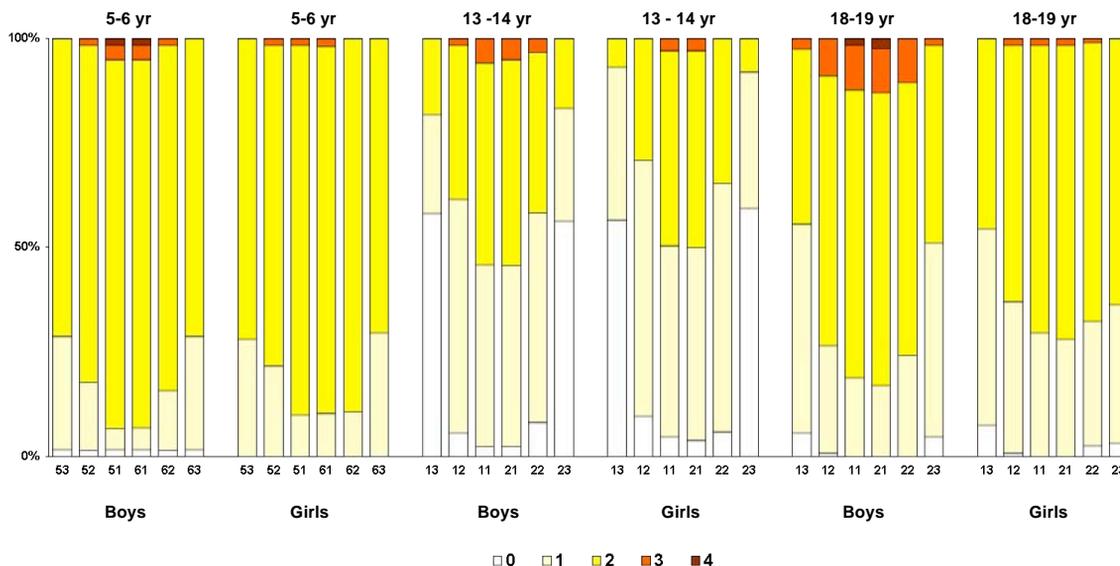
Intraexaminer concordance for the severity of maxillary anterior erosion and cupplings were for permanent teeth 71% and 80%, respectively. For the primary teeth, the corresponding figures were 64% and 76%. In cases of disagreement, the deviation was one scale unit except in two surfaces where it was two scale units.

The dropout of 192 patients were distributed as follows: 41 never showed up for their appointment; 103 did not accept to participate or failed to cooperate due to reasons such as disability to cooperate during the clinical examination, or occasionally language problems and/or functional disorders; and 48 failed to return the signed consent and were therefore excluded from the study.

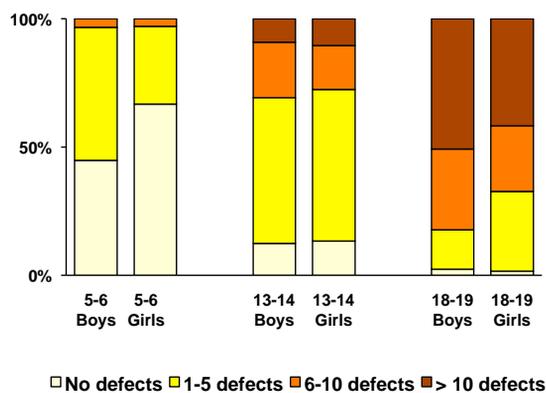
Percentage distribution of erosion grades on all graded anterior teeth in the different age groups are shown in Figure 1. Grade 3 or 4 erosion (Table 1) was found only on palatal surfaces in all age groups. Using the highest erosion score per individual, no gender differences were found in age groups 5-6 and 13-14, while in age group 18-19 boys exhibited significantly higher erosion ($P = 0.002$). The severity of erosion on anterior teeth was highest among 18-19 year-old boys, 15% of whom exhibited one or more anterior teeth with grade 3 or 4 erosion.

The distribution of cervical defects (total number/individual) and cupplings (highest score/individual) on all primary molars and on all first permanent molars are shown in Figures 2 and 3. In age groups 5-6 and 18-19, boys had significantly more cervical defects than girls ($P = 0.019$ and $P = 0.039$, respectively), but not in the 13-14 group. The most common site for cervical defects was on the right maxillary incisor (tooth number 11) in both 13-14 and 18-19 year group. As regards cupplings, boys had significantly higher scores in age groups 13-14 and 18-19 ($P = 0.02$ and $P = 0.01$, respectively), but not in age group 5-6. The most frequently found site for cupplings was on the mandibular first molar in the permanent teeth and first maxillary molar in the primary teeth. There was a statistically significant correlation between mean erosion scores on maxillary anterior permanent te-

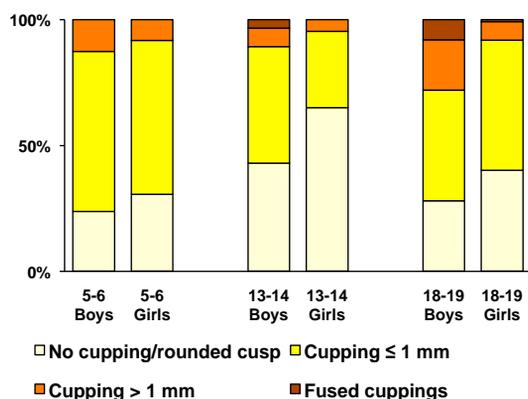
© **Figure 1.** Percentage distribution of erosion grades (Table 1) on buccal and lingual surfaces of primary (tooth numbers 53-63, age group 5-6 years) and permanent (tooth numbers 13-23, age group 13-14 and 18-19 years) maxillary anterior teeth, in boys and girls.



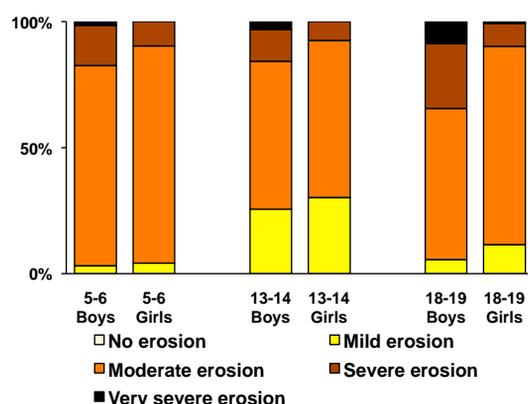
© **Figure 2.** Percentage distribution of number of cervical defects/individual on primary teeth in age group 5-6 years and permanent teeth in age groups 13-14 years and 18-19 years, in boys and girls.



© **Figure 3.** Percentage distribution of highest cupping grade/individual on primary molars (Table 2) in age group 5-6 years and first permanent molars in age groups 13-14 years and 18-19 years, in boys and girls.



© **Figure 4.** Percentage distribution of combined scores of highest occlusal wear/molar cupplings score and erosion grade on anterior teeth/individual (Tables 1 and 2), in the three groups, in boys and girls.



eth and number of cupplings ($r=0.47$, $P=0.001$) and buccal cervical defects ($r=0.36$, $P=0.001$) (groups 13-14 years and 18-19 years) but not so in primary teeth (group 5-6 years).

By using the SEPRS, the prevalence of severe/very severe erosion as obtained from the combined highest score of recorded dental erosion, on maxillary central incisors (tooth number 11 and 21) on palatal surfaces, and cupplings on mandibular first permanent molars (tooth number 36 and 46), was 11.9% (27 of 227 individuals) in the 13-14 group and 22.3% (55 of 247 individuals) in the 18-19 group. The corresponding figure for the 5-6 group (first primary molars, tooth numbers 51, 61) was 13.3% (18 of 135 individuals). The total prevalence among all age groups was 16.4% (100 of 609 individuals) and was highest in boys aged 18-19 years (34.4%; 43 of 125 individuals) (Fig. 4). Differences between boys and girls were only significant in the 18-19 group ($P=0.001$). If score 2 (moderate erosion) was included in the combined scoring of erosion and cupplings, the prevalence increased to 96.3% in the 5-6 group, 72.2% in the 13-14 group and to 91.5% in the 18-19 group.

Consumption of soft drinks was significantly higher among boys compared to girls in age groups 13-14 and 18-19, but not in age group 5-6 (Table 3).

There was a significant correlation between reported soft drink consumption and severity of dental erosion in the 18-19 group ($r=0.36$, $p=0.001$) and in the 13-14 group ($r=0.14$, $p=0.04$), but not in the 5-6 group.

As regards SEPRS, by using the combined highest scores for the palatal surfaces of maxillary central in-

© **Table 3** Mean soft drink (\pm SD) consumption (litres per year) for carbonated and all soft drinks in the 3 groups. P denotes differences between boys and girls.

Age group		Carbonated soft drinks	P	All soft drinks*	P
5-6	Boys	10.5 \pm 11.8	NS	50.3 \pm 42.4	NS
	Girls	10.7 \pm 11.6		53.3 \pm 50.0	
13-14	Boys	45.1 \pm 40.5	0.001	134.3 \pm 102.8	0.005
	Girls	31.4 \pm 38.0		103.3 \pm 92.2	
18-19	Boys	81.5 \pm 104.6	0.001	200.5 \pm 167.3	0.001
	Girls	37.5 \pm 64.3		101.8 \pm 86.5	

*Carbonated soft drinks, juice, still fruit drinks and sport drinks

cisors (tooth numbers 21/11) and cupping scores for tooth numbers 36/46, the sensitivity and specificity for predicting severe/very severe dental erosion were 100% and 98%, respectively, compared to grading all buccal and palatal surfaces on anterior teeth and all first molars. The corresponding figures for the primary teeth (palatal surfaces of maxillary central incisors and all first primary molars) were 100% for both sensitivity and specificity.

Discussion

The age groups for this study were chosen in consideration of different social and dental developmental stages. The youngest group of 5-6 year-olds typically have mainly primary teeth and are still dependent on parental care while the 13-14 year-olds have permanent teeth, have reached a greater level of independence and freedom, and fostered new friends and possibly habits in secondary schools. The 18-19 year-olds are typically about to leave the organized dental care system and will soon leave home, representing a generation with established behaviour strongly influenced by societal factors, e.g. dietary, computer/television habits, etc. In Sweden, almost all individuals in these age groups across all the socioeconomic scales receive their dental care from the Public Dental Service. Therefore, the sample is probably representative for these age groups of the Swedish population living in medium and small sized communities which Nora and Storå represent.

The scale for grading the severity of dental erosion has been extensively used in similar studies and it has been shown that it was associated with cuppings (20). The intraexaminer concordance was acceptable for scoring of cuppings (~80%) for both permanent and primary teeth. It was lower for maxillary anterior teeth (71% and 64% for permanent and primary teeth, respectively). However, it was felt that the grading of the grades 3 and 4 erosion (Table 1) seemed reliable from a clinical standpoint although in the calibration data set the number of recorded grade 3 and 4 erosion was too small for meaningful statistical analysis to be performed. Primary teeth have generally less pronounced anatomical structures than permanent teeth and changes of the surface anatomy, which is the early stages of dental erosion, may therefore be more difficult to detect. In addition, small children may have more problems to cooperate during the clinical examination. Consequently, assessment of dental erosion in primary teeth is connected with some uncertainties. Intraexaminer concordance was also somewhat lo-

wer compared to permanent teeth which verify that they are more difficult to assess.

The lesions formed by dental erosion typically appear as eroded buccal/palatal surfaces on maxillary anterior teeth and as cuppings on molars (8, 12, 18, 21). The method of using marker teeth, partial recording, has previously been evaluated. Johansson et al. (17) found that maxillary anterior teeth were most reliable for assessing erosion and that the palatal surfaces were the most commonly affected. In addition, first molar cuppings were also associated to the presence of anterior tooth erosion (18). This finding was later confirmed in another study where partial recording (grading first molar occlusal surfaces and palatal surfaces of upper incisor and canine teeth) resulted in a very small loss of information compared to full mouth scoring (25). It has also been stated that cupped lesions on the mandibular first permanent molar indicates the age of onset and severity of dental erosion (21).

In this study, recordings of smooth surface erosion and cuppings were performed on 6 maxillary anterior canine and incisor teeth (buccal and palatal surfaces or 13/53 to 23/63) and 4 permanent first molars or 8 primary molars, giving a total of 16/20 surfaces. When using SEPRS, the sensitivity and specificity for detecting grade 3 and 4 erosion were 100% and 98%, respectively, in permanent teeth (4 surfaces). The corresponding figures for primary teeth (6 surfaces) were 100% for both sensitivity and specificity. The method used for the grading of erosion on these four or six marker surfaces is relatively easy to use and not too time consuming compared to other scoring systems.

Methods which involve complete recording of the dentition give more information, but the gain might be limited, especially in epidemiological research, considering that the increased time consumption allow most probably a substantial lesser numbers of individuals to be examined. In epidemiological research it is suggested that the SEPRS using 4 respectively 6 marker teeth and surfaces is implemented.

In the clinical setting during routine examination either of the partial recording systems used in this study could be applied. However, in patients where the partial recording system has detected erosive damages, additional recording should be considered. It has to be stated clearly, that full mouth recording of dental erosion in regular clinical practice is costly and may even be unethical due to the extended examination time that is imposed and that unnecessary information is retrieved without providing any additional benefit for the patient.

The prevalence of severe/very severe dental erosion for all three age groups was 16.4%, and was generally higher for boys than girls. The highest figure was found in 18-19 year-old boys, 34% of whom had one or more teeth affected by severe/very severe erosion. The present overall prevalence compares favourably with that found in studies from other countries, and represents generally a median value of other studies (for reviews see refs. 15 and 20). In the neighbouring Scandinavian country of Denmark, however, only about 2% of 15-17 year-old children exhibited erosion into dentine (22). However, it has to be borne in mind that it is very difficult to compare different studies due to wide variations in methodology in grading dental erosion. Nevertheless, it can be concluded that the prevalence of erosion in the present study was alarmingly high.

In US, a national survey found that 4-8, 9-13 and 14-18 year-olds consumed 377, 516 and 808 ml of soft drinks daily, (corresponding to 138, 188 and 295 L/year), respectively (4), while Icelandic teenage males consumed about 800 ml of carbonated drinks per day (292 L/year) (5). The consumption of soft drinks is regarded as one of the main causes to dental erosion in children and adolescents (20). In this study, all soft drink consumption increased with age and was highest among 18-19 year-old boys who consumed an average of 200 l/year. In all age groups besides 5-6 year-olds, boys consumed significantly more soft drinks than girls. The significant correlation found here between soft drink consumption and dental erosion has previously been reported and is, therefore, not surprising (3, 16-19, 26).

The hypothesis that dental erosion is higher in boys and that dental erosion is correlated with soft drink consumption was confirmed. In view of the high prevalence of dental erosion and soft drink consumption among Swedish adolescents reported here, especially among 18-19 year-old boys, there is a need to introduce nationwide epidemiological routines for recording dental erosion as well as community-based preventive programs from an early age.

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Influence of dietary supplementation with *Lactobacillus reuteri* on the oral flora of healthy subjects

GABRIELA SINKIEWICZ¹, SOFIE CRONHOLM², LENNART LJUNGGREN¹,
GUNNAR DAHLÉN³, GUNILLA BRATTHALL²

Abstract

⊙ Investigate the presence of *Lactobacillus reuteri* in saliva after supplementation with *L. reuteri* and the probiotic effect of *L. reuteri* on plaque index and supra- and subgingival microbiota. **Material and Methods:** The study included 23 healthy individuals, randomised into test or control subjects. At baseline and after 12 weeks saliva samples, plaque index and supra- and subgingival plaque samples were obtained. The test subjects were given the study product (containing *L. reuteri*, ATCC 55730 and ATCC PTA 5289) and the control subjects placebo for 12 weeks. Microbiological analyses were done by checkerboard DNA-DNA hybridization technique and selective culturing for lactobacilli determination.

Results: A significant increase in total *Lactobacillus* counts in saliva occurred in both groups ($p < 0.05$) with a significant increase of *L. reuteri* ($p = 0.008$) in the test group. Termination of intervention resulted in a wash out of *L. reuteri*. The control group demonstrated a statistically significant increase in PII after 12 weeks ($p = 0.023$) whilst there was no significant change in the test group. A significant increase was found for most bacterial species in both groups in supra- and subgingival plaque with no significant difference for any of the species between the groups. The ratio between "bad/good" supragingival bacteria decreased for the test group but this decrease did not reach significance. The corresponding ratio for subgingival bacteria decreased significantly in both groups.

Supplementation of *L. reuteri* resulted in presence of *L. reuteri* in saliva but *L. reuteri* was washed out after termination of intervention. No significant effect on supra- or subgingival microbiota was observed. The significant increase in PII in the control group with no significant change in the test group may, however, indicate a probiotic effect of *L. reuteri* in this study population.

Key words

Lactobacilli, Lactobacillus reuteri, probiotics, oral health

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Inverkan av probiotiskt tuggummi med *Lactobacillus reuteri* på den orala floran hos friska individer

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Sammanfattning

⊙ Avsikten med studien var att undersöka förekomsten av *Lactobacillus reuteri* i saliv efter användandet av ett probiotiskt kosttillskott innehållande *L. reuteri* samt fastställa om *L. reuteri* har effekt på plackindex (PII) samt på den supra- och subgingivala mikrofloran.

Studien var dubbelblind, randomiserad, placebokontrollerad och löpte över 12 veckor. Totalt deltog 23 friska individer randomiserade i test- respektive kontrollgrupp. I försöket testades placebotuggummi mot tuggummi med *L. reuteri* (ATCC 55730 och ATCC PTA 5289). Tuggummi togs 2 gånger per dag, morgon och kväll efter tandborstning. Startdagen och efter 12 veckor samlades vilosaliv samt plack supra- och subgingivalt. Dessutom bedömdes plackindex enligt Silness & Loe på 4 indextänder mesialt och distalt. Efter ytterligare 4 veckor gjordes en uppföljning med prov på saliv och bedömning av plack på indextänderna. Mikrobiologisk analys utfördes med hjälp av checkerboard DNA-DNA hybridiseringsteknik samt odling på selektiva medier för bestämning av laktobacillpopulationen.

Totala laktobacillhalten i saliv ökade signifikant i båda grupperna ($p < 0,05$) med en signifikant ökning av *L. reuteri* i testgruppen ($p = 0,008$). Efter 16 veckor påträffades ingen *L. reuteri* i saliv. Kontrollgruppen visade en signifikant ökning av PII efter 12 veckor ($p = 0,023$), medan testgruppen inte visade någon förändring. I båda grupperna registrerades en signifikant ökning supra- och subgingivalt av de flesta bakteriearter, men det fanns ingen signifikant skillnad mellan grupperna för undersökta bakterier. Kvoten mellan "onda/goda" supragingivala bakterier minskade i testgruppen men var inte signifikant. Motsvarande kvot för subgingivala bakterier minskade signifikant i båda grupperna.

Slutsats: Intag av *L. reuteri* resulterade i förekomst av *L. reuteri* i saliv men bakterien måste tillföras kontinuerligt. Ingen signifikant förändring i den undersökta supra- och subgingivala mikrofloran kunde påvisas. Den signifikanta ökningen i PII i kontrollgruppen utan motsvarande förändring i testgruppen kan tyda på en probiotisk effekt av *L. reuteri* i denna population.

Introduction

Lactobacilli are commensal bacteria common to the digestive tract of mammals, and lactobacilli traditionally associated with foods are considered safe for human consumption (2). *Lactobacillus reuteri* is one of only 3-4 *Lactobacillus* species that naturally inhabits the digestive tract of humans, infants as well as adults (22, 25).

In a study by *Abrahamsson et al.* (1) it was reported that *L. reuteri* treatment to pregnant mothers and their offspring during the first year of life resulted in detection of *L. reuteri* in breast milk and infant stool. Foods containing *L. reuteri* have shown to have health-promoting effects in both adults and children (11, 13). The mechanism of action is thought to reside in the ability of *L. reuteri* to selectively inhibit pathogenic bacteria whilst having no inhibitory effect on commensal bacteria (14). The antimicrobial effect is due to several mechanisms affecting either adhesion or the metabolism of the target bacteria due to lowering pH that disfavour target bacteria in the microbial community or production of the antimicrobial compound 3-hydroxypropionaldehyde, known as reuterin as well as producing bacteriocins, which are antimicrobial peptides with a specific bacteriostatic/bacteriocid effect on target bacteria. Both streptococci and lactobacilli are well known bacteriocin producers against a number of oral bacteria.

Lactobacilli are found in the oral cavity (3) and have been shown to have varying ability to interfere with the growth of oral pathogens (17). *Caglar et al.* (5-10) have shown that probiotic strains of lactobacilli and bifidobacteria can reduce the levels of caries-associated bacteria in saliva. Another clinical trial by *Krassé et al.* (16) demonstrated a reduced prevalence of moderate to severe gingival inflammation as well as an improved plaque index in adults after regular use of probiotic chewing gums. *Mayanagi et al.* (20) reported that some periodontopathic bacteria were reduced by a probiotic strain of *L. salivarius*.

The aim of the present study was to investigate (i) the supra- and subgingival microbiota in healthy subjects and in particular the occurrence of *Lactobacillus reuteri* in plaque and saliva, and (ii) to investigate the influence on the microbiota after introduction of *L. reuteri*, through the use of probiotic chewing gums.

Material and methods

Study design

The study was a randomised, double-blind, placebo-controlled trial. Twenty-three healthy volunteers,

aged 18 years or more fulfilling the inclusion criteria were recruited locally. The subjects were informed of the details of the study both verbally and in writing. After written consent, the subjects were randomised into either the test group or the placebo group. The subjects were asked to continue their normal dietary and oral hygiene habits during the study period and not to use any oral antimicrobial preparations, such as mouth rinses or breathe fresheners. The inclusion criteria were: (i) subjects aged 18 years or more, (ii) signed writing informed consent, (iii) stated availability throughout the entire study period and willingness and capacity to comply with the protocol. The exclusion criteria were: (iv) participation in other clinical trials, (v) use of antibiotics, chlorhexidine, oral rinse solutions or treatment for periodontitis during the previous 6 months, (vi) use of all forms of nicotine (smoking, substitute gums etc), (vii) pregnancy, (viii) chronic disease which may be considered by the principle investigator, to affect the oral microbiota.

Resting saliva was collected from each participant at every visit according to the research plan. Plaque index (PII) according to *Silness & Løe* (27) was determined on two surfaces of each of 4 pre-defined teeth, including a premolar and molar in each jaw. Samples of supragingival plaque and samples of subgingival plaque in shallow pockets were scraped from the surfaces mentioned above for analysis of the microbiota. Registration of oral health status - gingivitis, probing pocket depth (PPD) and bleeding on probing (BOP, assessed as percentage of bleeding surfaces vs all surfaces) of the whole dentition was performed to ensure that the supplementation does not affect general oral health. Gingivitis was registered by inspection and classified as absent (0), partial (affecting less than 1/3 of the gingival (1)) and general (2). The participants were also interviewed about their frequency of dental visits per year.

After the initial analysis the test person was given the study product to start using the next morning. The study product (chewing gum) contained *L. reuteri* (an equal mix of ATCC PTA 5289 and ATCC 55730 at a total of 2x10⁸ CFU per dose, BioGaia AB, Sweden). The persons were instructed to take it twice a day, directly after dental hygiene procedures in the morning and in the evening. The gum should be chewed for a minimum of 10 min, since preliminary studies have shown that *L. reuteri* was released from the gums after 10 minutes of chewing. The subjects were given either the test or a placebo product but without *L. reuteri*. Both active and placebo are iden-

tical in taste, shape, texture and composition. Sucralose is used as a sweetener. The study or placebo product was taken daily for 12 ± 1 week after which the subjects were re-analysed in the same way as in the baseline investigation. After completion of the study, subjects were invited to return 4 weeks after the last intake of the product for reanalysis of saliva and PII to determine wash-out of *L. reuteri*. Sampling was done systematically in the morning.

Saliva samples

Sampling and microbiological analysis

Resting saliva was collected (1 ml) from each participant at every visit according to the research plan. The saliva was collected in a tube and diluted 10 fold by adding 8 ml 0.15 M NaCl and 1 ml glycerol, mixed and frozen to -80°C until analysis of *L. reuteri* ATCC PTA 5289, ATCC 55730 and total lactobacilli. Analyses were conducted within two weeks after sampling. Two microbiological analyses were conducted on these samples with the detection limit of $\geq 1.0 \times 10^2$ cfu/ml. The samples were processed by making 10-fold serial dilutions in 0.15 M NaCl. First, 0.1 ml portions of each dilution were inoculated on lactobacilli-selective agar plates (LBS; Becton Dickinson AB, Stockholm, Sweden) for the analysis of total count of Lactobacillus. Plates were incubated for 48-72 h at 37°C under anaerobic conditions (AnaeroGen, Oxoid, Stockholm, Sweden). Secondly, for the *L. reuteri* counts aliquots (100 μl) from each dilution were plated on de Man Rogosa Sharpe agar plates (MRS; Acumedia, Ljusne, Sweden) containing 20 g/L of sodium acetate and 50 mg/L of vancomycin (Sigma Chemical Co, St Louis, MO, USA) and onto MRS agar plates containing 2 mg/L of ampicillin (Sigma Chemical Co, St Louis, MO, USA) to differentiate between the 2 strains of *L. reuteri*. Plates were incubated for 48-72 h at 37°C under anaerobic conditions (AnaeroGen, Oxoid, Stockholm, Sweden). A replica plating technique (18), a copying of the microbial growth pattern from one MRS agar plate to a series of other MRS agar media (replica plates) was used. Plates were incubated as described above. This method facilitates the classification and selection of *L. reuteri* isolates to be stored for further identity using PCR analysis. *L. reuteri* colonies were identified and enumerated using a method based on the *L. reuteri*-specific production of reuterin from glycerol under anaerobic conditions at 37°C and pH 6-8 (12). Reuterin positive colonies were randomly selected from the replicated MRS media and frozen in a freezing medium, containing 4.7 mM K_2HPO_4 ,

1.3 mM KH_2PO_4 , 2.0 mM sodium citrate, 2.1 mM MgSO_4 , 15 % glycerol (Merck, Lund, Sweden) and stored at -80°C until further identity using PCR analysis.

PCR

To confirm the identity of *L. reuteri* and for strain identification among the reuterin positive colonies, isolates were randomly selected from the MRS media, purified by streak plating and subjected to sequence analysis of 16S rDNA, performed as described by Magnusson *et al.* 2003 (19). Bacterial DNA was isolated from bacteria grown in MRS broth using the DNeasy™ Tissue Kit (Qiagen). 16S rDNA was amplified by PCR (Biometra) (94°C for 30 s, 54°C for 30 s, 72°C for 80 s, step 1-3 30 cycles, 72°C for 10 min, 4°C for ∞) using primers 16SS (5'-AGA GTT TGA TCC TGG CTC-3'; position 8-25 in *E. coli* 16S rRNA) and 16SR (5'-CGG GAA CGT ATT CAC CG-3'; position 1385-1369 in *E. coli* 16S rRNA). The PCR products were electrophoresed on a 1 % agarose gel with TBE containing ethidium bromide as running buffer. A DNA ladder of 0.081-8.57 kbp (Roche Diagnostics GmbH, Mannheim, Germany) was used as a size marker together with 2 *L. reuteri* reference strains (ATCC PTA 5289 and ATCC 55730) and the gel was visualized (Quantity One) whereupon the RAPD patterns were able to be differentiated between the *L. reuteri* strains.

Plaque samples

Sampling and Checkerboard analysis

Supra- and subgingival plaque was sampled from the index teeth as described above. The samples were transferred to 100 μl TE buffer (10 mM Tris HCl, 1 mM EDTA, pH 7.6) and 100 μl 0.5 M NaOH were added and the suspensions were boiled for 5 min. After boiling 800 μl 5M ammonium acetate were added to each tube and the samples were processed with the checkerboard methodology according to standardized procedures (23, 29), against 19 bacterial species including 3 *Lactobacillus spp.*, *L. fermentum*, *L. acidophilus* and *L. reuteri*.

The occurrence of individuals positive for each of the investigated bacterial species was described at 2 different cut off levels, Score 1 and Score 3. Score 1 cut off level ($> 10^4$) was selected to contrast colonized versus non-colonized sites and score 3 cut off level ($> 10^5$) to contrast heavily colonized (score 3 or more) versus non-colonized and less heavily colonized individuals.

Statistics

Wilcoxon's rank sum and signed rank tests were used. P-values less than 5 % were considered statistically significant.

Ethical requirements

The medical Ethics Committee of Lund University, Sweden approved the study. All patients were given written information about the study and signed a consent form prior to inclusion in the project.

Results

Clinical characteristics

There were 11 subjects in the test group, 10 females and 1 male, with a mean age of 56.5 years. In the control group there were 12 subjects, 9 females and 3 males, with a mean age of 46.0 years.

In the test group 1 subject demonstrated a healthy gingiva, 9 subjects partial and 1 subject general gingivitis. In the control group the corresponding figures were 3 individuals with a healthy gingiva and 9 with partial gingivitis. The bleeding index (BOP) for the test group was 31.1 % (range 11-61) and for the control group 24 % (range 7-40). In the test group 8 out of 11 subjects demonstrated probing pocket depths (PPDs) of ≥ 5 mm (range 1-16). The corresponding figures for the control group were 7 subjects out of 12 with PPDs ≥ 5 mm (range 1-31). The supplementation of *L. reuteri* did not affect general oral health in this population.

The dentist visit habits were for the test group 1 subject less than once per year, 8 subjects once per year and 2 subjects more than once per year. The corresponding figures for the control group were 3 subjects less than once per year, 4 once per year and 5 more than once per year.

Plaque index

The mean PII of the 4 index teeth (approximal measurements only) was at baseline 0.94 for the test group (range 0.38-2.38) and 0.54 for the control group (range 0.13-1.00). At visit 2 - after use of the probiotic product - the mean PII of the index teeth was 1.11 (range 0.63-1.88) for the test group and 0.86 (range 0.38-1.38) for the control group. The change in PII between visit 1 and 2 for the test group was non-significant but the control group demonstrated a statistically significant increase in PII from visit 1 to visit 2 ($p=0.023$).

Saliva microbiology

A significant difference ($p=0.034$) was observed bet-

ween the test and control group regarding total Lactobacillus count at baseline as illustrated in Table 1. An increase in total Lactobacillus counts was found in both groups during the study period and resulted in significantly elevated counts after 16 weeks compared to baseline values, see Table 1.

Two subjects in the test group had *L. reuteri* in their saliva sample at baseline, one identified as ATCC 55730-like and the other as ATCC PTA 5289-like. All subjects but two had installed *L. reuteri* after 12 weeks of probiotic intervention in the test group. The probiotic intervention resulted in a statistically significant increase of *L. reuteri* (Table 2). Furthermore the distribution ratio in cfu between the two installed *L. reuteri* species in the saliva samples was 1:4 (24 % of ATCC 55730 and 76 % of ATCC PTA 5289) after 12 weeks (Table 3). *L. reuteri* constituted 13.8 % of the total lactobacilli count at visit two. Termination of intervention resulted in wash out of *L. reuteri* in the test group and after 16 weeks only one subject showed presence of *L. reuteri* identified as ATCC PTA 5289-like.

There were no significant differences in salivary *L. reuteri* counts in control group on any occasion. One subject in the control group showed presence of *L. reuteri* (ATCC 55730-like) at baseline and another subject showed presence of *L. reuteri* (ATCC PTA 5289-like) after 12 weeks. No *L. reuteri* was found in the control group after 16 weeks.

Plaque microbiology

A significant increase was found for most bacterial species in both groups and in supra- as well as subgingival plaque during the test period, however no statistical difference between test and control was detected. The highest average score was noted for *A. naeslundii* in both groups and both types of plaque (> 4.56). Lowest scores were noted for the three *Lactobacillus* species and only *L. reuteri* exceeded score 2 at one occasion (2.34 in supragingival plaque of the test group). It can be noted that the baseline values (Visit 1) generally showed lower values for the controls compared to those in the test group in both supragingival (Table 4) and subgingival samples (Table 5). Cross hybridizations between the three *Lactobacillus* strains were noted. Also a weak cross-hybridization between *L. reuteri* and *L. fermentum* and some of the streptococcal strains was seen. There was a tendency of decrease of the ratio between "bad/good" supragingival bacteria for the test group ($p=0.08$ compared to $p=0.52$ in the control group, see Table 6). The corresponding ratio for subgingi-

Table 1. Changes in total Lactobacillus counts in saliva samples, expressed as mean log cfu/ml \pm SD for each group at baseline and after 12 and 16 weeks respectively.

	N	Baseline	12 weeks	16 weeks ¹	p-value
Test group	11	4.1 \pm 1.3 (9/11)*	5.3 \pm 1.0 (11/11)	5.9 \pm 1.4 (10/10)*	p = 0.004
Control group	12	3.4 \pm 1.2 (12/12)	4.5 \pm 1.5 (12/12)	5.8 \pm 1.1 (12/12)*	p = 0.012
p-value		p = 0.034			

¹ 10 subjects included in the test group.

* p < 0.05.

Table 2. Changes in total L. reuteri counts in saliva samples, expressed as mean log cfu/ml \pm SD for each group at baseline and after 12 and 16 weeks respectively.

	N	Baseline	12 weeks	16 weeks ¹	p-value
Test group	11	2.4 \pm 0.3 (2/11)	4.2 \pm 1.4 (9/11)*	2.3 \pm 0.1 (1/10)	p = 0.008
Control group	12	2.4 \pm 0.5 (1/12)	2.4 \pm 0.4 (1/12)	< 2.3 (0/12)	
p-value			p = 0.0003		

¹ 10 subjects included in the test group.

* p < 0.05.

Table 3. The distribution of the L. reuteri strains (ATCC 55730 and PTA 5289) in saliva after 12 weeks of intervention. L. reuteri counts expressed as mean log cfu/ml \pm SD.

	N	ATCC 55730	ATCC PTA 5289
Test group	11	3.6 \pm 1.4 (7/11)*	4.1 \pm 1.5 (9/11)*
Control group	12	< 2.0 (0/12)	2.2 \pm 0.6 (1/12)
p-value		p = 0.013	p = 0.003

* p < 0.05.

Table 4. Mean score (SD) for each bacterial species in supragingival plaque as determined with the checkerboard method in the test group (Group A) compared to controls (Group B) and for visit 1 (Baseline) and visit 2 (end of study).

Bacteria	Visit 1 A	Visit 2 A	Mean difference	Visit1 B	Visit 2 B	Mean difference
P. gingivalis	1.75	2.45	0.70	1.23	1.85	0.63
P. intermedia	1.68	3.09	1.41	1.73	2.48	0.75
P. endodontalis	1.61	1.86	0.25	1.33	1.52	0.19
T. forsythia	1.36	1.45	0.09	0.46	0.83	0.38
A. actinomycetemcomitans	2.66	2.84	0.18	1.56	2.54	0.98
F. nucleatum	2.32	2.75	0.43	1.60	2.75*	1.15
T. denticola	3.64	3.80	0.16	2.21	3.15	0.94
P. micra	2.70	3.23	0.52	1.94	2.77	0.83
C. recta	0.82	1.34	0.52	0.33	0.90*	0.56
S. intermedia	2.18	2.86	0.68	1.15	2.67	1.52
S. oralis	3.27	3.50	0.23	2.71	3.21	0.50
S. sanguinis	1.98	3.55	1.57	1.29	3.06*	1.77
S. mutans	0.50	2.68**	2.18	0.38	1.71*	1.33
V. parvula	1.82	3.16*	1.34	1.33	2.63*	1.29
A. naeslundii	3.73	4.93*	1.20	3.73	4.94*	1.21
F. alocis	2.66	3.16	0.50	1.71	2.94**	1.23
L. reuteri	1.34	2.34	1.00	0.46	1.65***	1.19
L. fermentum	0.16	1.32**	1.16	0.04	0.90*	0.85
L. acidophilus	1.14	1.39	0.25	1.21	0.88	0.33

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 5. Mean score (SD) for each bacterial species in subgingival plaque as determined with the checkerboard method in the test group (Group A) compared to controls (Group B) and for visit 1 (Baseline) and visit 2 (end of study).

Bacteria	Visit 1 A	Visit 2 A	Mean difference	Visit 1 B	Visit 2 B	Mean difference
<i>P. gingivalis</i>	1.20	2.30**	1.09	1.06	1.40	0.33
<i>P. intermedia</i>	1.84	3.09**	1.25	1.29	2.69**	1.40
<i>P. endodontalis</i>	1.55	2.43*	0.89	1.31	1.88	0.56
<i>T. forsythia</i>	1.23	2.09*	0.86	0.63	1.42*	0.79
<i>A. actinomycetemcomitans</i>	1.77	2.57*	0.80	0.88	1.65	0.77
<i>F. nucleatum</i>	2.25	3.02**	1.43	1.13	2.46*	1.33
<i>T. denticola</i>	2.25	4.14**	1.16	1.79	2.46	0.67
<i>P. micra</i>	1.50	3.11	0.82	1.29	2.21	0.92
<i>C. recta</i>	0.00	1.52**	0.75	0.29	0.79	0.50
<i>S. intermedia</i>	0.50	2.43	0.91	0.60	2.25**	1.65
<i>S. oralis</i>	2.59	2.93	0.34	1.44	2.48*	1.04
<i>S. sanguinis</i>	1.39	3.30*	1.91	0.67	2.35*	1.69
<i>S. mutans</i>	0.61	2.52**	1.91	0.19	1.31*	1.13
<i>V. parvula</i>	1.09	2.80**	1.70	0.56	1.77*	1.21
<i>A. naeslundii</i>	2.84	4.82***	1.98	3.02	4.56**	1.54
<i>F. alocis</i>	1.68	3.16*	1.48	1.31	2.10	0.79
<i>L. reuteri</i>	0.70	2.00**	1.30	0.38	1.17*	0.79
<i>L. fermentum</i>	0.05	0.93**	0.89	0.13	0.94	0.81
<i>L. acidophilus</i>	0.50	1.14	0.64	0.50	0.94	0.44

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6. The ratio between bacteria classified as "good" * or "bad" ** for each patient in supragingival and subgingival plaque. Mean of four samples of each patient at visit 1 and 2 as well as the difference between visit 1 and 2.

Plaque	Subject group	Visit 1 (V1)	Visit 2 (V2)	Difference V1-V2
Supragingival	Group A	1.26 + 0.37	0.97 + 0.39	0.29 + 0.52 ($p = 0.08$)
Supragingival	Group B	1.05 + 0.31	0.93 + 0.33	0.12 + 0.55 ($p = 0.52$)
Subgingival	Group A	1.59 + 0.75	1.15 + 0.43	0.44 + 0.54 ($p = 0.02$)
Subgingival	Group B	1.48 + 0.75	0.96 + 0.43	0.52 + 0.66 ($p = 0.01$)

* "good" bacterial species included *S. intermedia*, *S. oralis*, *S. sanguinis*, *S. mutans*, *V. parvula*, *A. naeslundii*, *L. reuteri*, *L. fermentum*, *L. acidophilus*

** "bad" bacterial species included *P. gingivalis*, *P. intermedia*, *P. endodontalis*, *T. forsythia*, *A. actinomycetemcomitans*, *F. nucleatum*, *T. denticola*, *P. micra*, *C. rectus*, *F. alocis*

val bacteria decreased significantly both for the test ($p=0.02$) and the control group ($p=0.01$) with no significant difference between the two groups (Table 6).

Discussion

The study hypothesis was that by chewing a gum harboring a probiotic bacterial species, *Lactobacillus reuteri*, would have a significant impact both clinically (PII) and microbiologically in supra- and subgingival plaque. The direct target for the probiosis,

was a number of bacterial species associated with gingivitis/periodontitis and this should subsequently result in less plaque and/or a changed composition of the microbiota.

L. reuteri was present in 3/23 of the subjects at baseline. This prevalence is in accordance with previous studies (28). *L. reuteri* was present in both saliva and plaque during the experimental period but was washed out after the test period was terminated. This study showed a high prevalence (9/11) and high mean level of the two strains of *L. reuteri* in the saliva

of the subjects of the test group, which is in agreement with *Krasse et al.* (16) and *Caglar et al.* (10). Our study as well as *Caglar et al.* (10) also shows that the presence of *L. reuteri* in saliva is only temporary and that *L. reuteri* is washed out after the test period is terminated. The environmental prerequisites for a more permanent colonization and establishment of *L. reuteri* in the oral cavity might not be present. In a previous in vitro study (15) it has been shown that *L. reuteri* adherence is strain-dependent, where ATCC PTA 5289 show more adhesive properties compared to ATCC 55730. This is in agreement with the results in this study where the distribution ratio between ATCC 55730 and ATCC PTA 5289 was 1:4. One explanation to this is the strain origin since the ATCC PTA 5289 is an isolate from the oral cavity.

The change in PII between visit 1 and 2 for the test group was non-significant. The control group, however, demonstrated a statistically significant increase in PII from visit 1 to visit 2 ($p=0.023$) suggesting that *L. reuteri* may inhibit plaque build up as shown by *Krasse et al.* (16). Microbiologically no significant effect of the probiosis could be found, although there was a tendency ($p=0.08$) towards a healthier microbiota in the reuteri group. On the contrary, in both test and control subjects all bacterial species in all sample categories investigated showed a similar significant increase for most bacteria. This might have masked an underlying probiotic effect on the target bacteria, the ratio bad/good bacteria or the microbial composition in total.

In the present study all subjects most likely demonstrated a good oral hygiene at the first visit, knowing that they would be examined by a dental hygienist. During the information about the study the subjects were informed to keep their regular oral hygiene and that the product to be tested could influence the oral flora in a beneficial way, even though some of the individuals would get placebo material. This might have influenced the increased plaque index. This increase was, however, statistically significant for the control group only.

In the study by *Krasse et al.* (16) 59 subjects with moderate to severe gingivitis were included. The subjects were given one of two different *L. reuteri* formulations or a placebo. Gingival index decreased significantly in all 3 groups and one of the *L. reuteri* formulations (LR-1) improved gingival index significantly more than the placebo group. In contrast to the present study, plaque index decreased significantly in the two *L. reuteri* groups but there was no change in the placebo group. At the end of

the experiment, after 2 weeks, the test subjects were colonised with *L. reuteri* 65 and 95 % respectively. The different study populations and the short intervention period may explain the contrasting findings compared to our study.

Shimauchi et al. (26) evaluated the effect of probiotic intervention on the periodontal condition of subjects without severe periodontitis. A total of 66 volunteers received either *L. salivarius* WB21 containing tablets with xylitol or xylitol alone. Periodontal clinical parameters and whole saliva were examined at baseline, at 4 and 8 weeks (end of intervention). Periodontal parameters were improved in both groups after 8 weeks. Smokers in the test group, however, demonstrated a significantly greater improvement of plaque index and probing pocket depth compared to smokers in the control group. Salivary lactoferrin was also significantly reduced in smokers from the test group. Possible differences in smokers could not be verified in our study since smokers were excluded from the study population.

In the present study healthy volunteers were recruited locally, by purpose not from the Faculty of Odontology, in order to increase the chance to harbor the target bacteria both in supra- and subgingival in plaque. This was also confirmed in the baseline measurements where all bacteria in the panel were detected although at low levels (score 1-2). *A. naeslundii* reached the highest mean score of both plaque categories in the two subject groups which is in accordance with other studies using this method (30, 31). The present study used the checkerboard methodology to evaluate the probiotic effect of *L. reuteri* effect in plaque. This method has been used to measure microbiological effects of various treatment studies (4, 24). It is well suited for evaluation of many samples and bacterial species concomitantly. The disadvantage with the method is the risk of crosshybridizations which increase the background signal. This may mask the specific reaction and the data of lactobacilli should therefore be interpreted cautiously. The risk increases when probes from closely related species showed a low degree of crosshybridization. The problem is especially prominent for gram-positive bacteria where the DNA extraction procedure is more complicated. Among Lactobacillus species this problem seemed to be general even if *L. acidophilus* in a panel of 42 species used continuously by Forsyth Dental Center no Lactobacillus species are included. It cannot be concluded whether *L. reuteri* was established in the plaque of the test group or not. The increase in sig-

nals both in the test and control groups may be due to the cross hybridization with other lactobacilli and to some extent also streptococci. Such an establishment should be disclosed in future studies by culture on selective media.

In a dog study *Teughels et al.* (33) performed subgingival application of a bacterial mixture of *S. sanguinis*, *S. salivarius* and *S. mitis* in experimental periodontitis in beagle dogs. In each dog each one of the 4 quadrants were subjected to the following treatments: no treatment, scaling only, scaling plus one application of probiotics, scaling plus repeated application of probiotics. Significant reductions in PPD, BOP and attachment gain were achieved for all treatments with the exception of the non-treatment quadrant. There was no statistically significant difference between the treated quadrants for PPD and gain of attachment. For BOP, however, there was a statistical difference between scaling only and repeated applications of probiotics ($p=0.03$). To promote recolonization of bacteria no oral hygiene was performed after treatment, which is impossible in humans for ethical reasons. In this study no placebo was used in contrast to the present report. Whether the effect was mainly probiotic or also due to immunological responses was also discussed.

Twetman et al. (34) studied the effect of *L. reuteri* on the levels of inflammatory mediators in gingival crevicular fluid (GCF). Forty-two healthy adults with moderate gingivitis were included and divided into 3 groups, two groups receiving different amounts of *L. reuteri* containing chewing gum and one group placebo gum. The subjects were instructed to chew the gums for 2 weeks. Bleeding on probing (BOP) and GCF sampling were conducted at baseline and after 1, 2 and 4 weeks. Bleeding on probing and the amount of GCF decreased significantly in the two test groups. The levels of TNF-alpha and IL-8 in GCF decreased in one test group after 1 and 2 weeks, respectively, compared to baseline. It was concluded that the reduction of pro-inflammatory cytokines in GCF may be proof of the probiotic approach to gingival inflammation.

In an *in vitro* study by Van Hoogmoed et al. (35) the aim was to identify bacterial strains that reduce adhesion of periopathogens to surfaces with the hypotheses that change of adhesion properties would develop a healthier flora. Different streptococci, *Actinomyces naeslundii* and *Haemophilus parainfluenzae* were shown to inhibit the adhesion of *P. gingivalis* in this model.

The contribution of probiotics to oral health has

been reviewed by *Meurman & Stamatova* (21 and *Stamatova & Merurman* (32). The focus has been on *Lactobacillus* species due to the observation that they are producer strains of bacteriocins *in vitro* against many oral bacteria. Several studies have shown the effect of lactobacilli on *S. mutans* and *Candida* but the mechanism of action of probiotics in developing biofilms is not known and further research is needed in the field of periodontal diseases.

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Self-perceived oral health and obesity among 65 years old in two Swedish counties

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Abstract

© The aim of this study was to explore the association between oral health and obesity. The study was conducted in the spring of 2007 as a postal survey of all inhabitants born in 1942 and living in the two Swedish counties of Örebro and Östergötland. This questionnaire survey has been conducted every five years since 1992 but has been updated continually with additional questions and for the sweep used here, height and weight data were collected. A total of 8,313 individuals received the questionnaire and 6,078 of those responded (73,1%). The outcome variable oral health was measured using one global question and four detailed questions representing different aspects of oral health. The independent variable Body Mass Index (BMI) was calculated using self-reported height and weight. A difference in oral health between various BMI groups was found. The difference was both statistically significant and of clinical importance, particularly among the group with severe obesity who reported poorer self-perceived chewing capacity, lower satisfaction with dental appearance, increased mouth dryness and fewer teeth and lower overall satisfaction with oral health. In view of the increased risk of poor oral health demonstrated in this study for those with severe obesity, it may be of value to increase cooperation between dental care and primary health care for these patients.

Key words

Oral health, obesity, questionnaires, population studies, Body Mass Index

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Fetma och tandhälsa. En studie av 65-åringar i två svenska län

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Sammanfattning

© Studiens syfte var att studera sambandet mellan oral hälsa och fetma. Studien genomfördes våren 2007 som en enkätstudie av alla innevånare födda 1942 i två svenska landsting, Örebro läns landsting och Östergötlands läns landsting. Denna enkät har skickats till samma åldersgrupp vart femte år sedan 1992. Frågeställningarna har kontinuerligt kompletterats och 2007 kompletterades frågeställningarna med frågor om längd och vikt. Totalt 8,313 individer fick enkäten och 6,078 besvarade den (73,1%). Studien mätte munhälsa med hjälp av en global munhälsofråga samt fyra ytterligare frågeställningar som representerar olika aspekter av munhälsa. Den oberoende variabeln Body Mass Index (BMI) mättes med självrapporterad längd och vikt. Munhälsan varierade mellan olika BMI-grupper. Skillnaderna var både statistiskt signifikanta och kliniskt betydelsefulla. Speciellt hos gruppen med svår fetma, enligt BMI-gruppering, rapporterades sämre tuggfunktion, lägre nöjdhet med tändernas utseende, ökad muntorrhet och färre tänder samt en minskad tillfredsställelse med sin munhälsa generellt. Med den ökade risk för dålig munhälsa som denna studie påvisar för gruppen med svår fetma är det viktigt att öka samarbetet mellan tandvård och övrig hälso- och sjukvård för denna grupp av patienter.

Introduction

Obesity is a rapidly growing medical, social and economic problem in the Western world. Obesity entails an increased risk of premature death, coronary artery disease, diabetes and a number of other diseases as well as lower quality of life [21, 29, 41]. On the other hand, oral health have a different pattern in the Western world there many important determinants of oral health seems to be a decreasing problem [30, 42]. Nevertheless there has been an increased focus on associations between obesity and some components of oral health, including caries and number of teeth [52] for various age groups and among children [11] as well as adults [39]. The terms "oral health" and "dental health" are often used synonymously and with different definitions [14, 51]. Oral health as applied in this study is consistent with a Swedish definition from 2002; "Oral health is part of the general health and contributes to physical, mental and social well being by experienced and adequate oral functions in relation to individual circumstances and the absence of disease" [14]. It is also consistent with the health definition by Dolan [8] in terms of being a condition of comfortable and functional dentition that allows individuals to continue their desired social roles. Locker [24] summarized his view in the following way "when talking about oral health, our focus is not on the oral cavity itself but on the individual and the way in which oral diseases, disorders and conditions, whether confined to the oral cavity or linked to other medical conditions, threaten or impact on health, wellbeing and quality of life".

Although the problems with definitions can be confusing, it can be stated that an association between oral health and general health implies that

poor oral health is an indicator of poor general health [2]. Another factor making associations between obesity and oral health interesting is the idea of similar co-variation with lifestyle factors such as nutritional patterns [11]. Obesity and oral health can affect each other [52].

However, there are many studies showing conflicting results in this area [4-5, 10, 19, 28, 31, 33, 36-38]. There are few studies which focus on self-perceived oral health and obesity. This study focused on exploring these areas, to facilitate decisions about cooperation between different parts of medical services. The aim of this study was to explore the association between self-perceived oral health and obesity.

Methods

The study was conducted as a part of a postal survey in 2007. A total of 8,313 individuals received the questionnaire and 6,078 of those responded (73.1%). Subjects who did not answer the question about height and weight were excluded in this study. After excluding subjects with incomplete data for these questions, 5,732 individuals remained (69%). This study belongs to a longitudinal survey and data has earlier been collected in 1992, 1997 and 2002. The data were collected to be used as a tool for the planning of the dental health care services in Örebro and Östergötland counties. The survey started as a collaborative project and the counties was chosen by convenience and not with the purpose of being representative of the total Swedish country. The study design has previously been described by Unell [48]. Oral health was assessed from a conceptual model, adapted from Gilbert *et al.* [12] (Fig 1) using one single global item/question as indicator for a com-

Fig 1. Conceptual model of oral health showing associations between oral health constructs, adapted with revision from Gilbert *et al* [12]

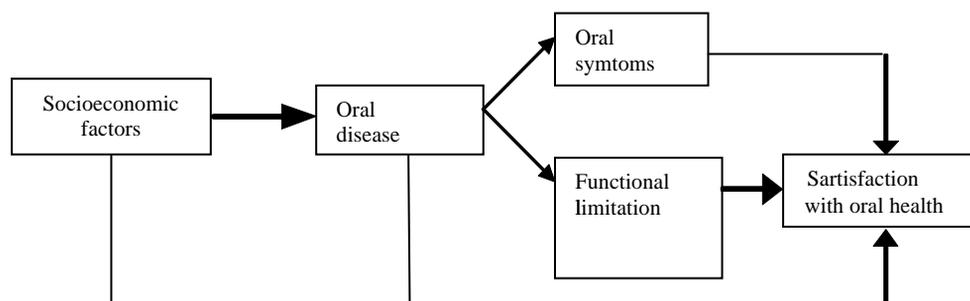


Table 1. Response rates of different aspects of oral health in % (n=5,732)

Oral health perspective	Questions oral health) (indicators for oral health	Answers and cut of points for dichotomizations	Total	Men	Women
Oral symptoms and functional limitations	Can you chew all sorts of food?	Very well	64.3	63.6	65.0
		Fairly well	29.5	29.6	29.4
		Less well	4.6	4.9	4.2
		Poorly	1.7	1.9	1.4
Oral symptoms and functional limitations	Are you satisfied with the appearance of your teeth?	Yes. very satisfied	14.1	15.4	12.7
		Yes. fairly satisfied	63.5	63.6	63.5
		No. not very satisfied	17.9	16.6	19.4
		No. absolutely not satisfied	4.4	4.4	4.4
Oral symptoms and functional limitations?	Do you feel dry in your mouth during the day	No. never	34.8	37.2	32.5
		No. seldom	37.0	39.7	34.2
		Yes. sometimes	22.3	19.2	25.5
		Yes. often	5.9	3.9	7.8
Disease	How many of your teeth do you have left?	All left	13.8	13.1	14.5
		Miss a few	58.2	58.7	57.8
		Miss fairly many	22.5	22.7	23.0
		Almost none left	2.5	3.0	2.2
Overall satisfaction with mouth	Are you in general satisfied with your teeth?	Completely toothless	2.5	2.6	2.5
		Yes. very satisfied	12.6	14.5	10.6
		Yes. fairly satisfied	64.4	63.6	65.3
		No. not very satisfied	17.0	15.8	18.3
		No. absolutely not satisfied	6.0	6.2	5.8

Table 2. Self-rated good oral health measured by one questions (oral disease). Logistic regression model (enter)

		Many remaining teeth	
		(OR)	95%CI
Gender	male	1	
	female	1.01	0.89-1.15
Education	primary education	1	
	secondary education	1.57***	1.32-1.86
	high school	2.15***	1.67-2.77
	university education	2.45***	2.04-2.94
	other education	1.44**	1.17-1.78
Place of residence	big town	1	
	small town	1.01	0.87-1.16
	rural	1.00	0.84-1.18
Experience of pedodontic dental care	scared several times	1	
	scared one time	1.76***	1.50-2.05
	never scared	2.33***	1.99-2.73
	don't remember	1.70***	1.26-2.29
Caregiver	public dentist	1	
	private dentist	1.84***	1.60-2.10
	other	0.86	0.43-1.71
	don't remember	0.08**	0.02-0.37
Country of birth	Sweden	1	
	other Scand. country	0.36***	0.25-0.51
	other country	0.44***	0.32-0.62
BMI group	normal weight	1	
	underweight	0.47	0.26-1.85
	overweight	0.94	0.81-1.09
	moderate obesity	0.67***	0.55-0.81
	severe obesity	0.47***	0.32-0.69
	extreme obesity	0.89	0.48-1.65

OR= Odds ratio, CI= Confidence interval. *P<0.05, **P<0.01, ***P<0.001

Table 3. Self-rated good oral health measured by three questions (oral, symptoms and functional limitations)). Logistic regression model (enter)

		Have good chewing capacity		Are satisfied with dental appearance		Are not dry in mouth during day	
		(OR)	95%CI				
Gender	male	1					
	female	1.35*	1.06-1.73	0.86*	0.75-0.99	0.60***	0.53-0.68
Education	primary education	1					
	secondary education	1.57**	1.13-2.19	0.98	0.82-1.18	1.10	0.93-1.30
	high school	2.53***	1.51-4.24	0.90	0.70-1.15	1.88***	1.45-2.43
	university education	2.45***	1.69-3.54	1.09	0.91-1.32	1.86***	1.56-2.22
	other education	1.44	0.97-2.14	0.96	0.771.20	1.15	0.94-1.42
Place of residence	big town	1					
	small town	1.19	0.92-1.55	1.20*	1.03-1.39	1.06	0.93-1.22
	rural	1.88***	1.32-2.68	1.39***	1.16-1.68	1.33**	1.12-1.58
Experience of pedodontic dental care	scared several times	1					
	scared one time	1.94***	1.43-2.62	2.00***	1.69-2.35	1.30**	1.12-1.58
	never scared	1.91***	1.43-2.56	2.30***	1.95-2.72	1.20*	1.03-1.39
	don't remember	2.53**	1.35-4.72	2.31***	1.64-3.24	1.27	0.94-1.71
Caregiver	public dentist	1					
	private dentist	1.75***	1.37-2.24	1.70***	1.47-1.96	1.25**	1.09-1.43
	other	0.70	0.27-1.83	1.36	0.64-2.86	0.71	0.36-1.40
	don't remember	0.24*	0.08-0.74	0.43	0.16-1.20	0.52	0.19-1.41
Country of birth	Sweden	1					
	other Scand. country	0.37***	0.23-0.62	0.96	0.64-1.43	0.72	0.50-1.02
	other country	0.26***	0.16-0.41	0.56**	0.40-0.79	0.65*	0.46-0.91
BMI group	normal weight	1					
	underweight	0.25**	0.11-0.56	0.56	0.31-1.01	0.59	0.33-1.04
	overweight	1.10	0.83-1.45	1.08	0.93-1.26	0.91	0.79-1.05
	moderate obesity	0.94	0.65-1.37	0.84	0.68-1.03	0.68***	0.56-0.83
	severe obesity	0.27***	0.16-0.45	0.61*	0.41-0.90	0.34***	0.23-0.50
	extreme obesity	0.41*	0.18-0.95	1.42	0.68-3.00	0.51*	0.29-0.92

OR= Odds ratio, CI= Confidence interval. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

pond oral health perspective and four more specific questions (Table 1). This model was proposed by adapting the work of *Locker* [25] & *Johnson and Wolinsky* [18] and has been evaluated in the Florida Dental Care study [13]. In accordance with this model, studies of oral health address the following main concepts: biological and physiological variables in terms of oral diseases, symptoms/functional limitations and oral disadvantage. Within this terminology, oral disease and tissue damage refers to disorders at the organic level or tissue loss. In this study one question ("How many teeth do you have left?") was used as an indicator of oral disease. This variable has been shown to be closely associated with clinical findings in an earlier study on this population [45]. Oral symptoms and functional limitations denote the consequences of disease and tissue damage for dysfunctions such as pain and inability to chew food adequately and were assessed with three questions. All five questions and their response categories are presented in Table 1.

All statistical analysis was performed using SPSS (version 14). Logistic regression analysis was performed with BMI group, gender, education, place of residence, frightening experience of pedodontic dental care, caregiver and country of birth as independent variables (Tables 2, 3 and 4) and the five questions in table 1 as dependent variables. For logistic regression the method "Enter" was used. All measures were modelled as series of dummy variables in the analysis. Body Mass Index (BMI) and cut off points, BMI group, frequency and range are shown in Table 5.

Statements of ethics

The original studies in 1992 and 1997 were approved by the Ethics Committee in the Örebro and Östergötland region, Sweden, but due to new regulations, approval by an ethics committee for the follow-up studies in 2002 and 2007 was not required.

Results

Analysis of non-response examined variation by

county and gender. The difference in non-response rates between counties was small, 26.4% and 27.7%, respectively ($p=0.227$). The non-response rate for men was somewhat higher (23.0%) than for women (21.3%) ($p < 0.001$).

All independent variables were tested for mutual correlation and no strong correlations exist. The strongest correlation found was between "frightening visit" and "country of birth" (Spearman's corre-

lation 0.103). Adjusted values for odds ratios did not differ noticeably from unadjusted values.

The proportion of women and men with BMI >30 were 16% and 17%, respectively (Table 5). The group with severe obesity (BMI =35-39.9) showed a statistically significant odds ratio for deteriorated oral health, regardless of which oral health perspective was used in the analysis compared with the normal weight group (Tables 2, 3 and 4). They had fewer remaining teeth, worse perceived chewing capacity, lower satisfaction with dental appearance, increased mouth dryness and lower overall satisfaction with oral health. The overweight group showed no statistically significant differences in odds ratios while the group with moderate obesity had fewer remaining teeth and increased mouth dryness compared with the normal weight group. The group with extreme obesity had worse perceived chewing capacity and increased mouth dryness and finally, the group with underweight had worse perceived chewing capacity compared with the normal weight group. There were small gender differences in associations but women had in general higher OR compared with men in "experience of pedodontic dental care" (seldom or never scared in pedodontic dental care) ($p < 0.001$) while men had higher OR in "caregiver" (private dentist) ($p < 0.001$).

Discussion

Although Statistics Sweden (SCB) provides detailed and updated information about residents in the country, it is important to consider potential problems with self-reported data. A census study minimizes some problems with selection bias and can be practical if the population is limited [27]. Despite that, non-response is often a problem. Other common limitations in validity for self-reported data can lead to recall and other forms of reporting bias. In addition, there is a possibility that behaviours that have a positive or negative attribution have been over or under reported. In this study it may lead to

Table 4. Self-rated good oral health, measured by a single global question. Logistic regression model (enter)

		Generally satisfied with oral health	
		(OR)	95%CI
Gender	male	1	
	female	0.88	0.77-1.01
Education	primary education	1	
	secondary education	1.09	0.90-1.30
	high school	1.17	0.91-1.50
	university education	1.45***	1.20-1.75
	other education	1.05	0.84-1.31
Place of residence	big town	1	
	small town	1.21*	1.04-1.41
	rural	1.40***	1.16-1.68
Experience of pedodontic dental care	scared several times	1	
	scared one time	1.91***	1.62-2.25
	never scared	2.32***	1.96-2.74
	don't remember	1.82***	1.33-2.51
Caregiver	public dentist	1	
	private dentist	1.77***	1.54-2.04
	other	0.73	0.37-1.45
	don't remember	0.40	0.15-1.10
Country of birth	Sweden	1	
	other Scand. country	0.63*	0.44-0.91
	other country	0.51***	0.36-0.72
BMI group	normal weight	1	
	underweight	0.82	0.43-1.57
	overweight	1.05	0.90-1.22
	moderate obesity	0.91	0.74-1.13
	severe obesity	0.43***	0.29-0.63
	extreme obesity	1.25	0.62-2.51

OR= Odds ratio, CI= Confidence interval. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 5. BMI groups by gender (n=5,732)

	BMI	Men		Women	
		Frequency	Percent	Frequency	Percent
Underweight	<18.5	8	0.3	46	1.6
Normal weight	18.5-24.9	911	31.8	1 264	44.1
Overweight	25-29.9	1 453	50.7	1 093	38.1
Moderate obesity	30-34.9	405	14.1	358	12.5
Severe obesity	35-39.9	68	2.4	72	2.5
Extreme obesity	>39.9	20	0.7	34	1.2

underestimation of weight and overestimation of height, resulting in lower BMI. This survey targeted all 65-year-old residents in two Swedish counties comprised both urban and rural areas. The response rate was high and differences in response rates by gender and between counties were small, indicating that the results are representative of people in these counties who were born in 1942. In broad terms, this sample is representative of the Swedish population for this birth cohort, excluding areas with a very high exclusively urban or rural composition [15]. The confidence intervals and internal consistency indicate that statistical significance is not an artefact of large sample size. Most of the results in this study were also of notable magnitude suggesting clinical relevance.

The measures and results have clear face validity and interpretation is facilitated by the fact that other studies have adopted this questionnaire in several countries [16-17, 32, 44-47]. The purpose of the survey was firstly to fulfil the county councils' obligations in planning and measuring health status for the inhabitants but secondly also for scientific research. A weakness of the study is that when the study began in 1992 there were no well-tested relevant questionnaire-based instruments available in Swedish. This has resulted in longitudinally consistent use of some original questions that are less than ideal. Despite this, the study has been demonstrated to be a useful research tool which has been used to influence policy [9].

Self-perceived oral health is a multidimensional construct and several authors have used different models to describe various determinants of oral health [13, 23, 26, 50]. In this study it is measured in several ways using a conceptual theory. Number of teeth is a relevant indicator of oral disease because more severe manifestations of both caries and periodontitis, the most frequent oral diseases, result in loss of teeth [40]. Chewing capacity, dental appearance and dry mouth reflect functional limitation, pain and discomfort. In this study, satisfaction with oral health is measured with a single global question. The use of a single item measure is widespread in medical disciplines other than odontology. They are deemed to be of value since they, can assess components of what a multi-item instrument measures [6, 34]. Earlier research has shown that single-item measures can be more than adequate for measuring oral health and general health [3, 7, 20, 34].

Despite the use of multiple measures of oral

health in this study, there are limited numbers of independent variables included in the logistic regression models, thus unobserved heterogeneity and the potential for misinterpretation of data.

The results show clinically important differences in oral health between those with obesity and normal weight. In this study the overweight group shows a small difference in oral health compared with the normal weight group while the group with severe obesity shows the clearest deterioration. The underweight group has also poorer oral health and in this respect is similar to the obese group. However, this group is small ($n=54$) and heavily skewed as concerns gender (Table 5). The BMI distribution by sex found by this study is consistent with other general population studies in similar areas [22]. The results demonstrate significant associations between people's satisfaction with their oral health and severe obesity. It also shows significant associations between different oral health determinants (number of teeth, chewing capacity, dental appearance, dry mouth) and severe obesity. This is consistent with other studies showing association between tooth loss and obesity [39, 52]. Partly because of the limited number of high qualitative studies, SBU (The Swedish Council on Technology Assessment in Health Care) have not previously reported any associations between obesity and caries in their caries report [43].

In contrast to the results from Östberg *et al.* (but consistent with Sheiham *et al.*), this study supports strong associations between obesity and number of teeth over the age of 60 years [39, 52]. In this study of 65-year olds, obesity (in particular severe obesity) was strongly associated with poor oral health, also when measured by number of teeth. Even so, comparing results can be problematic due to variation in study design and measures. This study is dependant on self-reported data to estimate BMI in contrast to the study of Östberg *et al.* In this study, self-reported number of teeth was dichotomized between all present or missing a few; and many missing, almost none left or completely toothless. In contrast, Östberg *et al.* used another dichotomized scale: more or fewer than twenty teeth. There were also differences between the studies in terms of age distribution. This study is a cross-sectional study of a single age group; so cohort and period effects can limit comparability with other groups [1].

In conclusion, our study provides strong support for the statement that obese patients, particularly those with severe obesity, are at risk of poorer oral

health. This is consistent with reports from WHO with recommendations on diet and physical activities to tackle the rapidly growing burden of diseases, including obesity [49] and caries [35], which are closely linked to unhealthy environments and lifestyles. These findings highlight the importance for health care providers to prioritize regular dental visits and advice for obese patients, in view of their increased risk of poor oral health. The poor oral health demonstrated in severely obese men and women, suggests that it may be of value to increase cooperation between dental care and primary health care for these patients.

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Dental care utilization in a Swedish county in 1993 and 2003

KATARINA SONDELL¹, BJÖRN SÖDERFELDT², ANDERS HUGOSON³

Abstract

© The aim of the present study is to analyse factors influencing the patterns of utilization of dental care in an adult urban Swedish population aged between 30 and 80 in the years 1993 and 2003. This study is part of two large epidemiological dental studies of randomly selected individuals, performed in 1993 and 2003. It comprises clinical and questionnaire data from 555 and 505 individuals in the two study years. In 1993, more patients visited the private dental care system more often than the public system. This difference still existed in 2003, but to a 50% lower extent. All age groups had less utilization of dental care in 2003 than in 1993. The largest change was seen in the 30-year age group in utilization patterns of dental care between the two study years. A hierarchical block regression method was performed in four steps, analysing utilization for the two study years separately. The dental service system influenced the utilization patterns significantly for both years. The health factors strengthened this main result. Irrespective of dental health, patients were predicted to visit the private dental care service system more often in both 1993 and 2003. The socio-economic differences between people in Sweden were of no consequence for dental care utilization. As to age and attitude towards treatment costs, a substantial change was observed and might reflect a change in social patterns with greater inequalities, but the overall picture of equal access in dental care in Sweden remains.

Key words

Dental care, dental health, dental care service system, utilization

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Tandvårdsutnyttjandet i en svensk kommun 1993 och 2003

KATARINA SONDELL, BJÖRN SÖDERFELDT, ANDERS HUGOSON

Sammanfattning

© Syftet med denna undersökning var att analysera de faktorer som påverkar en vuxen befolknings tandvårdsutnyttjande i en svensk kommun åren 1993 och 2003. Studien är en del av två större epidemiologiska undersökningar utförda på slumpmässigt utvalda individer. Dessa tvärsnittsundersökningar omfattar data från enkäter och kliniska undersökningar på 555 respektive 505 individer. Av resultaten framkom att under 1993 besökte fler patienter oftare privatfinansierade tandläkarmottagningar jämfört med offentligt finansierade mottagningar. Denna skillnad i besöksfrekvens kvarstod 2003 men hade halverats. Alla åldersgrupper 30, 40, 50, 60, 70, 80 år uppvisade lägre frekvens tandvårdsbesök 2003 jämfört med 1993. Den största skillnaden sågs i 30 års-gruppen mellan de två studerade åren. En hierarkisk blockregression utfördes i fyra steg för att analysera tandvårdsutnyttjandet för de två åren var för sig. Tandvårdsorganisationen i sig påverkade tandvårdsutnyttjandet signifikant båda åren. Hälsfaktorerna stärkte detta huvudresultat. Oavsett tandhälsa besökte patienter vid privatfinansierade mottagningar sin tandläkare oftare under 1993 och 2003 jämfört med patienterna vid offentligfinansierade mottagningar. De socioekonomiska skillnaderna mellan människor visade ingen påverkan på tandvårdsutnyttjandet. Vad gäller ålder och attityd till tandvårdskostnad observerades en tydlig skillnad och detta kan återspegla en förändring i sociala mönster mot ökad ojämlikhet, men den övergripande bilden av jämlika villkor för tandvårdsutnyttjande i Sverige kvarstår.

Introduction

National epidemiological studies in the industrialized countries indicate a marked improvement of oral health in adult populations during the last 20 years (2, 5, 13, 14, 16, 19, 23, 29, 35, 38, 40). This positive development is important not only for people but also for the organization and services of dental care (10). Several studies have found that oral health is not only dependent on dental diseases, but it is also influenced by socio-economic factors as well as by the utilization of dental care services (11, 21, 33). Sufficient access to dental care and regular attendance, especially during childhood, as well as improvements in environmental factors, may have contributed to the improved oral health, (2, 23). Thus, people with lower socio-economic status have poorer oral health but also a different pattern of dental care utilization (28, 36). Based on at least three large comprehensive oral health studies on selected parts of the Swedish population during the last 15 years, two of them carried out on the same 50-year-old cohort, it is concluded that social inequality in oral health still exists (11, 32, 33). Lower socio-economic status renders poorer oral health status as well as irregular dental care attendance behaviour. There is also a reciprocal relation, whereby oral health is likely to affect dental care utilization (18). Studies investigating dental care utilization in adult populations have found that it is also related to attitudes to the costs of dental care (7). Whether the actual individual cost of dental care has a causal effect on dental care utilization is still unclear. The results of relevant studies are contradictory and it is difficult to give a generalized interpretation (16, 35, 36, 39), partly because questions about family income almost always lead to a large non-response in questionnaire studies. It is generally assumed that low utilization in a population has a negative effect on oral health (24, 25). However, iatrogenesis as well as supplier-induced demand can play a role for such assumptions (9).

In the city of Jönköping in Sweden, a series of cross-sectional, epidemiological studies has been done in the field of dentistry covering the age groups 3–70 years in 1973, and the age groups 3–80 in 1983, 1993 and 2003. The rationale has been to illuminate a number of important issues about the oral diseases, to discover and analyse disease determinants, to evaluate the effect of dental care programmes, and the need for modifications of them. It has been concluded that in spite of an average very high attendance pattern in 2003 in all age groups, 25 per cent of the 30–40-year-olds still had not visited a dentist in the

last two years mainly because of low priority and economic restrictions (13).

Against this background, the following questions can be put:

1. Can social gradients be found in dental care utilization for different age groups?
2. Are there other factors affecting dental care utilization for different age groups?
3. Is dental care utilization in relation to different age groups altered over time?

The Petersen “conflict model” has been used to understand dental care utilization in population studies of adults (22, 33). This sociological model is based on interaction models and conflict sociology. It stresses the importance of both the primary effects of structural factors and the secondary effects of normative factors in society. Using the model in a longitudinal study from Sweden on a 50 year-old-age group, it was found that the type of dental care organization as well as the individual cost for dental care affected utilization (33). The model emphasizes four groups of explanatory factors to explain inequalities in dental health and can be used as a theoretical framework in analysing dental care utilization in adults:

- *Background factors:* family, country of birth, generation, experience of public dental service during childhood
- *Socio-economic factors:* material work and living conditions; social norms and values regarding teeth and dental care
- *Individual factors:* dental attendance behaviour, attitudes and perceptions regarding health, teeth and dental care
- *Dental health service system factors:* prices and subsidies of dental services, availability and accessibility, provider of care.

There are at least two aspects of dental care utilization to be considered in population studies: the quantity and the content of care received (33). Opinions differ, therefore, as to how utilization of dental care should be assessed (3). Failures to clearly separate between patient- and dentist-initiated visits, as well as failures to consider the volume or mix of care delivered per visit, are commonly considered as fundamental problems in studies of dental care utilization (37). The quantity of dental care utilization is rather easy to estimate in itself. Common methods are to assess data in various combinations of questions, such as time since last visit and regularity of dental care visits. This measure is considered an effective way of quantifying and could help

to illustrate differences among specific population groups once they enter the oral health care system (24). A problem is the overstatement of utilization frequency and the disregard of the visit content. Despite these shortcomings in establishing a proper dependent variable, it is still important to perform studies of utilization because of the strong relation between dental care utilization and oral health.

The aim of the present study was to analyse the utilization of dental care in 1993 and 2003 in an adult urban Swedish population in age groups 30–80. Questions to be answered were:

1. What factors influence dental care utilization?
2. Does dental care utilization differ in different age groups?
3. Did socio-economic and demographic patterns change between the two study years?
4. Do these factors differ between the age groups and the study years?

Materials and methods

This study is part of two large epidemiological dental studies, performed in 1993 and 2003, of randomly selected individuals from the city of Jönköping, a medium-sized city in Sweden. The two studies comprise data from individuals in each group reaching the age of 30, 40, 50, 60, 70 and 80 during 1993 and 2003, i.e. 555 and 505 individuals altogether for each of the two years. The clinical examinations were performed by five well experienced and calibrated dentists. The questionnaires were filled in at the clinic before the clinical examination and given to the personnel assisting the clinical examiner. Detailed information about the population base has been published elsewhere (13, 14).

Population and response rate

The frequencies and gender distributions of the study base are presented below (Table I). All patients were clinically and radiographically examined to determine the oral health status and were also asked to

answer a questionnaire containing questions about country of birth, health attitudes, socio-economic status, self-perceived general and oral health, dental care provider and dental care utilization behaviour. All clinical examinations and all questionnaires were completed and collected within 12 months. The participants were informed of the purpose of the investigations and gave their written informed consent to participate before the study began. The ethical rules for research described in the Helsinki Declaration were followed throughout the study. The study was approved in 2003 by the Regional Research Ethics Board at the University of Linköping, Sweden.

Non-response

All non-respondents were contacted by telephone and were asked about their reasons for not attending the clinical examination. The total non-response rate for 2003 was somewhat higher than for 1993. The non-response data are displayed below (Table 2). The most common reasons for declining participation in the study were “seriously ill, handicapped, senile”, “no special reason”, and “not interested”. Among the 80-year-olds, the percentage of non-respondents was high compared to the other age group for both the study years. Reasons given for non-participation among the 80-year-olds were: “had recently visited a dentist”, “had no teeth of their own”, “seriously ill, handicapped, or senile”. It was concluded that none of the reasons for non-participation were likely to have had any major influence on the results. Detailed information about the non-responders has been published elsewhere (13).

The analysis of the utilization was done using variables from all four factors of the utilization model. Utilization was thus set in relation to gender, age, country of birth, socio-economic group and education, also considering factors such as perceived general and oral health, well-being, clinical oral health status, attitudes to treatment costs, treatment need and to teeth, dental anxiety, and care provider organization.

Table 1. Number of individuals and sex distribution examined in 1993 and 2003

Age group	Examined 1993			Examined 2003		
	Men	Women	Total	Men	Women	Total
30	63	39	102	50	42	92
40	54	39	93	36	47	83
50	45	52	97	50	41	91
60	50	42	92	45	45	90
70	36	64	100	47	41	88
80	34	37	71	40	21	61
Total 30–80	282 (51%)	273 (49%)	555	268 (53%)	237 (47%)	505

Table 2. Non-responders in each age group in 1993 and in 2003

Age group	1993						2003					
	30	40	50	60	70	80	30	40	50	60	70	80
Percentage within age group (n)	22 (28)	28 (37)	25 (33)	29 (38)	23 (30)	45 (59)	29 (38)	36 (47)	30 (39)	31 (40)	32 (42)	53 (69)

Table 3. Variable description and differences in dental service utilization for the continuous independent variables between the years 1993 and 2003 by Student's t-test.

Variables	1993			2003		
	n	Mean (SD)	p-value	n	Mean (SD)	p-value
Age (range 30–80 years)						
< once/ year (%)	168	55.5 (18.9)	0.116	179	47.5 (17.1)	0.000
≥ once/ year (%)	388	53.0 (15.7)		319	57.1 (15.1)	
Well-being (range 1–9)						
< once/ year (%)	101	3.5 (1.5)	0.096	173	3.6 (1.5)	0.017
≥ once/ year (%)	388	3.3 (1.3)		313	3.3 (1.2)	
Attitude regarding treatment cost (range 1–7)						
< once/ year (%)	91	2.1 (1.5)	0.096	159	1.9 (1.2)	0.000
≥ once/ year (%)	366	2.4 (1.7)		292	2.7 (1.7)	
Perceived treatment need (range 0–5)						
< once/ year (%)	168	0.6 (1.1)	0.054	172	1.1 (1.1)	0.052
≥ once/ year (%)	388	0.8 (1.1)		317	0.9 (1.0)	
Attitude regarding own teeth (range 0–27)						
< once/ year (%)	98	10.1 (5.0)	0.006	172	11.1 (5.3)	0.024
≥ once/ year (%)	381	8.8 (4.2)		317	10.1 (4.6)	
Perceived oral health (range 24–46)						
< once/ year (%)	80	44.2 (2.6)	0.631	165	42.7 (4.3)	0.000
≥ once/ year (%)	314	44.3 (2.0)		309	44.0 (2.9)	
Dental health (range 0–120)						
< once/ year (%)	168	23.3 (25.0)	0.000	179	26.3 (22.4)	0.000
≥ once/ year (%)	388	46.3 (23.7)		316	43.2 (23.6)	
Periodontal health (range 1–5)						
< once/ year (%)	108	2.5 (1.2)	0.207	170	2.3 (1.2)	0.557
≥ once/ year (%)	381	2.6 (1.1)		312	2.4 (1.2)	

Questionnaire

The questions in the 1993 and the 2003 questionnaires were identical. Two different questionnaires with 101 and 68 questions, respectively, were used for both study years, one for the dentate group and one for the edentulous group. The questions were formulated somewhat differently for these two groups but the overall content was the same. The questions were as far as possible arranged to prevent one question from being influenced by the others. The variable construction based on these questions is described in detail and displayed below (Table III, Table IV).

The dependent variable, dental care utilization, was expressed by one question in the questionnaires: "Did you visit a dentist in both 2001 (1991) and 2002 (1992)?" Response alternatives were: Both years; only 2002 (1992); only 2001 (1991); neither of the years. The answers were analysed separately and pooled into two groups. Individuals who stated they had visited a dentist at least once a year during the two years constituted the group "normal consumers" and individuals who had visited a dentist less than once a year during the two years were pooled in the group "low consumers".

Table 4. Variable description and differences in dental service utilization for the categorical, independent variables between the years 1993 and 2003. Statistical differences tested by chi-squared.

Variables	1993			2003		
	<i>n</i> (%)	< once/ year (%)	≥ once/ year (%)	<i>n</i> (%)	< once/ year (%)	≥ once/ year (%)
Dental service system***						
Private	319 (66)	14	86	281 (60)	17	83
Public	160 (34)	29	71	187 (40)	55	45
Sex						
Men	282 (51)	32	68	236 (47)	37	63
Women	273 (49)	29	71	262 (53)	35	65
Country of birth***						
Born in Sweden	444 (91)	19	81	430 (87)	32	68
Not born in Sweden	46 (9)	46	54	63 (13)	60	40
Marital status **						
Married	164 (33)	23	77	153 (31)	45	55
Single	328 (67)	20	80	340 (69)	32	68
Education						
Low	221 (46)	19	81	157 (32)	32	68
Average	181 (37)	19	81	203 (42)	38	61
High	83 (17)	29	71	126 (26)	36	64
Occupational status***						
Working	282 (51)	22	78	278 (56)	64	36
Not working	274 (49)	39	61	220 (44)	64	36
Perceived general health						
Well	293 (76)	20	80	221 (71)	36	64
Not well	93 (24)	24	76	90 (29)	35	65

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

The independent variables used in the questionnaires were:

Background and socio-economic conditions

- Sex: man, woman
- Age: 30, 40, 50, 60, 70, and 80 years
- Country of birth: born in Sweden, not born in Sweden
- Education: primary education (low), high school/grammar school/college education 2 years (medium), college education 3 years or more (high)
- Marital status: married/cohabitant, single/divorced/widower
- Occupational status: working, not working

Individual factors and oral conditions

The component variables were coded in different ways. Minimum was 0 or 1 while maximum varied with 2 for the binary variables and 4, 5, or 10 for the scaled variables.

- *Perceived oral health*: Thirteen questions.

Ten questions with the response alternatives “yes” or “no”: “Does it hurt or do you feel discomfort when chewing?”, “Does it hurt or do you feel discomfort when you open your mouth or yawn?”, “Are you troubled by tinnitus?”, “Are you troubled by pain in your cheeks?”, “Do you often (every day) have pain in the mouth like stitches and burning sensations?”

Table 5. Logistic regression models of dental care utilization 1993 and 2003. Normal utilization (>once a year) contrasted with low utilization (< once a year)

Variables	Model 1		Model 2		Model 3		Model 4		1993		2003	
	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P
Dental health care service system	4.10	0.000	3.34	0.0001	3.85	0.0001	3.88	0.0001	2.81	0.003	4.55	0.0001
Dental service system. (ref. cat. public dental care)												
Background and socioeconomic conditions												
Age; in years			1.03	0.0001	1.02	0.0004	1.02	0.128	1.01	0.477	1.04	0.010
Sex (ref. cat. man)			1.12	0.500	1.10	0.624	1.09	0.695	0.91	0.783	1.43	0.196
Marital status (ref. cat. married)			1.33	0.107	1.30	0.199	1.32	0.210	1.04	0.909	1.41	0.245
Education (ref. cat. primary school)			–	–	–	–	–	–	–	–	–	–
1. Secondary school			1.26	0.227	1.21	0.438	1.40	0.205	1.74	0.19	1.66	0.180
2. Higher education			0.79	0.326	0.80	0.402	0.96	0.881	0.92	0.87	1.43	0.39
Country of birth (ref. cat. born in Sweden)			2.03	0.005	2.11	0.009	1.70	0.095	1.94	0.242	1.65	0.243
Occupational status (ref. cat. not working)			1.35	0.144	1.03	0.885	0.88	0.606	0.43	0.070	1.74	0.121
Individual factors												
Anxiety (range 5–10)					1.13	0.139	1.16	0.093	1.07	0.656	1.26	0.047
Well-being (range 2–10)					0.96	0.617	0.99	0.855	0.99	0.913	0.99	0.899
Attitude												
Attitude regarding own teeth (range 0–33)					0.95	0.016	0.95	0.032	0.98	0.564	0.97	0.282
Attitude regarding treatment cost (range 1–7)					1.28	0.001	1.32	0.001	1.13	0.302	1.62	0.0001
Health												
Perceived treatment need (range 0–5)							0.91	0.324	0.93	0.622	0.90	0.416
Perceived general health (ref. cat. well)							1.08	0.752	0.86	0.715	1.09	0.808
Perceived oral health (range 12–38)							1.07	0.060	0.96	0.640	1.07	0.105
Dental health (range 0–120)							1.01	0.018	1.01	0.510	1.01	0.196
Periodontal health (range 1–5)							1.02	0.841	1.03	0.869	0.90	0.443
Nagelkerke ²	0.13		0.18		0.24		0.29		0.16		0.40	
Model chi ² P	0.000		0.000		0.000		0.000		0.000		0.000	
N	947		925		781		705		309		396	
Correctly classified cases %	74.4		76.8		78.0		79.1		83.8		77.3	

“Do you often (every day) sense a metal taste?”, “Do you often (every day) sense a taste of salt?”, “Do you often (every day) sense a bad taste?”, “Do you often (every day) sense an electric taste?”, “Do you press or grind teeth?”. One question “How do you experience chewing?” with the four response alternatives “good”, “fairly good”, “rather bad”, and “bad”. One question “Are you dry in the mouth?” with the four response alternatives “never”, “occasionally”, “often”, “always”. One question “How serious do you think the problems in your mouth are?” with eleven response alternatives from 0 to 10 like “harder than anything else” to “not bad at all”: Range 12–38. A high value is a perceived healthy oral situation.

- *Perceived general health*: One question with the response alternatives “yes” or “no”: “Do you consider yourself a healthy person?”

- *Well-being*. One question “How do you like your life?”, with the six response alternatives “very good”, “good”, “rather good”, “rather bad”, “bad”, “very bad”. One question “Does loneliness bother you?” with four response alternatives “almost never”, “seldom”, “often”, “almost always”. Range 2–10. A low value indicates well-being.

- *Attitude to treatment costs*: One question with the response alternatives “less than 2000 SEK”, “about 2000 SEK”, “about 4000 SEK”, “about 6000 SEK”, “about 8000 SEK”, “about 10,000 SEK”, “more than 12,000 SEK”: “How much money are you prepared to spend every year to maintain your teeth in a healthy condition?” Range 1–7. A low value indicates a person not willing to spend much money on dental care.

- *Attitude regarding own teeth*: Three questions. Two questions with eleven response alternatives with items from 0 (very good) to 10 (very bad): “How are your teeth?” and “How do you maintain your teeth?”. One question with eleven response alternatives with items from 0 “very important” to 10 “quite unimportant”: “How important do you think it is to have teeth of your own when you become older?” Range 0–33. A low value indicates a sound, positive attitude.

- *Perceived treatment need*: One question with six items with the response alternatives ‘yes’ or ‘no’. The items were: “I wish to have my teeth fixed”, “I wish to have my teeth cleaned”, “I wish to have information about my teeth regarding caries and periodontitis”, “I wish to have information about how I can best take care of my teeth”, “I wish to have other treatment”, “Do you want something special done the next time you visit the dentist?” ‘Yes’ was coded 1, ‘no’ was coded 0. The total range was 0–5. A low va-

lue indicates a low subjective treatment need.

- *Anxiety*: One question “How do you feel when visiting the dentist?” with five statements: “I am unaffected”, “I am full of expectations”, “I feel uncomfortable”, “I feel scared”, “I feel sick”. Each of the statements had the response alternatives “yes” or “no”: Range 5–10. A low value indicates an unaffected individual.

Dental care service system

- *Dental care service systems*: One question with the response alternatives “private dental care clinic”, “public dental care clinic”, “another clinic, i.e. a specialist clinic”, “I don’t go to any dental clinic at all”: “Where do you go for your dental care?”

The alternatives “public dental care clinic” and “another clinic, i.e. specialist clinic” were pooled in one alternative, “public dental care”. The response alternative “no clinic at all” was labelled missing.

The independent variables used from the clinical examination were:

- *Dental health*: After clinical examination the numbers of decayed and filled surfaces of all remaining teeth were estimated for each patient according to the “DFS index” described by Frithjof et al (8). Range 0–120. The lowest value indicating caries-free but not necessary complete dentition.

- *Periodontal health*. After clinical and radiographic examination, all dentate individuals were classified according to Hugoson & Jordan’s criteria from 1982 (12). The criteria were: “healthy or almost healthy gingival units and normal alveolar bone height”, “gingivitis”, “alveolar bone loss around most teeth not exceeding 1/3 of the lengths of the roots”, “alveolar bone loss around most teeth ranging between 1/3 and 2/3 of the lengths of the roots”, “alveolar bone loss around most teeth exceeding 2/3 of the lengths of the roots”. The classification alternatives were: “a generally healthy parodontium”, “gingivitis”, “parodontitis levis”, “parodontitis gravis”, “parodontitis complicate”. Range 1–5. A low value indicates no damages to the tooth-supporting tissues.

Statistical analysis

Data were analysed using frequency distribution and contingency tables. Tests of significant differences were done using non-parametric tests such as chi-squared and Mann-Whitney, as well as parametric tests, primarily student’s t-test. For simplicity of presentation, t-test was used also for skewed variables, where all results also were controlled in non-parametric tests. For detection of risks of multicol-

linearity, intercorrelations between independent variables were investigated with cross-tabulations. No correlations ≥ 0.60 were found. Multiple logistic regression analysis was used with "dental care utilization less than once a year" versus "dental care utilization once a year or more" as the dependent variable. A hierarchical block regression method in four steps was used, adding blocks of variables to each step (4, 17). The independent variables were grouped in blocks of dental care service system; background and socio-economic conditions; individual factors; attitude; health status. The addition of the blocks was based on the Petersen "conflict model". The regression models were analysed for the two study years together and also separately. Bivariate associations were tested by means of chi-squared test. In the regression models the associations were expressed as odds ratios (OR). A difference was considered statistically significant when $P < 0.05$. Goodness of fit was assessed through classification plots, percentage of correctly predicted cases and calculation of Nagelkerke R^2 . Each age group was also analysed separately. All data analysis was performed in SPSS version 14.0 (SPSS Inc., Chicago, IL, USA).

Results

Cross-tabulations were performed to see the stability over the study years 1993 and 2003 for utilization patterns (Table 3, Table 4). In some cases there was stability, in some tangible changes. Bivariate analyses were performed to reveal differences. In 1993 more patients visited the private dental care system more often. This difference still existed in 2003 but to a 50% lower extent. Marital status, occupational status and country of birth influenced the utilization pattern statistically significantly for both study years. Utilization differences between age groups could only be answered by bivariate analyses (Table 3, Table 4), because the study base was too small in various age groups for logistic regression models. All age groups had less utilization of dental care in 2003 than in 1993. The largest change in utilization patterns of dental care between the two study years was seen in the 30-year age group. This age group had almost 50% less utilization of dental care service during 2003. The 40-year-old age group utilized the dental care service organizations more often in 1993 than the other age groups. The 70-year-old group showed this utilization pattern in 2003. All values described were statistically significant.

A hierarchical block regression method was performed in four steps for utilization for the two study

years separately (Table 5). In the first model, dental service system influenced the utilization patterns significantly for the two study years separately. In the second, third and fourth models when the other independent variables were subsequently put into the model in blocks, the dental service system still remained the most important factor for the utilization pattern for the study years separately. The health factors when put into the model as in model 4 did not influence, but in fact merely strengthened this main result. The association with country of birth became weaker. The education variable could not be associated with the main result at all.

Discussion

The theoretical model was useful and the statistical models revealed a good fit to theory. The statistical model had a good fit to data. All models were strongly significant with high figures for correctly clarified cases and Nagelkerke R^2 was high.

The main findings were that utilization of dental care in both 1993 and 2003 were strongly associated with the dental care service system. Incorporating the patients' health factors and attitudes in the analysis did not change this strong association. This result also confirms other studies stating that oral health is likely to affect dental care utilization,(18). It was noteworthy that the subjective and the clinical indicators of oral health displayed different patterns.

Dental care utilization is defined in different ways in the literature (20, 26, 30, 41) and is also rather complicated to operationalize. Firstly, it is hard to estimate exactly the content of utilization, meaning what kind of treatment has actually been delivered during dental care visits. In the present study the frequency of visits does not say whether the patient received full dental treatment, a regular check-up with the dental hygienist or, for example, just emergency care. Secondly, it is generally assumed that it is easier to establish the quantity of utilization. The dental care in the present study was provided by a dentist or a dental hygienist and these categories are comparable to those used in other Swedish studies (7, 15, 33, 34). Dental care utilization in the present study is self-reported. Self-reported utilization data suffers from bias. People in general exaggerate their attendance data, making interpretation to some extent uncertain (27). However, for analytic purposes this bias may be considered less important and can be assumed to be constant in a cohort study. It is possible that bias in self-reports or in response tendency is not structured along the same dimensions as utilization.

However, the results of the present study may well be interpreted as an effect of supplier-induced demand (9). That supplier inducement really exists within dentistry is also supported by several studies (9). Supplier inducement may operate mainly in two ways: by increasing the number of patients requesting care (supplier-induced demand) and by increasing the amount of care provided per patient (supplier-induced utilization) (31). Supplier inducement should be distinguished from the term overtreatment. Overtreatment should be used for a third-party definition of a difference when more dental care is actually delivered than should have been delivered. Overtreatment may exist even if there is no supplier inducement. It is also generally assumed that an increase in supply will have more effect on utilization than on demand and that supplier-induced utilization in fact can have an adverse effect on dental health (9).

In the present study the differences in dental care utilization patterns between private and public dental care systems had both increased and decreased between 1993 and 2003. In 1993, 67% of the individuals visited the private dental care organization. In 2003 this figure had decreased to 60%. These results are in accordance with several other Swedish studies (7,15, 20, 34, 36, 39). In the present study it was not possible to analyse the influence of family income and the actual patient cost for dental care due to a high non-response rate for these particular questions.

Between the study years a drastic alteration in the subsidy system for dental care took place. Patient charges for dental care were doubled between 1993 and 2003 due to these alterations. Other studies have found some correlations between costs for dental treatment and utilization patterns (34). In a study of a Swedish 50-year-old cohort during 1992 and 1997, very small changes in utilization of dental health care were found in spite of the change in the dental subsidy system in Sweden during this period (33). Dental care may have high price elasticity. The authors considered that rather many people at the age of 50–55 are well established in society and not so sensitive to cost changes.

On the other hand the patient group in the private dental care organization visited the dental care system 4 times more than the patient group in the public dental care despite their dental health status. These differences in utilization pattern between service systems still existed and increased in 2003. In 2003 these differences were also independent of background and socio-economic factors, patients'

attitudes and above all the patients' general and dental health status. With the limitation of the study, supplier-induced demand could be the only explanation. The regression model showed an interesting result. The association between care utilization and the subjective health indicators was unstable and non-significant over the two study years. The clinical indicators showed a stable and significant association in the total material, albeit non-significant for the separate years, due to the smaller material. The low absolute value of the OR is due to the extended scale of the variable. Almost all other studies rely only on subjective indicators. The result here may nuance the validity of the interpretation of the results of other studies.

The limitation of the study is above all the cross-sectional design which makes it impossible to draw any conclusion about development between the years. This assumption is also supported by other studies stating that differences in the dental care utilization patterns between years in epidemiology are chiefly the consequences of cohort effects (1, 6). Another limitation is the increasing numbers of no responders between the age groups and study years. A similar non-responding phenomenon has also been found in other recently published studies. The non-response was found to be age-related, with non-responders tending to be older (1). However, the strengths of the results of the present study are based on clinical patient data, and identical, well-designed questionnaires covering a very long time period.

Conclusions

The clinical health indicators showed a stable and significant association with care utilization in the total material. This was not the case for the subjective health indicators. Irrespective of dental health, the patient group in the private dental care organization was predicted to visit the dental care system four times more often than the patient group in the public dental care organization in both 1993 and 2003. The socio-economic differences between people in Sweden have increased during the last ten years and this has been of no consequence for dental care utilization and this goes for working status and country of birth as well. As to age and attitude towards treatment costs, a substantial change was observed between the study years. The variables were not significant in 1993, but strongly so in 2003. It may be that this reflects changing social patterns with greater inequalities both economically and over the generations. Still, the overall picture of equal access in dental care in Sweden remains.

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Abstracts

of free communications and posters presented at
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Subjects	Nos
Community and Hospital Dentistry, Others	1–10
Cariology, Endodontics.....	11–15
Periodontology.....	16–21
Orthodontics, Paediatric Dentistry.....	22–30
Prosthodontics.....	31–34
Stomatognathic Physiology, Others.....	35–41



In 2010 Swedish Dental Society celebrates 150 years. The painting shows the constitutional meeting in 1860



Utilization of dental care in Sweden 2004-2008

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Aim: To describe the self assessed dental health and utilization of dental care during the period 2004-2008 and study patterns of prediction.

Material and Methods: To describe the self assessed dental health and utilization of dental care during the period 2004-2008 and study patterns of prediction.

Results: Very good and rather good dental health was on average reported by 73% of the responders. Variation over the period and between genders was small, but with a significant increase over time. Proportion with visit to a dentist or dental hygienist during the last two years was 88%, with small change over the studied period. The lowest proportion was observed in age group 25-44, 80%. Seventeen percent had not visited a dentist/hygienist during the last three months although they reported need for treatment. This proportion decreased significantly over time independent of age and gender. Twelve percent of the participants reported that they had experienced need for dental care but had abstained for economic reasons, a change from 13% to 10%, with a most marked trend in the youngest group, 14% to 8%. Impaired dental health and low utilization of dental care was associated with low social and economic levels, life style factors as smoking, low physical activity, unfavourable dietary habits and prevalence of chronic disease and experience of lower well-being.

Conclusion: A large majority of the population report good dental health and high utilization of dental care, but approximately one in ten claims to have abstained from seeking dental care due to economic reasons. A comparison of the areas of explanatory factors, show that impaired dental health is equally well predicted by all. For models with utilization as dependent, the socio-economic factors had best predictive ability. Highest odds ratios were found in models for abstaining from needed dental care, with socio-economic factors as best predictors, and with better prediction among people above 45 years of age.



Sense of coherence - a health perspective within dental care

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Aim: Despite improvements, not all groups in the society enjoy the same oral health. This raises the question of why there are differences in oral status as well as the importance of finding new methods for maintaining oral health. Theoretical framework explaining the causal pathways, including both individuals' internal and external recourses in the society, is lacking. Antonovsky's concept 'Sense of Coherence' (SOC) has been shown to be related to health. The aim was to investigate the relationship between sense of coherence (SOC), oral health-related behaviour, knowledge of and attitudes to oral health in an adult Swedish population.

Material and Methods: A cross-sectional design with a stratified random sample of 910 individuals from Jönköping, Sweden, aged 20, 30, 40, 50, 60, 70 and 80 yrs, was obtained. The investigation used the Swedish short version of the SOC questionnaire comprising 13 items and self-reported questions about oral health habits and knowledge of and attitudes to oral health. In addition, a self-report questionnaire to elicit demographic information was included. A total of 589 individuals agreed to participate in the study.

Results: A total of 525 individuals, 261 men and 264 women, answered all the 13-item SOC questions, which constituted the final material for the study. After adjustment for all the sociodemographic factors included in the analysis, individuals with a stronger SOC had more healthy behaviour, such as lower frequency of snacks and drinks between meals, and displayed a higher degree of knowledge of caries and how to prevent it. Moreover, individuals with higher SOC scores had more positive attitudes, such as the importance of having their own teeth when getting older, satisfaction with their own teeth, better perception of their teeth and no dental anxiety, compared with individuals with a poorer SOC.

Conclusion: SOC was significantly associated with oral health-related behaviours, knowledge of dental caries and attitudes to oral health. Higher SOC scores may be a determinant for positive oral health-promoting behaviour, leading to the maintenance of oral health.



Adolescents referred for DF/DBMP: Attendance-pattern and prerequisites for structured behaviour treatment

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Aim: DF (Dental Fear) and DBMP (Dental Behaviour Management Problems) are related to impaired oral health. Many adolescents are referred because of DF/DBMP to specialist pediatric dentist clinics and depend on these clinics for their further treatment. The aim of this study was to investigate attendance-pattern and prerequisites for structured behaviour treatment in adolescents with DF/DBMP.

Material and Methods: A consecutive sample of all adolescents (n=144, mean age=15.5 yrs, 57% girls) referred because of DF/DBMP to the Specialist clinic of pediatric dentistry Göteborg, Public dental health service at Region Västra Götaland Sweden, during a 3-year period, was investigated using information from the referring dentist, medical records and the dentist's assessment at the subjects first visit at the clinic. Adolescents suitable for structured behaviour treatment were offered such treatment as part of a treatment study.

Results: Attendance-pattern: One-hundred and two subjects (71%) came to the clinic on the first summons, six (4%) came after cancellations but no failures to appear, 26 (18%) came after one or more fail-

ure to appear (the majority with no cancellations) and ten subjects (7%) never appeared at the clinic. Prerequisites for structured behaviour treatment: Fifty-two subjects (36%) were assessed as having conditions for and also accepted structured behaviour treatment, while 42 subjects (29%) were excluded due to mental retardation, neuropsychiatric disorder, severe psychosocial problems, language difficulties or failure to appear. Forty-four subjects (31%) declined behaviour treatment, many due to lack of motivation. Six subjects (4%) were excluded due to administration errors.

Conclusion: Many adolescents referred for DF/DBMP do not have prerequisites for structured behaviour treatment, often due to severe psychosocial problems or lack of motivation. This is probably the case also in other specialist clinics of pediatric dentistry as well. These aspects must be considered when planning for treatment and research on this group.



Background to ongoing research: Effective and simple treatment of dysphagia after stroke - a prospective, single-blind and randomised 2-centre study

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Aim: Stroke patients often suffer weak orofacial muscle function and swallowing difficulties, even without clinical establishment of central facial paresis. A close relationship has been shown between lip force (LF) and swallowing capacity (SC), regardless of presence or absence of facial palsy; however, it was not clear whether lip exercises could increase SC. This study intended to evaluate (i) whether oral screen training improves LF and SC in cases of oropharyngeal dysphagia after stroke, and (ii) whether improvements in LF and SC are associated with existence of central facial paresis, (iii) time between stroke debut and treatment initiation, (iv) age, or (v) gender. ▶

▷ Material and Methods: The study comprised 30 stroke patients, 49-88 years of age and with a pathological SC. Twenty-four patients had initial unilateral central facial paresis. All patients underwent LF testing with the Lip Force Meter (LF100) and SC testing before and after at least five weeks of oral screen self-training at home (3 pulling manoeuvres for 5-10 seconds with the oral screen inserted inside the lips, 3 times daily before mealtimes). Both LF100 and SC tests have a high intra- and inter-reliability and are reliable measurement methods for LF and SC. On average, lip training began a month after stroke debut and two years after onset of illness for 8 of the 13 patients with long-term dysphagia.

Results: Median LF improved from 7 newton (N) (0 - 27 N) to 18.5 N (7 - 44 N) after treatment, ($p < 0,001$); 15 N = lower limit for normal LF. Median SC was 0 ml/s (0 - 9.1 ml/s) before treatment and 12.1 ml/s (0 - 36.7) at follow-up, ($p < 0,001$); index = 10 ml/s. Facial palsy normalized or improved for all patients. All but one improved swallowing ability, and 19 of 30 stroke patients normalized SC. Neither LF nor SC was significantly influenced by existence of central facial paresis, time interval between stroke debut and treatment initiation (2 days -10 years), age or gender.

Conclusion: Simple oral screen training can safely and effectively improve LF and SC in cases of dysphagia after stroke, regardless of existence of central facial paresis or time interval between stroke debut and start of treatment. Facial palsy normalized or improved. Treatment results can more likely be attributed to orofacial sensorimotor stimulation, brain plasticity and functional reorganisation, than to buccinator mechanism training. The study opens new opportunities for rehabilitation of patients with dysphagia /facial paresis and bite or jaw deviations.

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Isolated oligodontia associated with mutations in EDARADD, AXIN2, MSX1 and PAX9 genes

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Aim: The aim of the present study was to investigate a cohort of young, unrelated individuals with isolated oligodontia for the prevalence of mutations in the AXIN2, MSX1, PAX9, EDA, and EDAR genes as well as in the novel candidate gene EDARADD. We also searched for genotype-phenotype correlations in carriers of mutations.

Material and Methods: Individuals with isolated oligodontia, defined as a congenital lack of six or more permanent teeth excluding third molars, were asked to participate. The individuals were born 1981-1994 and they originated from three counties in south-east Sweden. The cohort of 93 probands included 40 males (43.0%) and 53 females (57.0%) with a mean of 7.9 congenitally missing teeth (range 6-18). Peripheral blood samples were collected from all individuals with oligodontia, and genomic DNA was extracted from peripheral nucleated cells using standard techniques. Amplicons for denaturing gradient gel electrophoresis (DGGE) and DNA sequence analysis were generated by hot-start PCR. All variants identified were compared with sequences in the databases NCBI (<http://www.ncbi.nlm.nih.gov/Genbank/>), Human Gene Mutation Database (<http://www.hgmd.cf.ac.uk/ac/index.php>), the Biobase (<http://www.biobase-international.com/>) and with the sequences from all chromosomes included in this cohort in order to exclude polymorphisms.

Results: Mutation screening of all coding sequences of the six genes in 93 individuals revealed sequence alterations predicted to be damaging or potentially damaging in 14 individuals (15.1%): 7 girls and 7 boys. Four mutations were identified in each of the AXIN2, MSX1, and PAX9 genes, respectively. In addition, two probands were identified with mutations in the EDARADD gene. No mutation was found in the EDA or EDAR genes. With the exception of the c.1994dupG mutation in AXIN2, 13 of the 14 mutations are novel. In total, 122 teeth were missing in

the 14 probands with mutations, 69 (56.6%) in the maxilla and 53 (43.4%) in the mandible. Their mean number of missing teeth was 8.7 (range 6-18) compared to 7.7 (range 6-16) in the non-mutant group ($p>0.05$). There was a considerable overlap between mutant gene and patterns of missing teeth.

Conclusion: We found that 15% of probands with isolated oligodontia in an unselected cohort of 93 individuals are associated with primarily novel mutations in the coding regions of four genes: AXIN2, MSX1, PAX9, and EDARADD. This is the first report of mutations in EDARADD associated with isolated oligodontia. Our findings support an extensive genetic heterogeneity behind oligodontia, and we found no evidence for any specific genotype-phenotype correlations.



Histopathological diagnoses in Special Care Dentistry

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Aim: The aim of the study was to evaluate the correlation between the tentative diagnoses, made of the clinicians, with the diagnoses given by histopathological examinations. We also wanted to investigate what were the most frequent histopathological diagnoses.

Material and Methods: All biopsies that were sent for histopathological examination from the Clinic for Oral Medicine, Sahlgrenska University Hospital Östra, Gothenburg, during the period of 1993 - 2009 were included in the study. The diagnosis set by the clinician was compared with the result of the histopathological examination.

Results: A total of 900 histopathological diagnoses were evaluated, and compared with clinical diagnoses. 30% of the tentative diagnoses correlated exactly with the histopathological diagnoses. 3% of the biopsies showed a malignancy with 50% being squamous cell carcinoma. Tentative diagnosis malignancy was confirmed in 20% of these biopsies. Out of the non-

malignant tentative diagnoses 1% came back with a confirmed malignancy. The most frequent diagnoses were hyperplasia (25%), inflammation (12%), lichenoid reaction (12%), cyst (5%), granuloma (5%), malignancy (3%) and papilloma (2%).

Conclusion: It can be concluded that it is of major importance to verify the clinical diagnosis with a histopathological examination. This is due to the difficulty of telling the right diagnosis only by clinical examination. It is the clinical examination together with the histopathological examination, that helps to set the proper diagnosis.



Capillary supply and contractile protein composition in human intrinsic tongue muscles

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Introduction and aim: Human jaw and extraocular muscles have the most complex composition of contractile myosin heavy chain (MyHC) isoforms and the most extensive capillary supply of the human body. This specialization reflects functional adaptation to the requirement of natural jaw and eye movements. Another cranial muscle involved in complex movements is the human tongue. Although previous data on human intrinsic tongue muscles suggests biological specialization, the full MyHC isoform repertoire and capillary supply are unknown.

The aim was to evaluate whether human intrinsic tongue muscles also have a complex MyHC isoform composition and an extensive microvascularization as seen in other cranial muscles.

Material and Methods: Muscle samples from the anterior and posterior region of 5 human tongues were obtained at autopsy. The MyHC composition and capillary supply of three intrinsic muscles was analyzed with biochemical and immunochemical methods.

Results: Small muscle fibers containing only fast MyHCII predominated in the anterior region of the

▷ tongue (79%), whereas larger fibers containing only slow MyHC I (65%) or both slow MyHCI and fast MyHC II (20%) predominated in the posterior region. A minor fiber population co-expressed unusual MyHC isoforms such as MyHC foetal, MyHC slow tonic, MyHC α -cardiac, MyHC embryonic. The mean capillary density (CD) for the whole tongue was 796 ± 82 cap/mm², with no significant difference between regions or intrinsic muscles. The number of capillaries around each fiber (CAF) was higher in the posterior than anterior region (2.5 vs. 2.1, $p=0.009$). However, when correcting for fiber area (CAFA), the capillary supply of each fiber was higher in the anterior region (4.3 vs. 3.0, $p \leq 0.001$).

Conclusion: The microvascularization of the human tongue was twice as high as in limb muscles and more equivalent to human jaw and extraocular muscles. The regional differences in MyHC isoforms and high microvascularization, suggests that the human tongue is fatigue resistant independently of MyHC content. This result is in contrast to limb muscles, where fibers containing slow MyHCI generally are supplied by more capillaries than fibers containing fast MyHCII. The high proportion of fibers co-expressing MyHCI and MyHCII, indicate a wider spectrum of contraction properties in the tongue than in limb muscles. In conclusion, the human intrinsic tongue muscle showed internal specialization in capillary supply and distribution of MyHC isoforms, but not in the expression of unusual MyHC isoforms.



Effects of clomipramine on salivary secretion

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Aim: Clomipramine belongs to the group of classical tricyclic antidepressants. These drugs have a strong antidepressant effect, but they are also used in treatment of neuropathic pain. The most common adverse effect is oral dryness and it is considered to depend on an anticholinergic effect in the salivary glands. However, since clomipramine also exerts inhibitory effects in the central nervous system, it was

wondered by which principal mechanism clomipramine induces oral dryness. Therefore, the effect of clomipramine on the flow of saliva in response to an activation of the salivary reflex or to a peripheral cholinergic stimulus was studied.

Material and Methods: In 30 anaesthetized rats (pentobarbitone 20 mg/kg I.P. and ketamine 50 mg/kg I.M.) a catheter was inserted into the femoral vein for drug administration. The parotid duct was cannulated and all saliva secreted was collected. In the first series of experiments, secretion was induced by the application of citric acid on the tongue of the animal before and after increasing doses of clomipramine ($n=6$) or placebo ($n=6$). In the second series of experiments, secretion was induced by intravenous injections of metacholine (5 μ g/kg), before and after increasing doses of clomipramine ($n=9$) or placebo ($n=9$).

Results: Reflex activation of the salivary secretion evoked a well-maintained flow response in the control group. In the clomipramine group, the flow at baseline did not differ from that in the control group. However, intravenous injections of clomipramine markedly reduced the citric acid-evoked secretion in a dose-dependent way. Clomipramine 2 mg/kg and 5 mg/kg reduced the flow by 32% ($p < 0.05$) and by 60% ($p < 0.01$) respectively. Intravenous administration of metacholine evoked similar responses at baseline in the control group and the clomipramine group. In contrast to the reflexly evoked response, the response to metacholine was not reduced by clomipramine. However, at the largest dose of clomipramine (5 mg/kg) there was a tendency to reduction of the metacholine evoked flow (20%, n.s.)

Conclusion: Clomipramine seems to hamper salivary secretion mainly at a central level. The anticholinergic effects of the drug in the salivary glands seem to be of smaller importance. This means that dry mouth caused by clomipramine possibly could be treated successfully with cholinergic agonists or with acetylcholine esterase inhibitors.



Oral effects of *Ascophyllum nodosum*

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Aim: To investigate the effect of administration of a food supplement containing the seaweed *Ascophyllum nodosum* (AN) on the increase of halitosis, plaque and gingivitis and to measure changes of blood composition and pH in saliva and urine.

Material and Methods: The study was conducted by Summit Ridge Farms (Susquehanna, Pennsylvania, USA). Thirty Beagle dogs having plaque and dental calculus were randomly allocated into two groups. All were fed a standard dry diet. Fifteen dogs received 330 mg/10 kg b.w of the AN-containing supplement (PlaqueOff) mixed with their food once a day. Fifteen dogs served as a control group. One person recorded halitosis, plaque and gingivitis at baseline and after 88 days. Plaque and gingival bleeding were measured by colorimetric methods and halitosis by a halimeter. The pH of saliva and urine were measured at baseline and after 56 days. Laboratory tests including complete blood count and serum biochemistry profile were performed at baseline and after 56 days (39 parameters). Non-parametric tests were used to determine statistical differences between the groups. P-values < 0.05 were considered to be significant.

Results: The increase of plaque mean score (2.1) was greater in control dogs (SD 2.58) compared to dogs fed the AN-supplemented diet; 0.65 (SD 2.80). The increase was significant in control dogs only ($Z = 3.13$ $P < 0.001$). The increase of oral malodor was significant in the control group ($Z = 2.57$ $P < 0.01$) but not in the PO group ($z = 0.42$ ns). The increase of gingivitis was significant in the control group ($z = 1.99$ $P < 0.05$) but not in the PO group ($z = 1.65$ ns). Saliva pH dropped in both control and PO groups ($P < 0.001$) indicating that diet caused it. The urinary pH increased significantly in the control group ($z = 8.16$ $P < 0.001$) but not in the PO group ($z = 1.76$ ns). Minor changes in the composition of serum that occurred in the PO group also occurred in the control group.

Conclusion: Daily consumption of *Ascophyllum nodosum* reduces the increase of plaque, gingivitis

and malodor significantly by systemic routes and does not adversely change the composition of blood or pH of saliva or urine. Thus *Ascophyllum nodosum* is safe to eat.



Effects of long time running on NPY brain levels in SHR rats

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Aim: In order elucidate the effect of exercise on neuropeptide Y (NPY-LI) release in the hypothalamus-pituitary axis (HPA-axis).

Material and Methods: Sixteen spontaneous hypertensive rats ran for eight weeks and were compared against eight control rats that didn't have access to a running wheel. Neuropeptide Y (NPY)-like immunoreactivity (-LI) changes were examined via radio-immune analysis and protein analysis.

Results: Neurotensin-LI decreased in the hippocampus and in the hypothalamus. However, increased NPY-LI was found in the medial eminence, adenohypophysis and neurohypophysis. In the hypothalamus a negative correlation was found between running and the decrease in NPY-LI.

Conclusion: We suggested that long-time running in SHR alters autonomic neuropeptides in the HPA-axis that may reflect that muscular exercise exert an effect on the neuroendocrine axis.



Enzymatic activity of acid tolerant bacteria in dentine caries

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Aim: To investigate the composition of the aciduric microflora from three different levels in dentine caries lesions, using solid pH-selective media. Glycosidase and protease activity were also studied to eluci- ▶

- ▷ date the capacity of the biofilm to release nutrients from substrates available in dentine caries.

Material and Methods: Primary dentine caries lesions in 4 patients were sampled (superficially, centre and bottom) using a rose-bur. Samples were inoculated on pH-selective agars, colonies characterized morphologically and isolated. The isolates were identified by metabolic tests and/or PCR.

The glycosidase activity of bacterial strains was assayed using fluorogenic substrates (α -glucoside, β -glucosaminide, neuraminide, α -fucoside, β -fucoside, β -galactoside, α -galactoside, β -galactosaminide and β -glucoside. Samples were mixed with each substrate, incubated and absorbance recorded. Proteolytic activity was assessed using FITC-labelled casein as substrate. Samples were mixed with substrate, incubated and fluorescence recorded.

Results: 2-16% (bottom) and 2-50% (centre) of the total flora was found acid tolerant at pH 5.0.

The table shows the species composition in the lesions. Dominant species are marked with an asterisk.

Lesion	Bottom	Centre
Lesion 1	<i>S. sobrinus*</i> , <i>S. mutans</i> , <i>S. constellatus</i>	<i>S. sobrinus*</i> , <i>S. mutans</i> , <i>L. salivarius</i>
Lesion 2	<i>S. anginosus*</i> , <i>S. mutans</i> , <i>A. oris</i>	<i>S. sobrinus*</i> , <i>L. paracasei</i> , <i>S. anginosus</i>
Lesion 3	<i>L. plantarum*</i> , <i>S. mutans</i> , <i>L. rhamnosus</i> , <i>L. gasseri</i> , <i>B. dentium</i> , <i>L. spp</i>	<i>S. mutans*</i> , <i>L. rhamnosus</i> , <i>L. gasseri</i> , <i>L. paracasei</i> , <i>B. dentium</i> , <i>L. spp</i>
Lesion 4	<i>P. acnes*</i> , <i>S. salivarius/</i> vestibularis	<i>S. anginosus*</i> , <i>P. acnes</i>

The most common glycosidic enzyme was β -glucosidase. Although the consortia composition in each lesion varied, all exhibited a “basic package” of glycosidic and proteolytic enzymes; β -glucosidase, β -galactosidase and protease. Three consortia also tested positive for GlcNAcase.

Conclusion: The recovered microbiota at pH 5.0 included many oral species previously not considered particularly acid tolerant. Each lesion harboured a unique microbiota in terms of species composition and numbers of individual bacteria.

In contrast, the enzymatic profiles of the lesions showed great similarity, supporting the concept that

while lesion bacterial composition may vary, the enzymatic output are roughly the same, and when considered as a group, the bacteria possess an “enzymatic toolkit”, enabling them to degrade glycoproteins and other macromolecules for nutrition. Sponsored by Swedish Dental Society and the Crafoord Foundation.

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Salivary IgA in minor gland saliva of children and adults

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Aim: To study the salivary IgA-concentration in minor gland saliva in defined mucosal areas, and in unstimulated whole saliva, in children in different ages and young adults.

Material and Methods: 90 individuals were recruited: 3-year-old children (n = 30), 14-year-old children (n = 30), and young adults (n = 30). Minor gland saliva was collected on labial and buccal mucosa with filter papers and the volume was determined using a Periotron 8000. The whole saliva was collected by draining into a tube. Assessment of the salivary IgA-concentration was carried out in a sandwich ELISA. One-way ANOVA was used testing the differences between the age-groups (at the 0.05 level of significance).

Results: The salivary IgA-concentration in labial gland saliva was significantly lower (p

Conclusion: The salivary IgA-concentration in labial and un-stimulated whole saliva seems to increase with age. This may reflect a developing specific immune response in saliva of young children.

13

HLA and caries prevalence in preschool children in Skane

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Aim: Caries is one of the most common diseases of childhood; its aetiology is multifactorial though all contribution factors are not fully understood. The aim was to study the role of genetic factors in terms of the Human leukocyte antigen (HLA) complex. Previous studies have reported HLA-DR4 to be associated with high levels of mutans streptococci (MS), bacteria very much associated with dental caries.

Material and Methods: The study group comprised 528 children with assumed increased caries risk HLA genotypes: HLA-DQB1*02/0302, -DQB1*0302/0604 and -DQB1*0302/X, genotypes chosen as almost certain to have HLA-DR4. The control group comprised 381 children with other HLA genotypes. Caries data concerning decayed, extracted and filled teeth (deft) and new decayed teeth (dt) were obtained from the population based "Oral health epidemiological data base" at Region Skane from 2005-2008 when the children were 3-6 years old. Independent samples t-test and Fisher's exact test were applied to analyze the data.

Results: The caries prevalence in both the study and the control group was low: 96.4 % of the three year old and 88 % of the five year old children were caries free. Differences in mean values of deft and dt between the study and the control group, using an independent samples t-test, showed no significances, neither did the percentage of deft and dt using Fisher's exact test.

Conclusion: No association between HLA-DR4 and caries was obtained in this child population with very low caries prevalence. However, this study was a first preliminary study in a project named MuPiS, Mutans Prediction in Skane. The 909 participating children will be followed until they are 15 years old with new caries data, vast life-style questionnaires as well as saliva sampling for analyze of e.g. MS and IgA. The study was funded by The Crafoord foundation, Sweden.

14

Sterilisation and preservation of sterility of dental surfaces before and during endodontic treatment. An explorative pilot study

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Aim: To estimate the proportion of endodontic fields/teeth that became decontaminated by three different protocols, by 1/ 0,5 % tincture of chlorhexidine gluconate, 2/ by 30% hydrogen peroxide in combination with 0,5 % tincture of chlorhexidine gluconate and 3/ by 30% hydrogen peroxide in combination with a 10% tincture of iodine and to estimate the proportion of working fields/teeth that remained disinfected at the end of the endodontic treatment.

Material and Methods: 36 patients referred to the endodontic clinic in Uppsala participated in the study. The patients were randomised in three groups, one for each disinfection protocol, with 12 patients in each group. After rubber dam application the middle third on the buccal surface was sampled for microbiological cultivation on three occasions, sample A before decontamination, sample B immediately after decontamination and sample C immediately before the rubber dam was removed.

Results: An estimation of the efficacy of the disinfection protocols revealed that 83% of the samples in the chlorhexidine groups were disinfected when compared to 92% in the iodine group.

Conclusion: The material was too limited to give a statistically safe conclusion.

15

Experimental root fillings made with single cone technique and lateral condensation technique. A comparison of the obturation quality

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Aim: The aim of the study was to compare the obturation quality of root fillings performed either with single cone technique or with lateral condensation technique using radiography and microscopy for the analysis.

Material and Methods: Twenty extracted teeth, ten of which were molars and ten premolars, were instrumented by means of engine rotary technique. Ten molars and premolars were root filled using single cone technique and ten molars and premolars were root filled using lateral condensation technique. The root filling material was gutta-percha with AH plus as the sealer. Radiographs were taken in two projections of the teeth and the obturation quality of the root filling was estimated apically and more cervically. The teeth were then cut in cross-sections 2, 5 and 8 mm from the apex and photographs were taken in microscope. The percentage of the root canal area filled with guttapercha as well as the empty areas were calculated.

Results: Radiographically the root filling material filled out the root canal space to a lower extent in the teeth root filled with single cone technique compared to in the teeth root filled with lateral condensation technique. In the analysis based on microscopy the two techniques showed equivalent obturation quality in the apical part of the canals but in the more cervical parts, the root fillings made using lateral condensation technique filled out the root canal space better than the root fillings made using single cone technique. The mean value for empty canal space was 6.4 % with single cone technique and 1.7 % with lateral condensation technique.

Conclusion: The results of this study indicate that the obturation quality of the root fillings was better when lateral condensation technique was used compare to when single cone technique was used, especially in molars.

16

Survival of furcation-involved molars after active periodontal treatment. A retrospective analysis thirteen years or more

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Aim: The aim of this study was to evaluate the long term outcome of furcation involved molars in a population treated for periodontitis.

Material and Methods: Initially, the study sample consisted of 147 patients referred to the Department of Periodontology, Public Dental Service, Linköping. Periodontal treatment consisted of oral hygiene instructions, supra- and subgingival scaling and in indicated areas periodontal surgery. After treatment 99 patients agreed to participate in a two year prospective study on root caries in patients treated for periodontal disease. The patients got two years of maintenance treatment every third to fourth month. At the end of the prospective study most patients were in good periodontal health and were referred back for supportive treatment at the referring dentist. 13 years after periodontal treatment all 81 surviving patients were called for a new examination. 64 patients participated. The total number of teeth and molars, number of molars in each position and degree of furcation involvements (Hamp et al. 1975) were recorded after periodontal treatment (baseline) and at the 13-year examination.

Results: At baseline the 64 patients had 1537 teeth. A total of 217 teeth (14%) were extracted during follow up which lasted for an average of 178 months (SD 8.9). The number of molars at baseline was 361 out of which 94 were furcation involved to some degree. The number of molars with regard to the initial furcation involvement degree 0-III, were 267, 67, 25 and 2 respectively. 69 molars were extracted during follow up. The proportion of extractions with regard to the initial furcation involvement degree 0-III, were 15%, 27%, 40% and 100% respectively. There was no significant greater risk of losing an initially not furcated molar than a single rooted tooth. Further, there was a significant greater risk of losing an initially furcation involved molar than a single rooted tooth ($p < 0.01$).

Conclusion: In this material molar teeth with furcation involvement are frequently lost. However, more than 2/3 are still in function 13 years after treatment which indicate that molars with furcation involvement in many instances might survive a long time after periodontal treatment.

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Variations between caregivers in the assessment of patients with the same degree of periodontal disease

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Aim: Several studies have shown that dentists diagnose, assess and treat the same state of disease differently, and therefore it is believed that recourses are used ineffectively. The aim was to investigate how clinicians diagnose and treat patients with different severity of periodontal disease.

Material and Methods: The participants consisted of all dentists and dental hygienists employed by the Halland County Council. Surveys were distributed to all dental public health clinics through each clinics' supervisor. All caregivers answered the questionnaire on a defined occasion, thereafter the answered questionnaires were sent back by mail anonymously and participants were not identifiable. The questionnaire consisted of four cases including one panoramic image and four bitewings with four similar answer sheets attached. The anamnesis was the same for the four patients but they had different periodontal status; ranging from healthy to chronic periodontitis. After collecting the surveys the answers were transferred to a computer-based program where analyses were conducted concerning, e.g. the judgement whether or not the patients had a treatment need i.e. were healthy or had a periodontal disease. Furthermore, if they considered the patient to have a periodontal disease, which findings they used when diagnosing the disease, per se.

Results: Preliminary results showed that dentists and dental hygienists had different opinions regarding the periodontal status of the patients. Within both groups there was a variation regarding diagnostics;

i.e. the same patient received different diagnoses from different caregivers. The caregivers used different and varying numbers of findings when diagnosing. In some cases the findings were irrelevant, e.g. plaque and calculus were considered to be findings associated with a disease although they could also be found in a healthy patient.

Conclusion: Different caregivers assess the same patient differently. This might lead to a patient being under- or overtreated in relation to their periodontal status and implies a less effective utilisation of health care resources concerning periodontal treatment and the need for implementation of a decision support.

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Pain and discomfort after periodontal surgery

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Aim: Our knowledge of postoperative experience after periodontal surgery is limited. The aim of this study was to determine the level of and factors influencing pain and discomfort after periodontal surgery.

Material and Methods:

172 periodontitis patients (aged 30 to 76 years, 75M/97F) who were during the course of therapy surgically treated were included. Patients with extreme dental anxiety and patients in need of comprehensive pre-medication or pre-operative care were excluded. Flap surgery was performed as required by the individual treatment plan. If necessary, extractions of hopeless teeth were performed during the surgery. Use of analgetica was recommended and left to patients' own discretion. The time of anesthesia, first incision and last sutures were noted. At suture removal, patients were asked to evaluate postoperative pain and discomfort on a visual analogue scale (VAS). Both momentary pain and discomfort and retrospective evaluations of the worst experience between surgery and suture removal were recorded.

Results: The time passing from anaesthetic injection to last suture was on average 50.0 ± 12.3 (SD) min and from first incision to last suture 36.5 ± 11.9 (SD) min. At suture removal, momentary pain and discomfort (VAS > 0) was reported by 58.7 % and 74.4 % ▷

▷ of the patients, respectively. In retrospect, both pain and discomfort between surgery and suture removal were reported by 87.8% of the patients. VAS values for momentary pain and discomfort ranged from 0 to 49 (median 2) and from 0 to 94 (median 5.5), respectively. Worst retrospective pain and discomfort ranged from 0 to 100 with a median of 22 and 17, respectively. VAS values for pain were significantly ($p < 0.05$).

Conclusion: This study indicates that pain and discomfort after periodontal surgery is related to a number of patient and treatment related factors. Of these factors, the length of the operation is the factor that can most easily be influenced by the dental team.



The short-term effect of different rinsing products aimed to reduce halitosis

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Aim: The aim of the study was to evaluate the effect of different mouth rinses in the treatment of intra oral halitosis

Material and Methods: Twenty-five adults with intra-oral halitosis were included in a double blind, cross over randomized clinical study. The study consisted of six different test periods. The length of each test period was 12 hours. The test periods were separated by a washout period of one week. The following treatments were evaluated: A) Water, B) SB12®, C) Halita®, D) SB12® mild, E) Listerine® Total Care, F) RetarDEX®. The participants received coded bottles and instructions of how to use the rinsing solution. The participants were instructed to rinse with the solutions in the evening 12 hours before registrations. Registrations of volatile sulphur compounds (VSC) were made with a gas chromatograph OralChroma™ and with organoleptic scoring.

Results: Hydrogen sulphide measured with the OralChroma™ showed a significant difference between placebo and treatments B, C, F ($p < 0.001$) and for treatment D and E ($p < 0.01$). Significantly higher values were found for methyl mercaptan following use of placebo (water) compared to treatment B, F ($p < 0.001$), C, D ($p < 0.01$) and for treatment E ($p < 0.05$). The values of dimethyl sulphide were significantly lower in the treatment group F ($p < 0.001$), C, D ($p < 0.01$) and for treatment B ($p < 0.05$). Treatments B and C were significantly better in reducing hydrogen sulphide than treatment E ($p < 0.01$, $p < 0.05$). For methyl mercaptan treatment B had significantly better values than C ($p < 0.05$). Treatment F had significantly lower values for dimethyl sulphide compared to B, C, D ($p < 0.01$) and E ($p < 0.05$). The results of the organoleptic scores were significant better in treatments B, C, F ($p < 0.001$), D ($p < 0.01$) and treatment E ($p < 0.05$) compared to placebo. For the organoleptic scores treatment B was significantly better than treatments E ($p < 0.05$).

Conclusion: The active treatments had an effect on bad breath 12 hours after rinsing.

Treatments B and C showed the most pronounced reductions in oral halitosis.



Implant surface characteristics influence the outcome of treatment of peri-implantitis. An experimental study in dogs

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Aim: The aim of the present study was to analyze the effect of surgical treatment of peri-implantitis without systemic antibiotics at commercially available implants in dogs.

Material and Methods: Mandibular premolars and the 3 anterior premolars in the maxilla were extracted in 6 labrador dogs. At 3 months 4 implants representing 4 different systems - turned (Biomet 3i), TiOblast (Astra Tech AB), SLA (Straumann AG) and TiUnite (Nobel Biocare AB) were placed in a randomized order in the mandible. Three months after implant installation experimental peri-implantitis was initiated using ligatures and plaque formation

until 40 to 50% of the supporting bone was lost. The ligatures were removed and daily cleaning with toothbrush initiated. 4 weeks later, surgical therapy was performed, without systemic or local antimicrobial therapy. Meticulous mechanical cleaning of the implant surfaces using cotton gauze soaked in saline and profuse saline irrigation was used before suturing the flaps around the neck portion of the implants. The 5-months follow-up period was clinically and radiographically monitored. Block biopsies were retrieved for histological analysis.

Results: Surgical therapy resulted in improved clinical conditions at implants with turned, TiOblast and SLA surfaces, while at implants with a TiUnite surface swelling and redness in the peri-implant mucosa persisted. In addition, 2 of the TiUnite implants were lost at 10 and 18 weeks after surgery, respectively. The radiographic analysis revealed that bone gain occurred at implants with turned (2.22 mm), TiOblast (1.59 mm) and SLA (0.89 mm) surfaces following treatment. At TiUnite implants, however, a mean bone loss of 1.58 mm was found after treatment. The results from the histological analysis disclosed that resolution of peri-implantitis was achieved in tissues surrounding implants with turned and TiOblast surfaces and, to a smaller degree, also SLA surfaces. No signs of resolution were seen in sections representing TiUnite implants.

Conclusion: It is suggested that (i) resolution of peri-implantitis following treatment without systemic or local antimicrobial therapy is possible and that (ii) the outcome of therapy is influenced by implant surface characteristics.

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A retrospective multi-center clinical and microbiological analysis of peri-implantitis cases in Sweden; a follow-up period up to thirteen years after treatment

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Aim: The aim of this study was to follow retrospectively peri-implant cases from representative public and private dental clinics all around Sweden in order to map out the course of peri-implant disease

and identify microbiological features as well as diagnostic and treatment patterns among clinicians.

Material and Methods: 281 patient cases were selected from the archives of the Oral Microbiology department, Gothenburg, Sweden based on bacterial samples taken from diseased implants. A form was designed and filled in separately for each case including data on patient profile, implant profile, disease profile and type of treatment. Each case was followed-up after treatment for a period of up to thirteen years.

Results: The majority of the cases were severe peri-implantitis cases (93.1%). There was a great heterogeneity in disease initiation, in the timing for diagnosis as well as in the treatment strategy. In 54.7% of the cases it was not feasible to establish peri-implant health. Microbiological samples, mostly those analysed with a molecular technique (checkerboard DNA-DNA hybridization) failed to fully correspond to the severity of the disease, implying technical difficulties in capturing the associated microbiota.

Conclusion: Peri-implantitis needs to be diagnosed early. Established, long-standing peri-implantitis lesion may represent a true infection, hard to eradicate. Microbiological sampling methods should be improved and uniformed so as to fully unveil the microbiological profile of the disease. Homogenous evidence-based treatment protocols rather than empirical treatment attempts should also be adopted.

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Preterm children - orthodontic aspects. A study cast analysis

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Aim: The aim of this study was, in preterm children born before the gestational week 29 at Östra Sjukhuset in Gothenburg 1988-91, in adolescence, study the frequency of malocclusions, the palatal height and dento-alveolar length and the width at the first permanent molar and compare the results with a matched control group, healthy, born at term.

Material and Methods: The material included 40 preterm children and 40 controls. 36 study cast from the ▶

▷ preterm children (22 boys, 14 girls) and 39 study cast from the controls (25 boys, 14 girls) was diagnosed for the malocclusion (according to Thilander, Myrberg 1973). For the dento-alveolar measurements the casts were divided into two groups, 13 years (mean age 13.3) and 16 years (mean age 15.5) and measurements were performed with a digital caliper.

Results: The preterm children had less frequently Angle class I occlusion ($p=0.04$), more frequently Angle class II:1 malocclusion ($p=0.03$) and overjet >4 mm ($p=0.04$). Preterm boys at 13 years of age, have lower palatal height ($p=0.02$) and dento-alveolar width at the first permanent molars ($p=0.02$). Girls at 16 years of age have shorter maxillary dento-alveolar length ($p=0.02$).

Conclusion: As a conclusion there are differences in the frequency of malocclusions and there are dento-alveolar differences in very preterm children in adolescence.

◎ ◎ ◎ 23

Early treatment of posterior crossbite - an RCT-study on cost-effectiveness

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Aim: The aim of this study was to determine and evaluate the costs of crossbite correction with Quad Helix and expansion plate and to relate the costs to the effects. It was hypothesized that the two treatment methods would achieve similar results according to a cost-effectiveness analysis.

Material and Methods: The study comprised forty subjects in the mixed dentition with former unilateral posterior crossbite. Twenty patients had been treated with Quad Helix and twenty with expansion plate. Treatment time, number of visits, defaults and cancellations were registered. Direct costs (costs for dental office, staff costs and material costs) and indirect costs (loss of income of patients' parent owing to assumed time of absence from work) were calculated and evaluated regarding successful treatments, all treatments and re-treatments when needed.

Results: The findings of this study were that the Quad

Helix was superior considering both direct costs and indirect costs and caused less failures needing re-treatment. Even when comparing the successful cases only, the costs in Quad Helix group were still significantly lower than in the expansion plate group.

Conclusion: The results of this study clearly confirmed that Quad Helix was the most cost-effective method to correct posterior crossbite in the mixed dentition, and thereby should be the primary treatment of choice.

◎ ◎ ◎ 24

Ever increasing adoptions of children with cleft lip and palate?

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Aim: Cleft lip and/or palate (CLP) treatment is a multidisciplinary field including plastic and maxillofacial surgery, orthodontics, speech therapy and several other disciplines. CLP-teams have recently noticed a radical increase in the amount of patients due to adoptions. The aim of this study was to find out the number of extra patients associated with adoptions during 2007-2009.

Material and Methods: All six Swedish CLP-centers were asked to report the number of adopted children arriving to their team during 2007-2009, together with diagnoses and earlier treatment. These numbers were crosschecked against numbers reported by the accredited organizations for international adoptions to verify that no children were lost in the survey.

Results: During 2007-2009 153 children with CLP arrived to Sweden through adoption, the majority (142) originating from China. There has been an annual increase of these children, 24 in 2007, 42 in 2008, and 98 in 2009, the latter representing 14% of the total number of adopted children 2009. Mean age at arrival in Sweden was around 2 years. Of 141 children with cleft lip, 76 had already undergone lip surgery before arriving in Sweden. Contrary, of 134 children with of palatal cleft 31 had their palate closure made before arriving in Sweden. The adopted

children had more extensive clefts (diagnosis code Q37.4 and Q37.5) compared to the ones born in Sweden, 78% and 35% respectively. Furthermore, of the adopted children, 64 % had a frontal Class-III relationship already at arrival, indicating an extensive future treatment need. Most of the adopted children with clefts arrived to the CLP-teams in Gothenburg and in Stockholm.

Conclusion: Since 2007 the number of adopted children with CLP has doubled annually reaching 98 children in 2009. The vast majority of them originate from China and usually these children are the ones with the most severe clefts and with an extensive future treatment need.

As the resources for cleft-lip-and-palate-treatment are dimensioned for an average of about 180 patients born each year the increase by almost 100 patients with extensive treatment need is a challenge. The Cleft Lip and Palate-teams need more resources to fulfill their task.

◎ ◎ ◎ 25

Permanent tooth-crown dimensions in prematurely born children

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Aim: To evaluate permanent tooth-crown dimensions in prematurely born children and to compare the findings with full-term born controls.

Material and Methods: Preterm children of 8 to 10 years of age were selected from the Swedish Medical Birth Register. One group consisted of 36 extremely preterm children (born before the 29th gestational week), the other group included 37 very preterm children (born during gestational weeks 29 to 32). The preterm children were compared with a control group of 41 full-term born children, who were matched for gender, age, nationality and living area. Clinical examinations, study casts and panoramic radiographs were performed for each child. Permanent maxillary and mandibular first molars, central incisors and laterals were measured with a digital sliding calliper on study casts. The tooth-crowns were measured both mesiodistally and buccolingually. The examiner conducting the measurement analysis was unaware of the group to which the subject belonged.

Results: The maxillary and mandibular first molars were smaller mesiodistally and buccolingually ($p < 0.01$) whereas central incisors and lower laterals were smaller mesiodistally ($p < 0.02$) in the extremely preterm group compared to the full-term group. A reduction in tooth size of 5-8 % was found between the extremely preterm group and the full-term group. Furthermore, the maxillary first molars and mandibular left first molar were also smaller mesiodistally ($p < 0.035$) in the extremely preterm group compared to the very preterm group.

Conclusion: Premature birth is associated with reduced tooth-crown dimensions of permanent teeth and the more preterm birth the smaller tooth-crown dimensions.

◎ ◎ ◎ 26

Nocturnal enuresis and rapid maxillary expansion

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Background: Nocturnal enuresis (NE) is not uncommon in children. Some children wet their beds every night and have never been dry. Rapid Maxillary Expansion (RME) has the effect of widening the maxillary suture as well as the nasal width. There have been a few reports of RME having anti-enuretic effects.

Aims: To prospectively evaluate RME treatment in a group of severely therapy-resistant enuretic children who have long-standing resistance to medical therapy, while looking at prognostic factors and effects on sleep, respiration and blood oxygen saturation.

Material and Methods: Fourteen children (12 boys) with NE, aged 9-15 years old (mean age = 11), who wet their bed almost every night and had never been dry were referred from pediatric specialists and have completed the study so far. Sleep registrations (standard polysomnography including pulse oxymetry and respiratory work), Rhinomanometric measurements and bladder diaries were completed before and after RME, with an extra bladder diary completed with the orthodontic appliance in situ but before expansion of the maxilla to evaluate the possible placebo effect of RME for a period of four weeks. ▶

- ▷ After this period the maxilla was expanded for 10-14 days. Mean RME was 6.0 mm (range = 5-7).

Results: All but 6 of patients have become dry or almost dry. The number of wet nights per week pre-study, with appliance in situ and after maxillary expansion was 5.14 ± 1.61 , 4.57 ± 1.95 , and 2.43 ± 2.62 , respectively. The anti-enuretic effect was highly statistically significant [Within-subjects ANOVA $F(2, 26) = 28.67$; $p < 0.001$]. No prognostically significant factors were found among anamnestic or demographic data or bladder parameters, but some non-responders noted that the amounts of urine lost in bed during wet nights decreased during treatment. Polysomnographic and Rhinomanometric measurements will be analysed as more data is collected.

Conclusion: Orthodontic RME is a new option for treating children with NE and promises to be a potentially curative treatment of therapy-resistant nocturnal enuresis in some patients. Continuing research will give clues as to prognostic factors and the reason for the proposed anti-enuretic effect.

◎ ◎ ◎ 27

Caries prevalence, caries related factors and plaque-pH in adolescents with long-term asthma

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Aim: The aim of the present cross-sectional investigation was to study dental caries, various caries-related factors as well as gingival condition in 12-16-year-olds with long-term asthma ($n = 20$) and a matched healthy control group ($n = 20$).

Material and Methods: Data on dietary and oral hygiene habits, numbers of mutans streptococci and lactobacilli in saliva were also obtained. Lower salivary flow rate was found in the asthma group compared to the control group ($p < 0.05$). The Plaque-pH drop after a sucrose rinse was measured up to 40 min at two approximal tooth sites.

Results: The mean (\pm SD) of DFS, including manifest and initial caries, was 4.9 ± 5.5 in the asthma group and 1.4 ± 2.3 ($p < 0.01$) in the control group. Only one adolescent in the asthma group was ca-

ries free compared to 13 in the control group. Concerning pH in plaque, adolescents with asthma had lower initial value ($p < 0.01$) and more pronounced pH drop compared to the control group ($p < 0.05$). The Cariogram data showed that 55% of the subjects in the control group had a high chance avoiding caries compared to 10% in the asthma group ($p < 0.01$). The asthmatic adolescents had higher numbers of sites with gingival bleeding ($p < 0.01$), higher consumption of sugar-containing drinks (NS) and were more frequently mouthbreathers than the healthy controls (NS).

Conclusion: To conclude, adolescents with long-term asthma had higher total DFS and caries risk, decreased salivary rate, more gingival bleeding and lower plaque-pH than adolescents without asthma.

◎ ◎ ◎ 28

Caries prevalence at 20 years of age in relation to their caries experience at 3, 6, and 15 years of age

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Aim: To analyze the caries prevalence at 20 years of age in relation to their caries experience at 3, 6, and 15 years of age.

Material and Methods: 671 individuals have been longitudinally followed from 1 year to 20 years of age concerning oral health and lifestyle factors, including consumption pattern and oral hygiene measures. The children were examined at 1, 3, 6, and 15 years of age. At 20 years of age 500 of the individuals were exposed to a clinical and radiographic examination. 420 individuals completed all the examination at 3, 6, 15, and 20 years of age.

Results: In the caries-free group at 6 years of age, 127 of 420 (62%) were proximal caries-free at 20 years of age. In the group with manifest caries at 6 years of age, 62 (38%) were proximal caries-free at 20 years of age ($p < 0.001$). Out of the children with manifest caries at 6 years of age, 78 (48%) had proximal manifest caries at 20 years of age. In those who were caries-free at 6 years of age, 55 (27%) had proximal manifest caries at 20 years of age ($p < 0.001$). The

mean number of DFSa at 20 years of age was 1.99. For individuals with caries at 3 and 15 years of age the DFSa at 20 years of age was 7.32. For individuals with caries at 6 and 15 years of age the DFSa at 20 years of age was 4.54. For individuals with caries at 3 and 6 years of age but caries-free at 15 years of age the DFSa at 20 years of age was 1.27. For individuals who were caries-free at 3, 6 and 15 years of age the DFSa at 20 years of age was 0.92. The differences between the groups were statistically significant.

Conclusion: Individuals with caries during childhood and/or adolescence present more caries as young adults compared with individuals caries-free at any of the examinations during childhood and adolescence.

29

Caries and periodontal disease in adolescents with obesity

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Aim: This project was designed to test the hypothesis whether obesity in adolescents is associated with periodontal disease and/or dental caries.

Materials and methods: Obese (n=65) and normal weight adolescents (n=65) with a mean age of 14.5 years were clinically examined with respect to dental caries, visible plaque accumulation (VPI %), gingival inflammation in terms of bleeding on probing (BOP %), subgingival calculus, periodontal pockets and incipient alveolar bone loss. In addition the flow rate of stimulated whole saliva (ml/min) was determined. All subjects answered a questionnaire concerning medical conditions, medication, oral hygiene habits, smoking habits and sociodemographic background. Body Mass Index (BMI) was calculated and adjusted for age and gender (BMI-sds). Samples of gingival crevicular fluid (GCF) were collected and analyzed regarding the level of adiponectin, plasminogen activator inhibitor-1 (PAI-1), interleukin-1 β

(IL- β), interleukin-8 (IL-8) and tumor necrosis factor α (TNF- α).

Results: Obese subjects exhibited higher number of decayed surfaces (DS) (P=0.008) and exhibited more pathologic periodontal pockets (>4 mm) (P<0.001) but not incipient alveolar bone loss compared with the normal weight subjects. Obese subjects also showed higher VPI% (P<0.01), BOP>25% (P<0.001) and lower flow rate of stimulated whole saliva 1.2 ml/min versus 2.0 ml/min (P<0.001) compared to normal weight subjects. Higher levels of IL-1 β (P<0.001) and IL-8 (P=0.002) were measured in GCF from obese subjects compared with the controls. In a multivariate logistic regression analysis, adjusted BMI-sds (P=0.03; Odds Ratio (OR) 1.87) was significantly associated with the occurrence of pathologic periodontal pockets. Obesity in terms of BMI-sds as a continuous variable was significantly associated with decayed surface (DS>0) with OR=1.31 (unadjusted) and the association was not found to be confounded by any of the studied variables.

Conclusion: The results indicate that obesity in adolescents is associated with a negative effect on oral health in terms of dental caries and periodontal disease. The results highlight the importance of a close collaboration between dentists and pediatricians in prevention and treatment of obesity.

30

Distribution of elemental composition in enamel in aspects of general growth

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Aim: There is an individual likeliness to be affected by caries, calculus and erosion. How much of this individuality is depending on properties of the enamel? A first attempt to answer this question is made in this study by investigate how the differences in the chemical content in enamel ranges and whether differences are possible to relate to nutrition pattern, selected factors and to divergences in general growth, during the first year of life.

Material and Methods: The subjects comprised of

▷ patients referred to the Department of Pediatric Dentistry, Gothenburg, for extraction of a second primary molar. The inclusion criteria were: the child must be born and raised its first year in Sweden and to be healthy. The parents answered a questionnaire with selected questions of factors influencing the individual's first year. Eighteen children became eligible for the study and eighteen primary second molars with intact buccal surface, were collected. The dft and/or the DMFT were registered. Files from Child Health Centres were collected. Data of growth were analyzed as standard deviations of body mass index (BMISDS). The teeth were cut in bucco-lingual sections. All sections were examined in an Olympus polarizing light microscope (POLMI). One section of each tooth was analyzed in scanning electron microscope (SEM) and x-ray micro analysis (XRMA). The elements analyzed were carbon, oxygen, phosphorous and calcium.

Results: There is an individual composition of chemical content in enamel. An individual with experience of general anaesthesia during first year of life differ in mineral concentrations in enamel from the rest of the group. Individuals experienced general anaesthesia or respiratory problems during their first week of life showed mineralization defects in POLMI. Defects appeared as areas of lower grade of mineralization in the bulk of the postnatal enamel. The individuals being breastfed and not breastfed, differed in the enamel's mineral composition. The enamel had lower concentration of calcium and higher concentration of oxygen, when the individual was not breastfed. The individuals with increasing and decreasing BMISDS tend to have higher scores of dft and/or DMFT than individuals with a stable BMISDS during their first living year.

Conclusion: There is an individual chemical composition of enamel.

The composition and the mineralization in enamel might be influenced by factors in life.

This project indicates the need of a study based on larger patient material, in order to analyze how the general growth during the first year of life is reflected in enamel and how this affects the clinical outcome.

31

In-vitro testing 3-unit Y-TZP FDP's: The influence on support properties and complexity of tooth supporting analogues on fracture strength and fracture mode.

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Aim: The aim of the present study was to investigate how the choice of supporting tooth analogues i.e 3 different materials, and support complexity, i.e simple or complex design, influence the test results concerning fracture strength of FDPs made from Y-TZP.

Material and Methods: 24 Y-TZP FDP cores were CAD/CAM-produced. The FDP cores were then subjected to heat treatment to simulate veneering and then thermocycled for 5,000 cycles to simulate ageing. Further the FDPs were divided into 3 groups and were cemented on tooth-supporting analogues made from aluminium, polymer and DuraLay®. The tooth analogues made from aluminium and polymer were simple and machine milled design whilst the DuraLay® tooth analogues were of complex, hand-made design. The FDPs were preloaded for 10,000 cycles and finally loaded to fracture.

Results: The FDPs cemented on the stiff aluminium tooth analogues showed a significantly higher load-at-fracture value (1817 N). On the other hand there were no significant differences in load-at-fracture values between the groups cemented on the polymer (734 N) and DuraLay® (718 N) tooth analogues. All the FDPs fractured in the connector area but the fracture modes differed significantly between the group cemented on aluminium tooth analogues and the two other groups. None of the abutments failed during testing.

Conclusion: Resilient supporting tooth analogues made from polymer, with a non-complex design, and DuraLay® with complex design, give comparable test results when the test set-up is unchanged in all other aspects. Non-resilient (with an e-modulus of aluminium or higher) tooth analogues made from aluminium give high and unrealistic load-at-

fracture values together with adverse fracture modes compared to FDPs failing in clinical situation.

To achieve mutually comparable results there is a need for a standardised, simple test set-up for in-vitro testing of all-ceramic FDPs intended for cementation upon natural teeth.

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Impaction-modified Y-TZP: Bond- and flexural strength

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Aim: Combining adhesive cementation technique and the beneficial physical properties of Y-TZP is of clinical relevance. Because of the physical properties of Y-TZP, chemical bond is difficult to gain. Several surface modification techniques have been developed in order to create bondable cementation-surfaces of zirconia-reconstructions, among them a novel method based on an impaction medium used in combination with an additive production technique. The aim of the study was to evaluate the shear bond strength between Y-TZP with an impaction modified surface and two commercial bonding systems, Variolink®II and PanaviaTMF 2.0 and to evaluate the flexural strength of surface modified Y-TZP.

Material and Methods: Shear bond strength test: Thirty-two pairs of specimens were fabricated, all consisting of one disc of Y-TZP bonded to a block of feldspathic porcelain. Sixteen of the pairs had discs without surface modification, used as control and the remaining sixteen had the cementation-surface modified with an impaction medium. Subsequent to bonding, all specimens were subjected to thermo-cycling followed by shear bond strength test. Finally, the surfaces and failure modes were examined. Flexural strength test: Sixty discs were fabricated with a modified uniaxial press technique. Thirty of those were controls without any surface modification and subdivided into two groups of fifteen: one coated with cement on the cementation-surface and one without. The remaining thirty discs had the cementation-surface modified with an impaction medium and were also subdivided into two groups of fifteen: one coated with cement on the cementation-surface

and one without. All specimens were subjected to thermo-cycling, followed by flexural strength test. Surface analysis: Six specimens, three discs with surface modification and three discs without were analysed with a light microscope and an optical interferometer.

Results: The groups with modified surface showed significantly higher bond strength compared to the control group. The failure modes for the surface modified groups were primarily cohesive. The flexural strength test showed that the control groups achieved somewhat higher values compared to the surface modified group prior to cementation, but that this difference disappeared after cementation. Regarding surface structure the surface modified discs showed a significantly rougher surface compared to the control.

Conclusion: Within the limitation of this in-vitro study, impaction modification of Y-TZP surfaces can be

used to increase the bond strength of oxide based reconstructions. The surface modification does not affect the flexural strength of Y-TZP after cementation.

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Immediate loading of implants in fixed partial dentures on implant- or abutment-level.

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Aim: The aim of this 5-year prospective study is to evaluate implant stability and marginal bone alterations after immediate or delayed loading. We also examine soft and hard tissue conditions around implants with moderately rough (TiUnite™) abutments, smooth abutments or no abutments.

Material and Methods: 50 partially edentulous patients received three implants each. At two implants abutments were placed: one with a roughened surface (TiUnite™) and one abutment with a machine-

▶milled surface. At one implant the fixed partial denture was attached at implant level. After randomization, the implants were either immediately loaded with a fixed bridge or left unloaded for 3 months (control). Most patients received the treatment in the posterior maxilla.

Results: All patients were eligible for examination after one year. Four implants were lost in 3 patients in the test group while 2 implants were lost in 2 patients in the control group. In 3 test patients, one implant showed lowered stability after 2-4 weeks and was therefore unloaded. Thereafter, the implant stability improved allowing loading within 3-4 months. All other implants remained stable throughout the first year. A mean (S.E.) loss of marginal bone from surgery to 1 year was 1.8 (0.1) mm in the test group and 1.5 (0.1) mm in the control group (NS). In the control group, significantly more bone loss was found when the FPD was connected at implant level 1.9(0.2) mm compared to abutment level 1.3(0.3) mm at machined and 1.3(0.2) mm at moderately rough abutments. The mean buccal soft tissue changes from surgery to 1 year were 1.1(0.1) mm in the test and 1.8(0.2) mm in the control groups ($p=0.02$)

Conclusion: This study showed acceptable survival rates for immediate and delayed loading of implants in partially edentulous patients after one year. Regarding marginal bone loss, the use of abutments seems to be more favourable than if no abutments are used. Further analyses on soft and hard tissue changes will be presented.

◎ ◎ ◎ 34

A prospective comparison between Astra Tech and Brånemark implant systems, results after 13 years

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Aim: To evaluate long term prosthetic conditions, bone level change and soft tissue conditions in patients taking part in a former prospective comparative study between Astra Tech and Brånemark implant systems.

Material and Methods: Patients taking part in an earlier prospective comparative study (Åstrand et al 1999, 2002, 2004) between Astra Tech and Brånemark implants were recalled for examination 12-15 years ($\bar{x} = 13$ years) after delivery of cross arch implant supported bridges. 48 of originally 66 patients were available for examination. Two patients had been provided with removable dentures due to implant losses. Thus 46 patients; 25 patients with Astra Tech implants and 21 patients with Brånemark implants were still wearing implant supported bridges and constitute the examination groups further analysed. Intra Oral X-rays with paralleling technique were taken of all implants for bone level measurements. Clinical prosthetic conditions and plaque scores were recorded. After removal of the bridges probing pocket depths at buccal, lingual and proximal sites of each implant, bleeding and pus after probing were recorded.

Statistical analysis of difference in bone level change from year 1 to the examination in this study and differences in soft tissue conditions between the two implant systems were performed.

Results: No significant difference in bone level change was found between Astra Tech and Brånemark implant systems during the studied period. Patients in the Astra Tech group lost 10 implants and patients in the Brånemark group lost 8 implants in the time span from implant placement to the final examination after 12-15 years. One patient in the Astra Tech group lost 6 implants and one patient in the Brånemark group lost 5 implants. No significant differences between the two implant systems with respect to plaque, bleeding/pus on probing or failing attached mucosa were found. Totally 15% of the of the patients and 4% of the implants showed > 0.2 mm bone loss/year between the first year registration and the final examination together with bleeding and/or pus after probing. No significant differences were found between the implant systems. Three patients showed prosthetic complications in the need of repair and 5 bridges had minor ceramic chippings.

Conclusion: No significant differences in performance were found between Astra Tech and Brånemark implant systems in the studied period of 12-15 years.

◎ ◎ ◎ 35

Assessment of proprioceptive allodynia after tooth clenching

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Aim: This study evaluates the effects of experimental tooth clenching on vibrotactile and pressure sensitivity in healthy females.

Material and Methods: 16 healthy females (mean age 32 ± 10) participated in this study, which comprised three sessions. In each session participants were randomly assigned to a tooth clenching exercise, with a clenching level of 10%, 20%, or 40% of maximal voluntary clenching (MVC). The first day of each session, patients did six bouts of tooth clenching exercises, each bout lasting 5 minutes during 1 hour. Registrations were made at baseline, after each bout of tooth clenching (short perspective), and after 24 and 48 hours. A Vibrameter® was used to measure the vibration threshold (VT). A fixed vibratory stimulus (100 Hz, 399.99- μ m amplitude) was applied for 15 s and the perceived intensity of vibration (PIV) and perceived discomfort (PD) were rated on 0-50-100 scales (0 = no sensation; 50 = pain threshold/discomfort; 100 = worst imaginable pain/worst imaginable discomfort). An electronic algometer was used to measure pressure pain thresholds (PPT). A 0-10 visual analogue scale (VAS) measured pain intensity (VP) and fatigue (VF). All registrations were made on the central and most prominent part of the right masseter muscle.

Results: No main effects of contraction level was observed for VT ($P = 0.184$) or PIV ($P = 0.628$), but there were significant time effects ($P < 0.05$) and significant increase in PIV at 40 min compared to baseline (Dunnett: $P < 0.05$). There were no main effects of contraction level ($P = 0.524$) or time ($P = 0.705$) for PD. For PPT there was no effect of contraction ($P = 0.819$) but a significant time effect ($P < 0.001$). VP and VF were significantly increased at 40% MVC, and at 10-60 min and at 24h follow-up.

Conclusion: This study demonstrated that tooth clenching alters VT only in the short term perspec-

tive. Tooth clenching at different levels is associated with moderate levels of pain and fatigue and changes in PPT. The effect on PIV and PD was small, thus suggesting that tooth clenching is not directly related to DOMS.

◎ ◎ ◎ 36

Reported disability related to temporomandibular disorders, headaches and cervical pain among women with Sami origin.

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Aim: The primary aim of the study was to analyze how women rated impairment of daily life activities related to symptoms of TMD, headaches and cervical pain, respectively. A second aim was to analyze which factors that had influenced the ratings of impairment related to TMD.

Material and Methods: The study included 751 women, 21 to 70 year old, living in the communities of Kiruna or Gällivare, in the county of Norrbotten, Sweden. The women were all registered in either the Swedish Sami Parliaments electoral register or registered as reindeer owners or reindeer herders in the Swedish Board of Agriculture. A questionnaire focusing on frequency, duration, intensity of symptoms as well as impact on activities of daily life related to the symptoms was used. The symptoms interference on daily life activities were measured respectively, with numerical rating scales (NRS).

Results: Seventeen percent of the women reported that their symptoms in the jawa-face region to some degree disturbed their daily life and for six percent the interference was scored five or more on the NRS. Frequency, intensity and duration of jaw pain, impaired jaw opening and neck pain together with a low education level affected the statement of whether symptoms of TMD influenced daily life or not. Almost half of the study-population reported that headaches had a negative impact on their daily life activities and for 23 % this interference was scored five or more on the NRS. A similar pattern was reported for cervical pain.

Conclusion: Symptoms of TMD had lower impact on daily life activities compared to headaches and cervical pain. Frequent, intense pain in the jaws, with long duration, influenced the ratings of impairment on daily life related to TMD at most.

37

7-year follow-up of patients with persistent idiopathic dentoalveolar pain – preliminary results

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Aim: Atypical odontalgia (AO), also described as persistent idiopathic facial pain (intraoral dentoalveolar subset) is a chronic orofacial pain condition commonly suggested to involve neuropathic pain mechanisms. The long-term prognosis of neuropathic pain is generally not favorable, but has been insufficiently studied in intraoral pain patients. The aim of this prospective study was to examine the long-term prognosis of AO.

Material and Methods: We have earlier described the characteristics of 46 consecutive patients diagnosed with AO (List et al. 2007). Follow-up data on 32 of these patients (69%) have so far been collected and are included in this report.

In 2002 and 2009, the patients completed validated questionnaires and instruments including pain and disability characteristics (pain frequency, characteristic pain intensity (CPI), average pain intensity (0-10 numerical rating scale, NRS) and graded chronic pain severity (GCPS); psychological status (SCL-90R according to the RDC/TMD: depression and non-specific physical symptoms scores); ongoing treatment and a global improvement rating. Baseline and follow-up data were compared using paired samples t-test at 5% significance level.

Results: 26 women and 6 men were included (mean age 62, range 38-80 years). Pain intensity: 25% of the

patients reported >30% pain reduction, 47% reported 1-30% pain reduction, unchanged pain was reported by 22%, and increased pain by 3%.

Pain frequency: 61% reported continuous pain at baseline and 28% at follow-up ($p = .01$). Occasional pain was reported by 0% at baseline compared to 19% at follow-up ($p = .012$).

GCPS: Fewer patients scored Grade III-IV at follow-up (9%) than at baseline (28%; $p = 0.032$).

SCL-90 scores reported by the AO patients for depression at follow-up was: 47% severe, 19% moderate and 34% normal, and for non-specific physical symptoms 63% severe, 12% moderate and 25% normal with no significant differences between baseline and follow-up.

Global improvement was rated by 56% as improved, 38% as unchanged and 6% as worse.

Ongoing treatment was use of occlusal splints (41%); analgesics (28%); tranquillizers or sedatives (22%); antidepressants (16%); physiotherapy, relaxation or neurontin (all 9%) and acupuncture, chiropractic treatment or pregabalin (all 6%).

Conclusion: The preliminary data suggest that a majority of AO patients improve over time and experience pain reduction of some degree. Psychological status does not change accordingly, and a number of patients report unchanged or even increased pain. The objective of future analysis of this material will be to identify positive and negative predictors for persistent pain.

38

Prevalence of symptoms indicative of temporomandibular disorders in adults - cross-sectional epidemiological investigations covering two decades

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Aim: Information regarding secular trends on temporomandibular disorders (TMD) are very scarce and it has been the main objective of the study to elucidate this issue.

Material and Methods: The investigation has a repeated cross-sectional design. Three independent and randomly selected samples of around 100 indi-

▷ Individuals in the age groups of 20, 30, 40, 50, 60 and 70 years, a total of 1704 subjects, participated in the Jönköping studies 1983, 1993 and 2003. The participation rate was 77% in 1983, 75% in 1993 and 68% in 2003. All subjects were examined by means of a questionnaire and a structured interview regarding the presence of TMD-related symptoms. The prevalence of symptoms and the Anamnestic Dysfunction Index (Ai) was estimated for the whole population and each age group in each examination occasion. Binary logistic regression analyses were performed in order to evaluate any associations between TMD-related symptoms and the Ai as dependent variables and each of the independent variables: age group, gender, reported bruxism, trauma (1983), self-perceived health impairment and the year of investigation.

Results: The prevalence of the separate symptoms varied between the different examinations with most of the changes, except for the TMJ clicking, not being statistical significant. However, an increase of the Ai I and Ai II for the whole population was observed in 2003 compared to 1983. The prevalence of recurrent headache in 20-year-old subjects, especially in women, raised strikingly in 2003. Jaw tiredness was associated to female gender. Reported bruxism, which increased during the study period, and self-perceived health impairment were associated to most of the symptoms and the Ai.

Conclusion: An increase of the prevalence of TMD-related symptoms expressed as Anamnestic Dysfunction Index I and II has been noticed over a twenty-year period.

◎ ◎ ◎ 39

Comparison of TMD pain between Adolescents in India and Sweden

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Aim: To evaluate the prevalence of TMD pain and headache among adolescents in India. To compare school absence, analgesic consumption, jaw function and perceived treatment need among adolescents with TMD pain, with a group of adolescents with TMD pain in Sweden.

Material and Methods: Three cohorts were investigated, one in India and two in Sweden. In India a total of 951 adolescents aged 12 to 17 years participated. The subjects were students in private schools. The investigation consisted of a questionnaire including questions on prevalence, pain intensity, consequences of pain, and health seeking behaviors for TMD pain and headache. In Östergötland County, Sweden, TMD pain was recorded for all consecutive Public Dental Service (PDS) patients aged 12-19 years, a total of 28,899. In a population-based sample, 587 consecutive patients aged 12-19 years answered a postal questionnaire. The questions were about TMD pain and were the same as the questions used in the Indian sample.

Results: The main findings were that the prevalence of TMD pain among adolescents in India was 15.6% and slightly higher among girls than boys. More than half of the subjects suffered from headache. Comparing the consequences of TMD pain in India and Sweden, the results revealed significantly higher rates of analgesic consumption ($p=0.017$) and pain intensity ($p=0.006$) in Sweden. Functional limitations were significantly more severe in India than in Sweden ($p=0,000$).

Conclusion: The prevalence of TMD pain was higher in India than in Sweden. In both countries TMD pain was reported to affect the individual's activities in daily life.

◎ ◎ ◎ 40

Adolescents with TMD pain - the Living with TMD pain phenomenon

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Aim: The aim of this study was to acquire a deeper understanding of adolescents' experiences of living with temporomandibular disorder (TMD) pain.

Method: Twenty-one adolescents with TMD pain, aged 15 to 19, were strategically selected from a group of patients referred to an orofacial pain clinic. The patients were examined and received diagnoses per the Research Diagnostic Criteria for Temporomandibular Disorders. One-on-one interviews that

followed a semi-structured protocol focused on the patient's experiences of living with TMD pain. The interviews were recorded and transcribed verbatim, followed by content analysis to get a deeper understanding of adolescents' experiences living with TMD pain.

Results: Content analysis led to the overall theme "Adolescents with TMD live in recurrent pain; physical problems and daily demands form a vicious circle that causes adolescents to oscillate between hope and despondency". The manifest content forming the theme consisted of three categories that evolved from 13 subcategories. For instance, three subcategories -feels tired, irritated, and down; cannot eat, chew, open the mouth wide, yawn, or kiss; has to knuckle down to cope with all the demands and stress in school -evolved into the physical problems and daily demands form a vicious circle category.

Conclusion: TMD pain is a substantial problem for affected adolescents and has consequences for all aspects of their life. In this study, the adolescents were able to talk openly and introduce issues outside of the interview protocol. Qualitative analysis deepens our understanding of the adolescent patient with pain.



Tooth wear among the adult population in Skåne, Sweden

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Aim: To determine the prevalence of tooth wear and possible contributing factors in adults.

Material and Methods: A self-reported questionnaire was sent to a randomly selected sample of 1000 individuals living in the county of Skåne in the southern part of Sweden. The subjects were 20-89 years old and registered as living in the region during 2006. The sample was obtained from SPAR (The Government's Person Address Register) together with background variables such as gender, domicile, address and age in five-year-intervals. All subjects were offered a clinical examination. Out of the 1000 sub-

jects, 630 answered the questionnaire and 451 were clinically examined. History, clinical examination, photographs, x-rays and saliva samples were performed by calibrated dentists. Tooth wear was recorded at a scale 0-4 (0 is no wear and 4 is wear to half of the tooth length).

Results: The results in this study are from the 451 subjects having a complete examination. Six percent of these considered themselves in need of treatment due to tooth wear. The most common degree of wear was 2, registered in 57% of the subjects. Of those with grade 3 and 4 (severe), 14% wanted treatment compared to 4% of those with less or no wear. Severe tooth wear was twice as common in men compared to women. Among subjects with severe tooth wear, 10% had reported TMD-pain (pain in the face, jaw, temple, in or in front of ear once a week or more often) compared to 7% in the group with less or no wear. Pain at chewing or opening of the mouth was reported by 8% of the subjects with severe tooth wear compared to 6% among those with less or no wear. More than one fifth of the subjects reported drinking some acidic drinks at least once a day. Frequent drinking of acidic drinks, acid fruits and snuff did not result in a higher prevalence of tooth wear in this survey.

Conclusion: Six percent reported need for treatment due to tooth wear. Those with severe tooth wear did not have more TMD-pain compared to those with less or no tooth wear. None of the tested contributing factors could explain the tooth-wear in this survey. Further analysis is needed to test coexisting risk factors for tooth wear.

Swedish Dental Journal

Contents of Volume 34, 2010

Author, Title	Page	Issue	Author, Title	Page	Issue
Al-Harthy, Al-Bishri, Ekberg, Nilner Temporomandibular disorder pain in adult Saudi Arabians referred for specialised dental treatment	149	3	organisation. An example from Swedish Public Dental Health Services	167	3
Chetpakdeechit, Stavropoulos, Hagberg Dental appearance, with focus on the anterior maxillary dentition, in young adults with bilateral cleft lip and palate (CLP)	27	1	Robertsson, Mohlin, Thilander Aesthetic evaluation in subjects treated due to congenitally missing laterals	177	4
Carcuac, Jansson Peri-implantitis in a specialist clinic of periodontology	53	2	Sinkiewicz, Cronholm, Ljunggren, Dahlén, Bratthall Influence of dietary supplementation with <i>Lactobacillus reuteri</i> on the oral flora of healthy subjects	197	4
Christidis, Smedberg, Hägglund, Hedenberg-Magnusson Patients' experience of care and treatment outcome at the Department of Clinical Oral Physiology Dental Public Service in Stockholm	43	1	Slavnic, Marcusson Duration of orthodontic treatment in conjunction with orthognathic surgery	159	3
Dimberg, Bondemark, Söderfeldt, Lennartsson Prevalence of malocclusion traits and sucking habits among 3-year old children	35	1	Sonbul, Birkhed The preventive effect of a modified fluoride toothpaste technique on approximal caries in adults with high caries prevalence: a 2-year clinical trial	9	1
Ekbäck, Näslund, Montgomery, Ordell Self-perceived oral health and obesity among 65 years old in two Swedish counties	207	4	Sondell, Söderfeldt, Hugoson Dental care utilization in a Swedish county in 1993 and 2003	217	4
Hasselkvist, Johansson, Johansson Dental erosion and soft drink consumption in Swedish children and adolescents and the development of a simplified erosion partial recording system	187	4	Ståhlacke, Unell, Söderfeldt, Ekbäck, Ordell Self-perceived oral health among 65 and 75 years old in two Swedish counties	107	2
Hellén-Halme, Hänsel Petersson Influence of education level and experience on detection of approximal caries in digital dental radiographs	63	2	Taube, Steiniger, Nietzsche, Norén Scanning electron microscopic and X-ray micro analysis on tooth enamel exposed to alkaline agents	129	3
Jalali, Lindh A randomized prospective clinical evaluation of two desensitizing agents on cervical dentine sensitivity. A pilot study	2	79	Wide Boman, Lundgren, Berggren, Carlsson Psychosocial and dental factors in the maintenance of severe dental fear	121	3
Johansson, Johansson, Unell, Norring, Carlsson Eating disorders and signs and symptom of temporomandibular disorders	3	139	Wennhall, Norlund, Matsson, Twetman Cost-analysis of an oral health outreach program for pre-school children in a low socioeconomic multicultural area in Sweden	1	1
Josefsson, Bjerklin, Lindsten Self-perceived orthodontic treatment need and prevalence of malocclusion in 18- and 19-year-olds in Sweden with different geographic origin	2	95	Wikén Albertsson, van Dijken Awareness of toothbrushing and dentifrice habits in regularly dental care receiving adults	71	2
Lindquist, Gisselsson, Wennerholm Effect of chlorhexidine gel on approximal caries increment in adolescents with high caries risk using professional flossing compared to individual trays	17	1	Östberg, Ericsson, Wennström, Abrahamsson Socio-economic and lifestyle factors in relation to priority of dental care in a Swedish adolescent population	87	2
Ordell, Söderfeldt Management structures and beliefs in a professional			Abstracts of free communications and posters presented at the 46th Annual Congress of the Swedish Dental Society, Göteborg, November 18-20, 2010	229	4

Posttidning **B**



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