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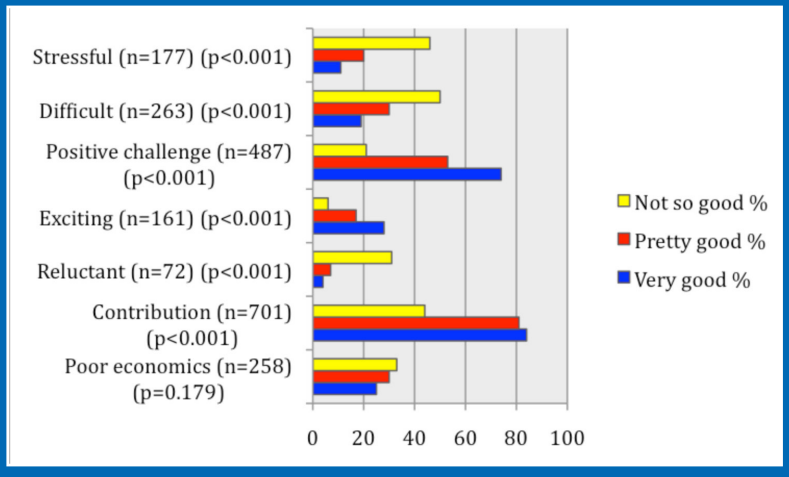

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Production
Carina Frohm, Tfn +46 (0)8 666 15 16
carina.frohm@tandlakarforbundet.se

Editorial address
Swedish Dental Journal
Odontologiska Institutionen
Box 1030, SE-551 11 Jönköping, Sweden
Tfn: +46 (0)36 32 46 04
Fax: +46 (0)36 71 22 35

Subscription/business address
Swedish Dental Journal
Box 1217, SE-111 82 Stockholm, Sweden
Tfn: +46 (0)8 666 15 00
Fax: +46 (0)8 662 58 42
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Introduction
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Comparison of oral status in an adult population 35 – 75 year of age in the county of Dalarna, Sweden in 1983 and 2008

KRISTINA EDMAN[1,2], KERSTIN ÖHRN[3], ANDERS HOLMLUND[4], BIRGITTA NORDSTRÖM[5], MÅNS HEDIN[6], DAN HELLBERG[7,8]

Abstract

◉ The aim was to study the prevalence and distribution of number of teeth, number of intact and decayed teeth and prevalence and distribution of removable dentures and periodontal disease over 25 years 1983-2008. Two cross-sectional studies (EpiWux) were performed in the County of Dalarna, Sweden in 1983 and 2008. In the 1983 study a random sample of 1012 individuals were invited to participate in this epidemiological and clinical study and 1440 individuals in 2008. A total number of 1695 individuals, stratified into geographical areas (rural and urban areas), in the age groups 35, 50, 65 and 75 answered a questionnaire and were also clinically and radiographically examined. The number of edentulous individuals decreased from 15 % in 1983 to 3 % in 2008. Number of teeth increased from 22.7 in 1983 to 24.2 in 2008 and decayed surfaces per tooth showed a three-time reduction over this period of time. As a consequence of better oral status the prevalence of complete removable dentures in both jaws decreased from 15 % in 1983 to 2 % in 2008. Individuals with moderate periodontitis decreased from 45 % in 1983 to 16 % in 2008.

Conclusion: Covering a period of 25 years the present study can report dramatic improvements in all aspects of dental status that were investigated. This is encouraging for dental care professionals, but will not necessarily lead to less demand for dental care in the future as the population is aging with a substantial increase in number of teeth.

Key words

Periodontal disease, dental caries, epidemiology, edentulousness, removable dentures

[1]Centre for Oral Rehabilitation, Falun,
[2]Department of Surgical Sciences, Faculty of Medicine, Uppsala University, Uppsala,
[3]Dalarna University, Falun,
[4]National Dental Service Gävleborg, Gävle,
[5]Administrative Centre for Public Dental Service, Falun,
[6]Department of Oral Radiologi, Falun Hospital, Falun,
[7]Center for Clinical Research, Falun,
[8]Department of Women´s and Children´s Health, Uppsala University, Uppsala, Sweden

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Vuxnas mun- och tandhälsa – en tvärsnittsstudie i landstinget Dalarna, 1983 och 2008

Kristina Edman, Kerstin Öhrn, Anders Holmlund, Birgitta Nordström, Måns Hedin, Dan Hellberg

Sammanfattning

◉ Syftet med studien var att studera förekomst och utbredning av antal tänder, antal intakta och karierade tänder, förekomst av avtagbar protetik samt parodontal sjukdom över en 25-årsperiod 1983-2008.

Två tvärsnittsstudier (EpiWux) genomfördes i Landstinget Dalarna 1983 och 2008. I 1983 års studie drogs ett slumpmässigt urval av 1012 individer som erbjöds att medverka i denna epidemiologiska och kliniska undersökning, och 1440 individer 2008. Totalt 1695 individer, stratifierade i geografiska områden (tätort och glesbygd) i åldersgrupperna 35-, 50-, 65- och 75 år besvarade en enkät samt undersöktes kliniskt och röntgenologiskt.

Antalet tandlösa individer minskade från 15 % 1983 till 3 % 2008. Antal tänder ökade från 22.7 1983 till 24.2 2008 och karierade ytor per tand minskade trefalt under denna 25-års period. Som en effekt av bättre tandstatus minskade förekomsten av avtagbara helproteser i båda käkar från 15 % 1983 till 2 % 2008. Individer med moderat parodontit minskade från 45 % 1983 till 16 % 2008.

Under denna 25-års period har en dramatisk förbättring av alla undersökningsvariabler skett. Detta är uppmuntrande för tandvårdsprofessionen, men leder nödvändigtvis inte till mindre arbetsbörda för tandvården i framtiden då populationen förväntas leva längre och även behålla sina egna tänder livet ut.

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Introduction

A common and widely accepted measurement of dental health is number of teeth. There has been a reduction in tooth loss among adults, especially in industrialized countries, during the last decades (22, 27, 34) and Swedish studies have also shown a reduction of edentulous individuals and consequently the number of remaining teeth has increased during the same period (1, 12, 33). The WHO goal of at least 20 teeth, which is regarded as a functionally dentition, at the age of 80 has not yet been met but is being approached in some countries (32). As a consequence of the increased number of teeth the prevalence of removable dentures has decreased (12, 33, 36) but the prevalence varies between European countries (8, 35). The prevalence of dental caries has been reported to decrease during the last decades in all ages (12, 13, 14, 29). Nevertheless, dental caries is still a major problem in most countries, affecting the vast majority of adults (18, 20, 27). In addition, periodontal healthy individuals have increased (14, 16, 30) but the prevalence of periodontal disease varies considerable between countries (28). Severe periodontal disease is however still a major problem especially in higher age groups (17, 24). *Muller et al.* (2007) reported that there is a lack of epidemiological studies on edentulism and tooth loss in many countries in Europe and that the quality of available studies and the study design varied considerably (22). *Zitzman et al* (35) reported the same problem regarding epidemiological studies on prosthetic dental restorations. Therefore one has to interpret the results with a certain caution.

Since 1983 cross-sectional surveys on dental health and attitudes to dental care, have been carried out every fifth year, in the County of Dalarna, Sweden, but the results have never been published in scientific papers. The aim of these surveys has been to describe dental status in the age groups 35 – 75. Knowledge about dental status is essential for planning and implementing oral health programs and the studies have also been used for planning future dental services based on the populations' needs and demands.

The aim of the present study was to compare oral status in an adult Swedish population between 1983 and 2008.

Material and methods

Subjects

A random sample of 1012 individuals from the County of Dalarna, Sweden was selected from Dalarna population register January 1st in 1982 and 1440 individuals December 1st in 2007. The sample was stratified into geographical areas (rural and urban areas) and gender. The population in 1982 was evenly distributed by age in the age intervals 20-39, 40-59 and 60-79 corresponding to 0.5% of the population. These were grouped into four age intervals so that the mean age was close to 35, 50, 65 and 75 years of age, corresponding to age groups in the 2008 survey. The mean age in the four 1983 groups was 35.1 (28-42), 51.3 (43-59), 64.8 (60-70) and 74.2 (71-79) respectively. In 2007, 360 individuals were evenly distributed in each of the age groups 35, 50, 65, and 75.

The study included a questionnaire and a clinical examination.

Questionnaire

All individuals were invited by mail to participate in the study. They were informed of the purpose of the study and that it was voluntarily to participate.

In the 1983 study the questionnaire was distributed by mail in the beginning of 1982 and, if necessary, completed by telephone interviews. In 2008 the questionnaires and a stamped envelope, were sent out in the beginning of the year. Two reminders were sent out with three weeks intervals. Every tenth of non-respondents were contacted by telephone and asked about their reasons for not attending. The questionnaire included 31 questions in 1983 and has been revised for every survey and included 69 questions in 2008 on self-perceived oral health, dental care habits and availability of dental care, oral hygiene habits and living conditions, level of education, medication and tobacco use.

Clinical examination

The study subjects who returned the questionnaire were offered a clinical examination free of charge including 2-4 bite-wing radiographs in the molar- and premolar regions, performed by their ordinary dental practitioner. Individuals without regular contact with a dental practitioner were offered a referral to a dental practitioner free of choice. The clinical examinations in 1983 were performed between November 1982 and June 1983. The clinical examination in 2008 started in February and was completed in October 2008. All data and radiographs in 1983 were sent in by mail. Data in 2008, including radiographs from Public Dental Services were available electronically.

Variables used in the clinical examination were those used in regular clinical examinations such as; number of existing teeth, prevalence of periodon-

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tal disease and dental caries, occurrence of previous restorations and removable dentures.
When conducting the clinical examination a structured protocol was used. The examiners received written instructions how to complete the protocol and criteria for the clinical variables.

All radiographs were reviewed by two calibrated dentists at the Centre for Oral Rehabilitation, Falun, Sweden and Administrative Centre for Public Dental Service, Falun, Sweden. Analogue radiographs were evaluated by the use of binoculars according to *Mattsson* (21). Both digital and analogue radiographs were accepted if not older than 6 months. Practitioners using analogue radiographs received four double analogue radiographs and an radiograph holder for analogue technique. Instructions for how to place the radiograph sensor/holder were dispatch and the criteria that had to be fulfilled was; all molars and premolars had to be visible, the distal surface of the last molar and distal surface of the canine and the alveolar bone had to be visible and the projection had to be ortoradiell. Radiographs were not taken on edentulous individuals.

Edentulism and number of teeth
The number of edentulous individuals and the number of existing incisors, canines, premolars and molars were recorded.

Intact teeth
Intact teeth, i.e. teeth with no restorations or dental caries were registered.

Dental caries
All tooth surfaces were clinically and radiographically examined for primary caries (new caries lesions on surfaces with no restorations) and secondary caries (lesions on a restored surface) according to the criteria used by *Gröndahl et al.* (6). Caries lesions on root surfaces were also recorded according to the criteria used by *Nyvad &Fejerskov* (25) Active root surface caries: the texture of a lesion is rough, yellowish or light brownish and soft on light probing.

Removable dentures
Removable dentures, complete and partial in one or both jaws were registered.

Periodontal disease
Periodontal disease was evaluated on radiographs in the premolar and molar regions in both jaws and was considered as representative for the whole dentition. Periodontal status was divided into three groups; healthy, moderate periodontitis and advanced periodontitis.

Healthy: healthy or almost healthy gingival units and normal alveolar bone height in the molar-premolar regions.

Moderate periodontitis: Alveolar bone loss not exceeding 1/3 of the length of the roots, occasional furcation defects degree II and III and angular bony defects on not more than 2-3 teeth in the molar-premolar regions.

Advanced periodontitis: Alveolar bone loss exceeding more than 1/3 of the length of the roots, furcation defects degree II and III and/or angular bony defects on > 3 teeth in the molar-pre-molar regions. With no molar present; alveolar bone loss > 2/3 of the root length and > 50% of the existing premolars.

Data processing
Data from 1983 were manually introduced to Predictive Analytics SoftWare, version 18.0 (PASW). All clinical data in 2008 were recorded on a transference template. The questionnaire and the transference template were scanned and exported to PASW. Frequencies, mean values and distributions were calculated. For comparisons of categorical variables Pearson Chi-2 test was used, and t-test was used for continuous variables. A p-value < 0.05 was regarded statistically significant.

The ethical research rules of the Helsinki Declaration were followed (4). The study was approved by the Ethical Committee at the University of Uppsala, Uppsala, Sweden. Before the clinical examination the individuals were orally and by written information informed about the study and confidentiality. Written and oral informed consent was obtained from the participant.

Results

Participation rate
The response rate regarding the questionnaire in the 1983 survey was 90% (n=912) and in 2008 78 % (n=1130). The most common reason for not participating in the study in 1983 was inability to reach the individuals by ordinary mail or telephone and the most common reason for refusal was "never participate in questionnaire surveys". The most common reason for refusal to answer the questionnaire in 2008 were "do not want to participate" and "illness". The responders that completed the questionnaire and accepted a clinical examination was in 1983 and 2008 survey 93 % (n=727) and 86% (n=968) respec-

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Table 1. Distribution of age and gender of participants in the 1983 and 2008 surveys.

	1983				2008		
			Questionnaire				
	Total %	Female %	Male %	Age	Total %	Female %	Male %
Responders	90.1 (n=912)	50.7(n=462)	49.3(n=450)	-	78.5 (n=1130)	54.2(n=612)	45.8 (n=518)
Available	86.3 (n=787)	50.8(n=400)	49.2(n=387)	-	100.0 (n=1130)	54.2(n=612)	45.8 (n=518)
35.1[1]	35.5	45.5	54.5	35	21.9	54.7	45.3
51.3[1]	30.8	56.2	43.8	50	24.8	53.6	46.4
64.8[1]	23.1	47.8	52.2	65	26.8	55.8	44.4
74.2[1]	10.7	59.5	40.5	75	26.5	52.7	47.3
			Clinical examination				
Participants	92.6(n=727)	92.5 (n=370)	92.3 (n=357)		85.7 (n=968)	54.5 (n=528)	45.5 (n=440)
35.1[1]	97.9	98.4	97.4	35	83.8	54.6	45.4
51.3[1]	93.4	96.3	89.6	50	87.9	52.4	47.6
64.8[1]	90.7	92.0	89.5	65	88.5	57.5	52.5
74.2[1]	75.0	68.0	85.3	75	82.3	53.4	46.6

[1]Mean age in the 1983 survey

tively (Table 1). Reasons for not attending the clinical examination in 1983 were "not motivated", particular in edentulous individuals, "transportation problems" and "illness". In 2008 the reasons were "do not want to participate and "illness" but in most cases the reason was not mentioned.

Edentulism

There were considerable differences in prevalence of edentulism between 1983 and 2008. The frequency of edentulous individuals were 15.5 % in 1983 compared to 2.8 % in 2008 (p=<0.0001). Significantly fewer participants, women and men, in all age groups above 35 were edentulous in 2008 compared to 1983 (Figure 1). In 1983, women in the age group 50 were edentulous in a higher frequency compared to men (16.8 % vs. 5.3 %, p=0.009). In 2008 there were no significant differences between men and women.

Dental status (third molar excluded)

Number of teeth

Number of teeth increased significantly between the two surveys, most pronounced in the three highest age groups (edentulous individuals excluded). In 1983 the mean value of teeth was 22.7 compared to 24.2 in 2008 (p=<0.0001). There were significant differences (p=<0.0001) in all age groups and in the different groups of teeth between the two surveys except among 35 year old regarding incisors and canines (Figure 2).

Intact teeth

Vast differences in number of intact teeth's appear between the two surveys. This is particularly true in the two younger age groups, where the number of intact teeth was almost twice as many in 2008 compared to 1983. All differences were highly significant (p=<0.0001) regarding intact incisors and canines in the age groups 35-, 50- and 65, intact premolars and molars in the age groups 35- and 50 and for total number of intact teeth in all age groups except age group 75 (Figure 3). Large improvements between the two surveys, for intact number of teeth by total number of teeth, were also seen in the age groups 35-, and 50 (p=<0.0001) and 75 (p=0.0003) (Table 4). The differences between men and women in the two surveys were not pronounced, but there was a tendency for men to have more intact teeth than women.

Decayed surfaces

In 1983 the participants had almost three times as many decayed surfaces and decayed surfaces per tooth compared to 2008 (p=0.0001) and few differences were observed between younger and older age groups. When decayed surfaces by number of existing teeth were estimated there was an increase with increasing age in both 1983 and 2008 (Table 4).

Prevalence of removable dentures

The number of individuals with different types of

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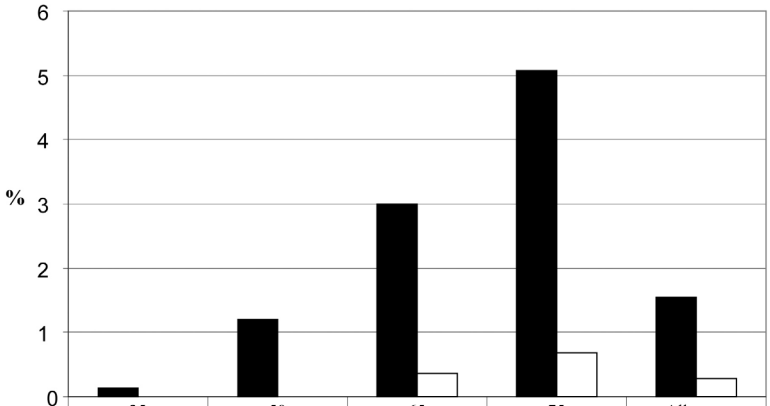
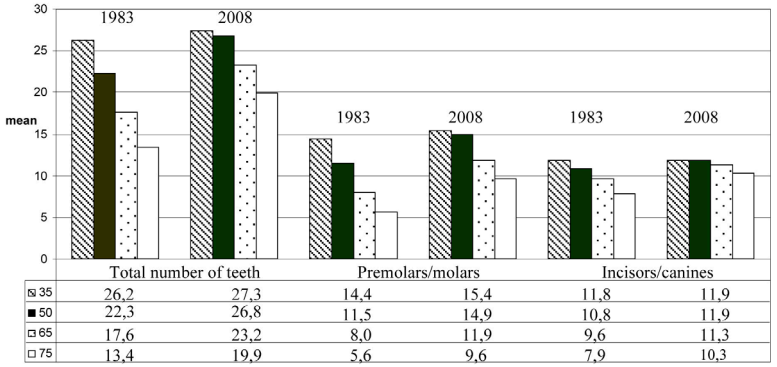
Figure 1. Occurrence of edentulism in the different age groups. p=<0.0001 in all age groups above 35.



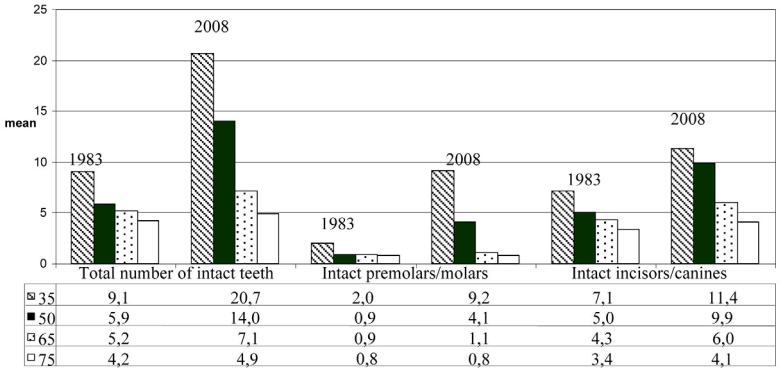
	35	50	65	75	All
■ 1983	1,5	12,0	30,1	50,8	15,5
□ 2008	0	0	3,7	6,9	2,8

Figure 2. Mean number of teeth and mean number of teeth in different groups of teeth. Significant differences in all age groups except regarding incisors and canines in the age group 35.



	Total number of teeth		Premolars/molars		Incisors/canines	
⊠ 35	26,2	27,3	14,4	15,4	11,8	11,9
■ 50	22,3	26,8	11,5	14,9	10,8	11,9
⊡ 65	17,6	23,2	8,0	11,9	9,6	11,3
□ 75	13,4	19,9	5,6	9,6	7,9	10,3

Figure 3. Mean number of intact teeth in the different groups of teeth and intact teeth by number of teeth. Significant differences in the two youngest age groups and in age group 65 regarding intact incisors and canines and total number of intact teeth



	Total number of intact teeth		Intact premolars/molars		Intact incisors/canines	
⊠ 35	9,1	20,7	2,0	9,2	7,1	11,4
■ 50	5,9	14,0	0,9	4,1	5,0	9,9
⊡ 65	5,2	7,1	0,9	1,1	4,3	6,0
□ 75	4,2	4,9	0,8	0,8	3,4	4,1

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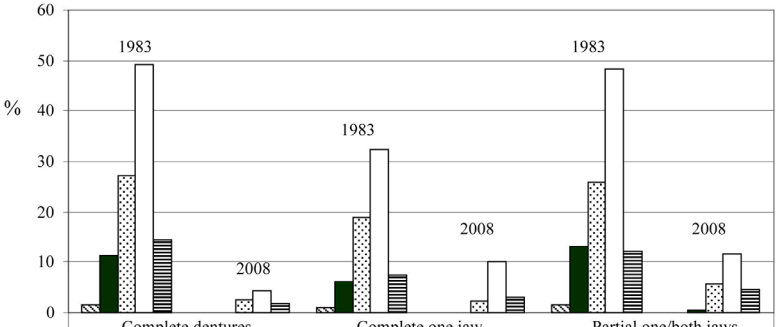
Table 2. Intact teeth by number of teeth (significant differences in all age groups except age group 65), decayed surfaces (significant differences in all age groups) and decayed surfaces by number of teeth (significant differences in all age groups).

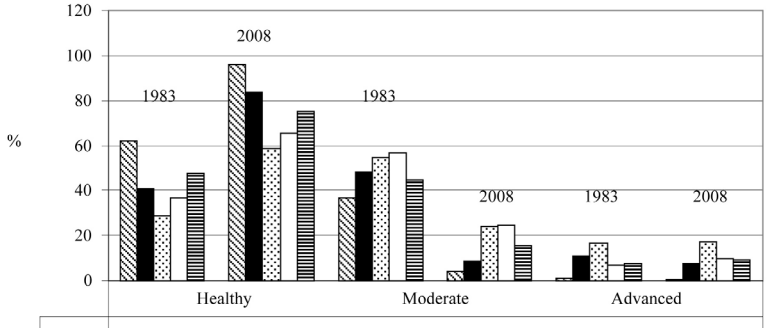
	Intact teeth/number of teeth		Decayed surfaces		Decayed surfaces/tooth	
Age	1983	2008	1983	2008	1983	2008
35	0.34	0.75	2.0	0.7	0.08	0.03
50	0.25	0.52	2.0	0.7	0.13	0.03
65	0.28	0.31	2.1	0.8	0.15	0.03
75	0.36	0.22	1.9	0.8	0.20	0.05
Total	0.31	0.44	2.0	0.7	0.11	0.03

Figure 4. Prevalence of dentures in the different age groups. Significant differences in all age groups except age group 35.



	Complete dentures		Complete one jaw		Partial one/both jaws	
35	1,5	0	1,0	0	1,5	0
50	11,5	0	6,1	0	13,1	0,4
65	27,1	2,6	19,0	2,3	25,9	5,8
75	49,2	4,5	32,3	10,0	48,4	11,7
Total	14,6	1,9	7,5	3,1	12,2	4,6

Figure 5. Distribution of periodontal disease in the different age groups. Significant differences in all age groups regarding healthy individuals and moderate periodontitis.



	Healthy		Moderate		Advanced	
35	61,9	95,7	36,9	3,9	1,1	0,5
50	41,0	84,1	48,2	8,5	10,8	7,3
65	28,9	58,5	54,4	24,0	16,7	17,4
75	36,7	65,4	56,7	24,7	6,7	10,0
Total	47,8	75,1	44,8	15,7	7,4	9,2

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removable dentures decreased significantly in all age groups above 35, between 1983 and 2008. The largest improvement was seen among complete denture wearers with a decreasing prevalence from 14.6 % to 1.9 % (p=0.0001) (Figure 4). In the 1983 survey significantly more women than men in the age group 50, wore complete removable dentures (16.0 % vs. 5.3 %, p=0.0001). In 2008 no individuals below the age of 65 wore complete dentures in both jaws and there were no gender differences.

Periodontal disease

The prevalence of individuals with moderate periodontitis decreased dramatically between 1983 and 2008. Moderate periodontitis in all age groups showed statistically significant improvements between 1983 and 2008 (p=0.0001). The prevalence of advanced periodontitis remained similar with a prevalence of 7.4 in 1983 and 9.2 in 2008 (Table 6). When comparing women and men in 1983, women was significant healthier regarding moderate periodontitis compared to men (p=<0.05) in age groups 35 and 75, while in 2008 women showed to be significant healthier compared to men in the age group 35 (p=0.015). No statistically significant difference between men and women was found regarding advanced periodontitis.

Discussion

The major finding of the present study was the dramatic improvements in dental status by age groups during the last 25 years. The number of edentulous individuals has decreased in all age groups. Number of teeth as well as number of intact teeth increased significantly in all age groups. The oral status improvement was also reflected by the decreasing number of decayed tooth surfaces which showed a three times reduction in all age groups. The prevalence of moderate periodontal disease decreased from 44.8% to 15.7% in the whole study population, while individuals with advanced periodontitis remained almost the same in 1983 and 2008 (7.4% and 9.2%). As a consequence of the improved dental status the overall prevalence of complete removable dentures decreased from 14.6% to 1.9 %. The largest improvements were shown in the age group 50 where reductions were found in all kinds of removable dentures. It is beyond the aim of this study to analyse causes for these improvements, but birth-cohort effects probably play a major role.

The results from the present study on edentulism were similar to those found in other epidemiological studies (12, 14, 33). The present study showed that the most considerable reduction in edentulism occurred in the age group 75 followed by age group 65. These results correspond to the analysis conducted by The Swedish National Board of Health and Welfare in 2009 (31). In the present study there is a marginally higher prevalence of edentulous individuals (15.5% in 1983 and 2.8% in 2008) compared with *Hugoson et al* who showed a prevalence of 12% in 1983 and 1% in 2003 (14). This might be explained by the inclusion of individuals. The study population of the present studies was stratified to cover both rural and urban areas with the intention to reflect dental status in all parts of the County. In the studies by *Hugoson et al.* the individuals were stratified from four different parishes in a middle-sized town (12). *Laurell et al.* conducted in 1983 a study on dental health in the County of Gävleborg, Sweden, which showed similar results as the present study regarding data from 1983 (19).

The difference between European countries, but also globally is however still great according to WHO: s report in 2003 (27). In Europe, Bosnia and Herzegovina reported 78 % edentulousness, Finland 41 % and Denmark 27 % among individuals 65 years and older. Globally, according to the same report, Canada reported 58 % and the US reported 26% in the age groups above 65. A review conducted by *Muller et al.* also showed a huge global variance of edentulism (22). The present study indicates that Sweden is among the countries with the lowest prevalence of edentulism.

The number of existing teeth has increased significantly in all age groups between 1983 and 2008, most pronounced in the higher age groups. This is in accordance with other studies (12, 33) which show similar results. Other studies have shown a somewhat lower mean number of teeth (mean 17) in a population over 65 year of age compared to the present study and age groups 65 and 75 in 2008, that showed a mean number of teeth by 23.2 and 19.9 respectevely (5, 8).

The dental status improvement between 1983 and 2008 was also reflected in the decreasing number of decayed surfaces per tooth. There was a three-time reduction from 0.11 to 0.03 per tooth in the total study population. This might reflect introduction of fluoride into tooth paste and increasing number of dentists and dental hygienists and consequently increased availability to dental care (1, 3, 9) so, the need for dental care will probably increase depending on an older population using more drugs and conse-

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quently have a higher prevalence of xerostomia. For decayed teeth *Hugoson et al.* showed somewhat lower prevalence, except for the age groups 30 and 40 (12), compared to 35 year olds in the present study which might depend on the stratification of the population.

The total number of individuals with complete removable dentures in both jaws drastically decreased between 1983 and 2008. In a Norwegian study (8) of clinically examined individuals, 67-99 year of age, 31.6% had complete removable dentures compared with 2.6% and 4.5% among the 65- and 75 year olds in the present study and 1% among 40- to 70 year olds in the study conducted by *Hugoson et al.*(12). Complete removable dentures in one jaw on the other hand, showed a lower frequency in the present study compared to *Hugoson et al.* (3.1% vs.8%) as well as removable partial dentures (4.6 vs. 9%) (12).

The prevalence of moderate periodontal disease decreased considerable between 1983 and 2008. The number of comparative studies that report prevalence over time are limited and the study design vary considerably which makes it hard to compare different studies. There is no golden standard for how to measure periodontal disease, and there is a lack of agreement of which criteria to be used. The results of previous studies, however, indicate a decrease of moderate periodontitis in general (2, 11, 15, 30). Individuals with advanced periodontitis remain almost the same over these periods. Despite improving dental care and public knowledge about prevention, it is possible that advanced periodontitis will be a challenge also in the future as there are factors that we not yet can influence such as the heritages for the regulation of the host response (7, 23). Even though different index are used when measuring periodontal disease, the trend in different studies seem to point in the same direction with a prevalence of severe periodontitis of 10-15% (26). The strengths of the present study are the comparison of the periodontitis prevalence over a 25-year period and the large number of participants who had a clinical examination completed with intra oral radiographs. The classification method for periodontal disease in the present study is in many ways similar to *Hugoson & Jordan* (10, 15). The diagnosis was based on bite wing radiographs covering premolars and molars in both jaws and examined by two dentists who reached consensus in the evaluation of the radiographs.

This study could clearly show cohort effects as dental status improved between every age group during 1983 and 2008. Another cohort study presented similar effects on edentulism in five birth cohorts born between 1901 and 1930 who were examined at 70 year of age (36), and the same trend was also seen in a Norwegian population (9).

Covering a period of 25 years our study could report dramatic improvements in all aspects of dental status that were investigated. This might be explained by the populations increased access to dental care and preventive dental care provided by dental hygienists and dentists. This will not necessarily lead to less demand for dental care in the future as populations are aging with a substantial increase in number of teeth. With higher age, the risk for disease and medication increases which leads to higher prevalence of xerostomia that consequently might lead to impaired oral status.

As several epidemiological studies in different parts of Sweden have been conducted during the years and which results correspond well with results from the present study, it is possible to assume that these results are representative for Sweden in general.

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Corresponding author:
Kristina Edman
Centre for Oral Rehabilitation
Manhemsvägen 28
SE-791 31 Falun, Sweden.
E-mail: kristina.edman@ltdalarna.se

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A dental phobia treatment within the Swedish National Health Insurance

CATHARINA HÄGGLIN[1,2], ULLA WIDE BOMAN[1,2]

Abstract

◎ Severe dental fear/phobia (DF) is a problem for both dental care providers and for patients who often suffer from impaired oral health and from social and emotional distress. The aim of this paper was to present the Swedish model for DF treatment within the National Health Insurance System, and to describe the dental phobia treatment and its outcome at The Dental Fear Research and Treatment Clinic (DFRTC) in Gothenburg.

A literature review was made of relevant policy documents on dental phobia treatment from the National Health Insurance System and for Västra Götaland region on published outcome studies from DFRTC. The treatment manual of DFRTC was also used.

In Sweden, adult patients with severe DF are able to undergo behavioral treatment within the National Health Insurance System if the patient and caregivers fulfil defined criteria that must be approved for each individual case. At DFRTC dental phobia behavioral treatment is given by psychologists and dentists in an integrated model. The goal is to refer patients for general dental care outside the DFRTC after completing treatment. The DF treatment at DFRTC has shown positive effects on dental fear, attendance and acceptance of dental treatment for 80% of patients. Follow-up after 2 and 10 years confirmed these results and showed improved oral health. In addition, positive psychosomatic and psychosocial side-effects were reported, and benefits also for society were evident in terms of reduced sick-leave.

In conlusion, in Sweden a model has been developed within the National Health Insurance System helping individuals with DF. Behavioral treatment conducted at DFRTC has proven successful in helping patients cope with dental care, leading to regular attendance and better oral health.

Key words

Dental anxiety, dental phobia, behavioral medicine, treatment model

[1] Department of Behavioral and Community Dentistry, Institute of Odontology, the Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden

[2] Clinic of Special Care Dentistry and Oral Medicine, Göteborg, Public Dental Service, Region Västra Götaland, Sweden

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Tandvårdsfobibehandling inom ramen för det Särskilda Tandvårdsstödet

Catharina Hägglin, Ulla Wide Boman

Sammanfattning

◎ Svår tandvårdsrädsla/tandvårdsfobi är ett problem både för den drabbade patienten och för tandvårdspersonalen. Fobibehandling kan beviljas som ”Led i sjukdomsbehandling vid extrem tandvårdsrädsla” inom det Särskilda Tandvårdsstödet. Syftet med detta arbete är att presentera den svenska modellen för behandling av svår tandvårdsrädsla inom ramen för det Särskilda Tandvårdsstödet, och vidare att beskriva verksamheten vid enheten för tandvårdsrädslebehandling (The Dental Fear Research and Treatment Clinic, DFRTC) vid Specialkliniken för sjukhustandvård/oral medicin i Göteborg och de behandlingsresultat som finns redovisade.

Studien baseras på en litteratursökning av nationella policy dokument om tandvårdsrädslebehandling inom sjukvårdssystemet, samt regionala dokument relevanta för verksamheten vid DFRTC. Vårdprogrammet för DFRTC har också använts.

I Sverige medges behandling av svår tandvårdsrädsla inom ramen för sjukvårdande behandling om patienten och behandlaren uppfyller ett antal kriterier som prövas i varje enskilt fall. Vid DFRTC ges beteendeinriktad manualiserad behandling i en modell där psykologer och tandvårdsteam arbetar integrerat. Målet är att efter avslutad behandling remittera patienten till allmäntandvården.

Behandlingen vid DFRTC har visat goda effekter för 80% av patienterna avseende tandvårdsrädsla och förmågan att genomföra regelbunden tandvård. Uppföljning efter 2 och 10 år konfirmerar dessa resultat och visar på förbättrad oral hälsa. Dessutom har positiva psykosomatiska och psykosociala effekter rapporterats, och samhällsekonomiska vinster i form av reducerad sjukskrivning.

Konklusion: I Sverige kan patienter med svår tandvårdsrädsla få behandling inom sjukvårdssystemet. Behandlingsmodellen vid DFRTC har visat goda effekter.

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Introduction

The prevalence of severe dental fear/dental phobia (DF) is about 4-7% among adults (10, 16, 18). The condition presents serious problems to patients and to the providers of dental care (12). Individuals with DF often suffer from impaired oral health (1, 19) as well as psychological and social distress (14, 22). DF also leads to costs for society following interrupted and cancelled treatments, expensive treatment under general anaesthesia, and increased levels of sick-leave (9). A recent study found that only a third of patients referred for dental treatment under sedation completed the full treatment (8). In a recent meta-analysis, it was concluded that available behavioral interventions for DF in adults are successful (13).

The Dental Fear Research and Treatment Clinic (DFRTC) in Gothenburg has acted as a model for the Swedish National Health Insurance System policy on dental phobia treatment. The National Health Insurance System for DF treatment for adult patients was implemented in 1999 and is unique in an international perspective. Facts about Sweden and Swedish medical and dental care are found in Table 1.

The aim of this paper was to present the Swedish National Health Insurance System model for DF treatment, its organisation and economic structure. The aim was further to describe the dental phobia treatment and its outcome at the DFRTC in Gothenburg.

Material and Methods

A literature review was made of relevant policy documents on dental phobia treatment from the National Health Insurance System and for the region of Västra Götaland where DFRTC is situated, and on published outcome studies from DFRTC. The treatment manual of DFRTC was also used.

Results

The National Health Insurance System for treatment of dental phobia

In 1999 the Swedish government decided to establish National Health Insurance coverage for treatment of extreme dental fear among adults (21). In order to qualify as suffering from extreme dental fear, and thereby to be entitled to DF treatment, patients must: 1) have avoided dental care for several years, except for brief acute treatment, in spite of a significant need for dental care; 2) suffer from severe dental fear, according to assessments made by a dentist as well as a psychologist, psychiatrist or psychotherapist. Both of these criteria have to be met if the patient is to be entitled to treatment under the insu-

Table 1. Facts about Sweden and Medical and Dental care services in Sweden

Sweden
• Population: 9.4 million inhabitants • Human Development Index: 7th in the world • Form of government: Representative democracy • Counties: 20 (two of these are larger "regions") • Capital: Stockholm • Second largest city: Gothenburg (Pop. 500,000 and 1 million in the greater urban area)
Medical care
• Publicly funded and largely decentralized (operated by County Councils) • Costs for health and medical care account for about 9% of Sweden's gross domestic product (GDP) • Costs for health and medical care paid for by: County council and municipal taxes (bulk), and contributions from the national government, while patient fees cover only a small percentage • High-cost ceiling: After a patient has paid a total of SEK 900 (EUR 100) within one year, medical consultations within 12 months of the first consultation are free of charge
Dental care
• Public and private (with the same regulations and about the same fees) • Number of dentists: 7,500 (per capita: 81 per 100,000) • Cost: Free (publicly funded) ≤ 19 years of age (regular dental care ≥ 3 years of age), ≥20 years of age a part or the entire cost is paid (with a publicly funded high-cost protection) • Dental care is available at the same fee rates as for medical care in the following cases: if dental care is needed for disease control (for example: while receiving radiation treatment to the head or neck), if extra care is required in daily life (for example: the elderly, unwell and functionally impaired persons) and for dental phobia treatment

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rance scheme (21). According to the Swedish Dental Service Act, the primarily aim of the treatment is to cure the dental phobia (21). Furthermore, treatment must be delivered by dentists and/or dental hygienists who have well-documented knowledge about patients with extreme dental fear and be carried out in close cooperation with a psychologist, psychiatrist or psychotherapist. For each patient, a treatment plan must be submitted to the County Council's Board for Oral Health for approval.

Sweden is divided into different Counties that organize public medical and dental care and each has a degree of independence. Thus, the Counties have some authority to design their own regulations in relation to issues such as the National Health Insurance System. The National Swedish Board of Health and Welfare has given recommendations to the County Councils concerning the handling of the Health Insurance System for dental phobia. For example, the National Swedish Board of Health and Welfare recommends eight hours of treatment for managing dental phobia (20). The Health Insurance System is supposed to cover not only the phobia treatment but also the dental care provided while the patient is undergoing phobia treatment. The Health Insurance System also could cover acute dental treatments, such as extractions and endodontic treatments that are carried out under general anaesthesia before or during phobia treatment (21). The patient pays the general fee for public medical care (currently SEK 80-300, appr. EUR 9-30 per visit) with a high cost ceiling of SEK 900 (EUR 100) (Table 1). In the following, we will describe the Gothenburg model, which is one of the most thoroughly investigated and evaluated.

The Gothenburg model

In Gothenburg, dental phobia treatment and research has been conducted since 1975 (7), when a clinic for patients with special needs was established through co-operation between the University of Gothenburg, the Institute of Odontology, and the Public Dental Service in Göteborg. The clinic was later transformed to the DFRTC, when a co-operation with the Institute of Psychology at the University of Gothenburg was established. The clinic is nowadays a specialist unit associated with the Clinic of Special Care Dentistry and Oral Medicine. Four dentists and two psychologists are employed and divide their time between delivering treatment and conducting research. The director of the DFRTC since its inception was Ulf Berggren (1948 - 2009), a senior consultant and professor in Odontological Psychology. The treatment model (the Gothenburg model) used at the clinic is based upon the research that professor Berggren and Sven G. Carlsson, professor in Psychology, have been conducting for the past thirty years with support from the National Institutes of Health (NIH), the Swedish Research Council and others (4, 5). To the best of our knowledge, this was the first unit combining research and regular clinical care of adult patients with severe dental fear.

At the DFRTC roughly 250 new patients are treated each year (2). About 50% of the patients are referred from physicians and dentists and 50% come through self-referrals, often initiated by the patients' relatives or employers. On average, these patients have avoided dental care for 13 years. Half of the patients undergo phobia treatment. Once the DF treatment and clinical rehearsals as well as confirmatory dental treatment at the clinic have been completed, the goal is to refer patients for general dental care to complete their dental treatment and, most importantly, to receive regular dental check-ups in the future.

The DFRTC belongs to the County of Västra Götaland, where the regulations governing dental phobia treatment have been formulated as follows: A maximum of 10 treatment visits (two examination visits, one by the dentist and one by the psychologist, psychiatrist or psychotherapist and eight treatment visits) are covered by the County Council's Board (at present with SEK 1200 per hour, EUR 130). The County Council's Board also covers acute dental treatment under general anaesthesia or sedation to eliminate pain in order to make phobia treatment possible. The phobia treatment at the DFRTC follows a schedule: Examination, Treatment and Follow-up (Figure 1).

During the examination part the patient meets the dentist twice, for an interview including psychometric questionnaires and an adapted clinical examination, and the psychologist for another interview (Figure 1). A therapy plan is then established. The treatment modality is influenced by the patient's oral and psychological status and preferences. The need for acute dental treatment is considered. If patient consent for phobia treatment is obtained and the patient is considered suitable for phobia treatment, the dental phobia treatment plan is sent to the County Council's Board for approval. While half the numbers of new patients undergo phobia treatment about 50% are judged not to be suitable for DF treatment due to severe psychiatric disorders,

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◎ **Figure 1.** Flowchart assessment and treatment steps

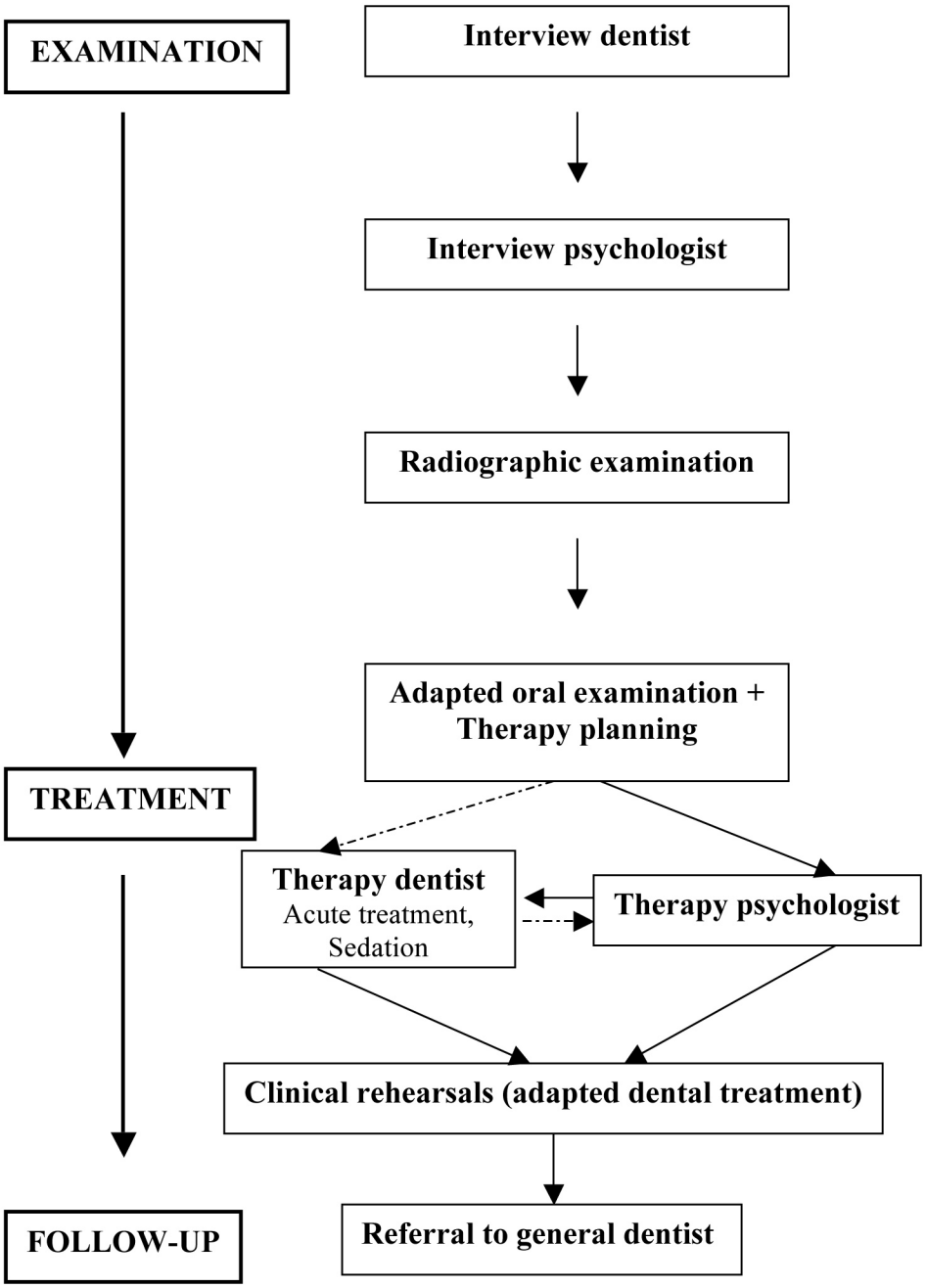

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Figure 2. Patient in treatment by psychologist Ulla Wide Boman at the Dental Fear and Research Clinic.

acute crises, drug abuse, severe social problems or lack of motivation. These patients are treated with adapted clinical treatment, under general anaesthesia or other modes of sedation. In the following text, only phobia treatment will be described.

Dental phobia treatment by the psychologist starts with 5-7 individual sessions based on Cognitive behaviour therapy (CBT) (17). The interventions are adapted to the individual patient's needs as identified at the initial assessment and the functional behaviour analysis. The psychologist works at the dental clinic in close collaboration with the dental care teams, and treatment sessions are held in a fully equipped dentistry room. A broad-based package of interventions described in a manual is used (2). The most common interventions are the following: With *psycho-education*, patients learn that fear is an adaptive and normal reaction to threat. Exposure is the key intervention in CBT treatment of anxiety related to particular objects and situations. Graded exposure is conducted, during which the patient approaches the feared objects and experiencing the situation, with bodily sensations, thoughts, the desire to flee and feelings of fear. The level of anxiety typically rises, and should be significantly reduced before exposure is continued. Data screens are used for presentation of visual stimuli (DVD scenes) of a patient who does not suffer from DF attending a dental clinic for care (Figure 2). These exposures are combined with presentation of instruments. *Cognitive restructuring* is used to change the patient's dysfunctional thoughts and images. Then, *behavioral experiments* are planned and conducted, allowing the patient to try out new forms of cognition and behaviours. In this way, cognitive and behavioral interventions are combined

With *relaxation* and calm breathing techniques the patient learns to relax and control psychological reactions, and this also facilitates exposure. Originally, all exposure was conducted in the form of systematic desensitization, which combines exposure and relaxation. Bio-feedback technique may be used to improve relaxation, and to facilitate exposure and systematic desensitization. Patients with blood/injury/injection phobia including a tendency to faint due to low blood pressure, learn to use *applied tension*. *Self-assertiveness training* is given when appropriate. This implies learning to communicate personal opinions, feelings and needs in a constructive way, instead of using passive or aggressive responses. When the patient has completed the treatment program with the psychologist, the patient continues to

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the dental team to complete the DF treatment with clinical rehearsal, as outlined in the therapy plan. For patients suffering from needle phobia, dental nurses with a special training often give clinical rehearsals. These clinical rehearsals have the function as behavioral experiments as part of the CBT. It is essential that the patient is given the opportunity to practice and evaluate the new strategies from the treatment with the psychologist. Apart from restorative treatment, these visits at the dental team include giving the patient preparatory and ongoing information, increased control, gradual exposure, relaxation training and positive reinforcement. The psychologist usually does not attend these sessions, since the goal is to make the patient independent and confident in the situation.

If the patient requires further clinical adaption they pay the regular fee for the time used for the restorative therapy. After completing treatment, the patient rates level of dental fear, and the dentist rates the patient's cooperation. Since the objective of the treatment is to make the patient able to manage conventional regular treatments with other dentists, the last step in the treatment is to refer the patient to general dental care. A follow-up questionnaire is sent to the new dentist to assess cooperation and patient-rated dental fear.

Outcome of the Gothenburg model

The dental phobia treatment at the DFRTC has achieved demonstrably positive effects, both in the short and long term. In a randomized study comparing behavioral therapy (BT) with general anaesthesia (GA), more patients with BT managed conventional treatment (92 % vs. 69 %) and were transferred to general dental care (6). (Both experimental groups were subjected to two conventional dental treatments at the DFRTC before referred to general dental care). While both groups reported reduced DF after treatment this was most marked in the BT group where the subjects had a significantly lower level of DF than the GA group ($p<0.001$; corresponding to effect size $d = 0.87$). The dentists rated the patients' treatment cooperation higher after treatment only in the BT group ($p<0.001$, corresponding to effect size $d=1.04$). The BT group also had less avoidant behaviour during treatment (late cancelations and cancelled appointments). More patients in the BT group than in the GA group (80 % vs. 57 %) had regular dental care after 2 years and reported lower DF (on a normal level) (3). Similar results were found in a 10-year follow-up (11).

Generalised effects of treatment on psychosomatic, emotional and social factors have also been reported (11). A retrospective register study including a control group showed reduced sick-leave in the DF group, from Mdn 14.0 days per year before treatment to Mdn 3.5 days after treatment, thus demonstrating benefits for both patients and for society (9). Follow-up studies have demonstrated positive effects on oral health as well (11). Research at the DFRTC has also been directed towards different modes of DF treatment (5, 15).

Conclusion

DF is a problem for both dental care providers and for patients, who often suffer from impaired oral health and from social and emotional distress. Effective behavioral interventions exist, and Sweden has developed a model within the national insurance system that makes it possible to help individuals suffering from severe dental fear. This treatment is available at a moderate cost to the patient. The DFRTC in Gothenburg has specialized teams that include psychologists and dental teams that work in an integrated manner to provide behavioral interventions coordinated with dental care. Positive treatment effects are reported. It is recognised that there is need for further outcome studies.

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Corresponding author:
Dr Catharina Hägglin,
Department of Behavioral and Community Dentistry,
Institute of Odontology,
Sahlgrenska Academy at the University of Gothenburg,
Box 450
SE-405 30 Göteborg, Sweden
E-mail catharina.hagglin@odontologi.gu.se

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Dentists' views on fearful patients. Problems and promises

CARL-OTTO BRAHM[1,6], JESPER LUNDGREN[3,5], SVEN G CARLSSON[1,3], PETER NILSSON[6], JILL CORBEIL[2], CATHARINA HÄGGLIN[1,4]

Abstract

◎ A large number of patients treated in the general dental health service in Western countries report dental fear to some degree. Dentists' views of treating these fearful patients are not well described in the literature. Therefore, the aims of the study were to explore dentists' attitudes towards, experience of, and feelings about treating fearful patients.

The sample consisted of 1293 members of the Association of Public Health Dentists in Sweden who were asked to respond to a web survey concerning dental fear.

The response rate was 69% (n=889). The majority of the responding dentists stated that dental fear is a problem in routine dental care, treating patients with dental fear is a positive challenge and they felt they were making a contribution. They also reported that treating patients with dental fear is associated with hard work, poor revenues, and little appreciation by employers. Female dentists reported a greater proportion of patients with dental fear and greater self-efficacy regarding the treatment of these patients, compared with their male colleagues. Dentists trained in other EU countries reported stress more often and less perceived contribution when treating fearful patients, compared with colleagues trained in Sweden.

Conclusion: Dentists' views of treating fearful patients are mainly positive; however, it is problematic that dentists feel stress and that dentists who treat many fearful patients feel their employers do not appreciate their efforts.

Key words

Dental fear, dentist, attitudes, experiences, stress

[1] Department of Behavioural and Community Dentistry,
[2] Dental Hygienist Programme, Institute of Odontology, Sahlgrenska Academy,
[3] Department of Psychology, University of Gothenburg;
[4] Clinic of Special Care Dentistry and Oral Medicine,
[5] Research Center, Public Dental Service, Region Västra Götaland, Gothenburg;
[6] Department of Oral and Maxillofacial surgery, Institute for Postgraduate Dental Education, Jönköping, Sweden

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Svenska tandläkares uppfattning om behandling av patienter med tandvårdsrädsla

Carl-Otto Brahm, Jesper Lundgren, Sven G Carlsson, Peter Nilsson, Jill Corbeil, Catharina Hägglin

Sammanfattning

◉ Bakgrund och syfte: Ett stort antal tandvårdspatienter i västvärlden rapporterar någon grad av tandvårdsrädsla. Tandläkares uppfattning om behandling av dessa patienter är sparsamt beskriven i litteraturen. Studiens syfte var att undersöka tandläkares attityder, erfarenhet och känslor kring behandling av vuxna patienter med tandvårdsrädsla. Material och metod: Urvalet bestod av 1293 tandläkare anslutna till Tjänstetandläkarna, som via mail tillfrågades om att besvara en web-enkät angående tandvårdsrädsla. Resultat: Bland de tandläkare som uppfyllde inklusionskriterierna var svarsfrekvensen 69 % (n=889). Majoriteten av de tandläkare som besvarade enkäten upplever tandvårdsrädsla som ett problem inom allmäntandvården, att behandling av patienter med tandvårdsrädsla innebär en utmaning samt att de gör en insats vid behandling av denna patientkategori. Tandläkarna rapporterade också att behandling av patienter med tandvårdsrädsla innebär hårt arbete, låga intäkter, och att arbetet har litet stöd av arbetsgivarna. I jämförelse med manliga tandläkare rapporterade kvinnliga en högre andel tandvårdsrädda patienter och ett större självförtroende vid behandling av dessa patienter. Tandläkare utbildade i annat EU-land rapporterade mer stress och mindre känsla av att göra en insats vid behandling av tandvårdsrädda patienter, jämfört med tandläkare utbildade I Sverige. Konklusion: Tandläkares syn på behandling av patienter med tandvårdsrädsla är huvudsakligen positiv. Dock rapporterar en stor andel att de upplever denna typ av behandling som stressande, och att arbetsgivaren inte visar tillräcklig uppskattning.

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Introduction

Dental fear is recognized as one of the most common fears and phobias (1, 8, 25). Dental fear is a heterogeneous condition that could be described in different ways, through different intensities or different qualities. *Moore et al.* (21) used fear subgroups, defined by cut-offs in psychometric measures, in order to show differences in strength; low, moderate, and high dental fear. The moderate dental fear subgroup was not characterized by gender differences, negative dentist contacts or general fearfulness, as much as the high dental fear subgroup. The 'Seattle Diagnostic System' (19), on the other hand, proposes four major diagnostic types based on different qualities: (I) conditioned fear of specific painful or unpleasant stimuli (drills, needles, smells, etc.), (II) anxiety about somatic reactions during treatment (panic attacks, fainting, etc.), (III) patients with other complicating trait anxiety or multiphobic symptoms, and (IV) distrust of dental professionals. Dividing patients with dental fear into subgroups may be regarded as an academic exercise, but both categorizations, indeed, have clinical relevance. The dentist should be able to deliver care to as many fearful patients as possible, leaving only the most severe cases to experts. Compared with the extensive knowledge of high dental fear, little is known about the mild to moderate forms of dental fear and their impact on care delivery. The prevalence of mild to moderate dental fear is approximately 35-45% in a western population (10, 18, 20, 32).

Dental fear may create psychological and practical problems, not only for the patient but also for the dental team members. However, only a few studies have reported on dental fear from a dentist perspective (11, 12, 22, 24, 33). The consequences of dental fear, like behavioural management problems, missed appointments and late cancellations, are factors that cause stress (11, 12, 22, 24, 33). On the one hand, anxious patients are thought to complain excessively and to be problematic and unreliable (11, 33). Treating fearful patients may cause irritation, anger and frustration (33). The treatment is often time-consuming and economically unprofitable (12, 22, 33). On the other hand, dentists usually treat fearful patients despite the extra time needed (12, 22). Some dentists see the extra time as an investment in the future of their dental practice (22). Furthermore, dentists are satisfied with the quality of care and enjoy helping anxious patients (12). Those studies reported on background data including age, gender and time of practice, but only three of them analyzed group differences (11, 22, 33). None of them took cultural aspects into consideration.

The Swedish National Board of Health and Welfare regulations comprehend patients with extreme or phobic dental fear referred for specialized phobia treatment (15). Those patients are not charged according to established dental treatment rates, but considerable lower fees. Considerably, the economic strain that these patients may experience is limited.

In 2008, the Swedish National Board of Health and Welfare registered 7449 active Swedish dentists, 4112 in the public dental service and 3337 in private practice (29). Some of these active dentists are trained abroad. In 2007, the Public Dental Service recruited approximately 450 foreign dentists to rural areas in Sweden, due to a shortage of dentists (16, 27, 30). In 2010-2011, there were 268 known Swedish dental students at dental schools abroad (3).

The aim of the present study was to explore attitudes, experiences and feelings regarding treatment of patients with dental fear among dentists in Sweden, and the impact of gender, age and site of education.

Materials and methods

Sample

The sample consisted of members of the Association of Public Health Dentists in Sweden. Of a total of 3934 members (approximately 96% of dentists in the Public Dental Service), e-mail addresses were available for 1556 members. These dentists were asked to respond to a web survey concerning dental fear. All members older than 69 years were excluded beforehand. The legal Swedish retirement age is 65; however, some dentists are still practising at 69 years of age.

In order to assess the representativeness of the sample, demographic data (age and gender) were collected for all the members of the Association of Public Health Dentists.

Formal ethical approval was not necessary, according to information given by the Ethical committee at Gothenburg University. However, the study followed the ethical considerations of the Helsinki declaration. Participation in the web survey was voluntary. Information about the study, formulated according to the general outlines provided by the Ethics Committee at the University of Gothenburg, was attached to the web survey.

The web survey

The web-survey was carried out in 2009. The survey was tested in a pilot study, with 10 dentists respon-

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ding to and commenting on the questionnaire. The web survey was sent by e-mail, and two reminders were sent with one week in between. The web survey contained questions about background factors and the dentists' attitudes, experiences and emotions regarding the treatment of patients with dental fear.

Background factors were age, gender, site of education ('any of the four Dental schools in Sweden' or 'other country - specified') and number of years working as a dentist. The correlation between age and years of practice was strong (0.89). In the youngest age group, 94% had 0-5 years of practice, and in the oldest age group, 99% had more than 15 years of practice. In analyses, 'years of practice' showed a stronger outcome than age, and was therefore used as a background factor in all results presented, except those in Table 1. Other background factors asked for were 'estimated proportion of adult patients', and 'working hours in per cent of full time'; both questions to be answered on a scale from 0-100. In Sweden, full-time work is considered to be 40 hours. The last background question addressed the responding dentists' own feelings about being a dental patient, and could be answered in one of four ways referring to discomfort/dental fear and dichotomized as 'Yes' in the sense of 'I do not like it or I think it is rather unpleasant'; 'I am very frightened or I think it is very unpleasant'; and 'I am terrified'; or 'No' meaning 'I do not care at all'. (14). In the affirmative group the dentists reported both discomfort and fear/anxiety, concepts that are not equivalent but express negative emotions regarding dental treatment.

Five of the questions in the survey referred to the dentists' attitudes, experiences and feelings regarding treatment of patients with dental fear. The response alternatives to the question 'Do you think dental fear is a problem in the dental health care service?' were four and dichotomized into 'Yes' in the sense of 'Yes, ought to be focused on more', 'Yes, but nothing to be done about it', 'Yes, but other problems are more important', and 'No' meaning 'No, not particularly'. The question 'Do you feel stress before treating a patient that you know has dental fear?' was answered on a scale from 1 ('always') to 5 ('never'). The question 'How do you feel/think about treating an adult patient with dental fear?' was answered from seven given options (Figure 1) and/or an own option given as a qualitative remark. It was possible to mark one to three of the given response alternatives. In one analysis the response alternatives were categorized and analyzed as principally 'positive' ('positive challenge', 'exciting', and 'making a contribution')

Table 1. Gender distribution in different age groups among all members of the Association of Public Health Dentists in Sweden (APHD) (n=3994) and members that responded to this study (n=889).

	APHD total (%)		Responders (%)			
Age	Men	Women	Men	Women	χ^2	p-value
24-30	26	74	21	79	1.8	0.176
31-40	30	70	31	69	0.05	0.823
41-50	28	72	29	71	0.08	0.772
51-69	44	56	46	54	0.5	0.529

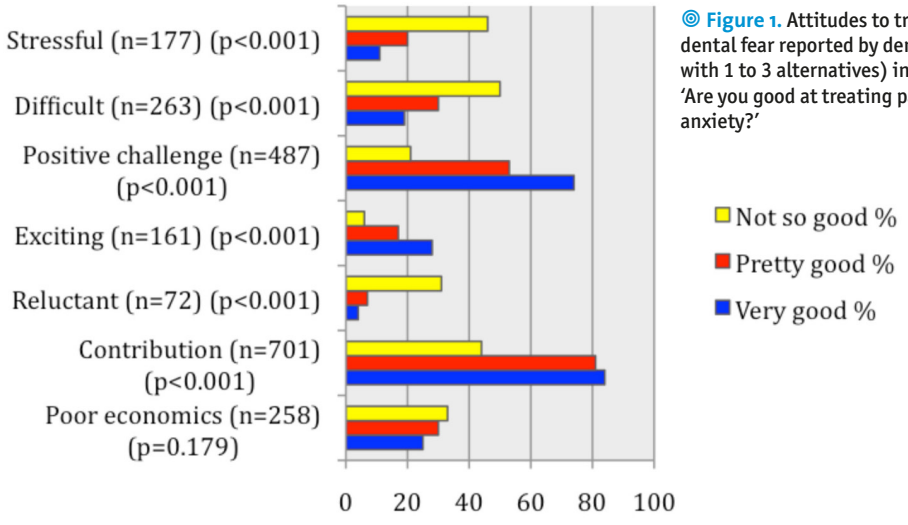

Figure 1. Attitudes to treating patients with dental fear reported by dentists (possible to respond with 1 to 3 alternatives) in relation to self-efficacy: 'Are you good at treating patients with dental anxiety?'

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or principally 'negative' ('stressful', 'difficult', and 'reluctantly'). In this analysis, 'poor economics' was omitted. 'Do you find yourself good at treating adult patients with dental fear?' could be answered: 'Yes, very good,' 'Yes, pretty good,' 'No, not so good,' or 'Not at all'. The last two alternatives were merged, as only one dentist replied 'not at all.' This question was referred to as self-efficacy, which is commonly defined as the belief in one's capabilities to achieve a goal or an outcome (5). The dentists were also asked to estimate the proportion of their patients suffering from dental fear on a scale from 0 to 100%.

Statistical analyses

Practically no data were missing as all questions were compulsory and it was not possible to return the web survey without responding to all questions. Since mainly ordinal scales were used and the distributions were non-normal, we preferred non-parametric inferential statistics. However, responses to continuous scales were reported by using mean values and standard deviations (SD). For correlations the Spearman´s Rank Order Correlation was used. The Chi-square test (Table 1) and bivariate logistic regression adjusting for years of practice were used for analyses of relationships. All dependent background variables were dichotomized before being entered in the analyses. However, the covariate variables were not. In Table 3 and Figure 1, attitudes were dependent variables in the bivariate logistic regression analyses. The pre-chosen level of significance was $p<0.05$.

Results

E-mail addresses were available for 1556 members of the Swedish Association of Public Health Dentists. The inclusion criterion 'working as a dentist treating not only children', was not met for 253 of these members and another ten e-mails were returned by auto-response due to vacation, parental leave, etc. Out of 1293 remaining dentists, 889 (69%) returned their surveys. In Table 1, the gender distribution in the different age groups is shown for members of the Association of Public Health Dentists in total (n=3934, age<70 years) and for those members who responded to the survey. No significant differences were found.

A majority of the respondents had had their dental training in Sweden (n=809), and 10% had been trained abroad (n=80) (Table 2). In the latter group, 49 (61%) were trained in a European Union country, 24 (30%) in a third country (a country that is not a member of the EU or affiliated to the European Employment Strategy (EES)), and for 7 dentists, information on specific country of education was missing. Countries representing the European Union in this study were Poland (n=16), Germany (n=11), Greece (n=6), Romania (n=4), Finland (n=3), the Netherlands, Hungary, Denmark, Estonia, France, and Spain. Norway (n=3) was also included in the EU group due to a cooperation agreement. Third countries were Iraq (n=7), Russia (n=4), Azerbaijan, Belarus, Bosnia, Colombia, Lithuania, Mexico, Pakistan, Serbia, Syria, United States of America, and Venezuela.

Table 2. The background factors years of practice, site of education, and discomfort/dental fear, in relation to gender.

	Gender						
	Men		Women		Total		
	n=319	(35.9%)	n=570	(64.1%)	n=889		
	n	%	n	%	n	%	p
Years of practice							
0-1	13	4.1	29	5.1	42	4.7	<0.001
2-5	45	14.1	144	25.3	189	21.3	
6-15	44	13.8	107	18.8	151	17.0	
> 15	217	68.0	290	50.9	507	57.0	
Education							
Sweden	292	91.5	517	90.7	809	91.0	0.912
Abroad	27	8.5	57	9.3	80	9.0	
Discomfort/ dental fear							
Yes	100	31.3	211	37.0	311	35.0	0.125
No	219	68.7	359	63.0	578	65.0	

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In Table 2 background data of the respondents (years of practice, education, discomfort/dental fear) are presented in total and in relation to gender. The average weekly working time was 88%, and the mean proportion of adult patients in the dental practices was 68%.

A greater proportion of the dentists trained abroad reported own discomfort/dental fear (50%) compared with Swedish trained dentists (33%) (p=0.018).

'Do you think dental fear is a problem in the dental health care service?'

A total of 712 dentists (80%) regarded dental fear as a problem in dental care with no significant differences found for gender, site of education, and own discomfort/dental fear. The frequency distributions of the response alternatives were 'Yes, ought to be focused on more' (67%), 'Yes, but nothing to be done about it' (5%), 'Yes, but other problems are more important' (8%), 'No, not particularly' (20%). However, significant differences were found for years of practice concerning dental fear as a problem in dental care ('0-1 year' 79%, '2-5 years' 88%, '6-15 years' 78%, '>15 years' 78%) (p=0.020), and self-efficacy ('very good' 82%, 'pretty good' 80%, 'not so good' 75%) (p=0.023).

'Do you feel stress before treating a patient that you know has dental fear?'

Feelings of stress before treating a patient suffering from dental fear were reported 'always/usually' by 9.6% of the dentists, 'sometimes' by 37% and 'seldom/never' by 54%. 'Always/usually' feeling stress was significantly more common among dentists trained abroad (24%) than among dentists trained in Sweden (8%) (p=0.030).

Rarely or never feeling stress before treatment of fearful patients were more commonly reported by dentists with no own discomfort/fear in the dental situation compared with their discomfort/fearful colleagues (57% and 48% respectively) (p=0.037). No significant differences were found for gender and years of practice.

'Do you find yourself good at treating adult patients with dental fear?'

Of the 889 dentists, 19% regarded themselves as 'very good' at treating patients with dental fear, 73% as 'pretty good', and 8% 'not particularly/not at all good'. More women (21%) than men (16%) reported being very good at treating fearful patients (p=0.001). Low self-efficacy compared to higher corresponded to more feelings of stress ('always/often/sometimes') before treatment ('not so good' 67%, 'pretty good' 49%, 'very good' 28%) (p<0.001). No statistically significant differences were found for years of practice, own discomfort/dental fear, or site of education.

'How do you feel/think about treating an adult patient with dental fear?'

The most common attitudes towards treating a fearful patient were 'making a contribution' (79%) and

Table 3. Replies to the question 'How do you feel/think about treating a patient with dental fear?' in relation to years of practice and site of education (possible to respond with 1 to 3 alternatives).

	Stressful %	Difficult %	Positive challenge %	Exciting %	Reluctant %	Making a contribution %	Poor economy %
Total	20	30	55	18	8	79	29
Years of practice							
0-1	17	24	62	26	12	81	10
2-5	24	31	55	26	8	72	26
6-15	27	29	42	17	10	76	27
>15	17	30	58	15	7	82	32
p	0.069	0.830	0.486	0.001	0.369	0.018	0.003
Education							
Sweden	19	29	55	18	8	81	30
Abroad	32	30	51	15	11	61	24
p	0.015	0.683	0.551	0.299	0.325	< 0.001	0.446

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'a positive challenge' (55%). Men were more reluctant (12%) than women (6%) to treat fearful patients ($p<0.001$), but no other statistically significant differences in attitudes were reported according to gender. In Table 3 the seven response alternatives are shown in total, and in accordance with years of practice and place of education. The attitude 'stress' was reported more commonly among dentists trained abroad than among Swedish-trained dentists (Table 3). The majority of the dentists, 67%, reported mainly positive attitudes, 16% mainly negative ones, and 17% reported one positive and one negative attitude. Only negative attitudes were reported by 10% of the dentists. Twenty-one percent of the male dentists reported principally negative attitudes, compared with 14% of their female colleagues ($p=0.008$).

When separating 'abroad' into the EU and 'third country,' the EU-trained dentists experienced more 'stress' (35%) than dentists trained in a third country (13%) and in Sweden (19%) ($p=0.030$). The EU-trained dentists also reported less 'feeling of contribution' (59%) compared with dentists trained in a third country (75%) or in Sweden (81%) ($p=0.005$).

In Figure 1 the responses to the different alternatives are shown according to self-efficacy when treating fearful patients.

There were no significant differences between the numbers of marked alternatives on this multiple-choice item according to background factors. The open comments to the question 'How do you feel/think about treating an adult patient with dental fear?' illustrate the dual nature of the dental fear challenge: problems and promises. Several of the respondents expressed a positive attitude to treating fearful patients: 'Makes you develop as a dentist and a human being'; '[gives] positive feedback'; 'Stimulating to feel the patient's trust'; 'Rewarding'. Others, in a more neutral tone, declared that giving care to the fearful patient is an integral part of their job: '[it is] my job'; '[it is] necessary'; 'part of the normal variation'. Many comment on the taxing aspects of giving care to fearful patients: '[it is] heavy'; 'It requests focus and devotion, therefore tiring'; 'taxing and time-consuming'; 'takes a lot of energy [which] makes you tired afterwards, though in a positive manner.' The most common type of comment had to do with financial and organizational obstacles. One respondent declared: '[I] would gladly have more fearful patients…but within the public dental care system it is ONLY the economic result that counts and this in turn affects your salary which means that you get punished…' Another similar remark: 'Difficult question to answer, because I really believe that I make a contribution [when treating fearful patients], but it does not make your employer appreciate you, given the present economic situation. When on emergency duty, it is stressing because you are not given the time needed'. Some plainly declared that taking care of fearful patients is an economic burden because the extra time needed is not allotted.

Estimated proportion of adult patients with dental fear

The estimated mean proportion of dental fear patients treated was 16% (SD=15.2). Female dentists reported a significantly higher proportion of patients with dental fear (mean 18%, SD=16.3) than did male dentists (mean 14%, SD=12.6) ($p=0.002$). Dentists experiencing feelings of discomfort/dental fear when being patients themselves reported having more fearful patients (mean 19%, SD=16.9) than non-fearful dentists did (mean 15%, SD=14.1) ($p=0.004$). Fewer patients suffering from dental fear were reported if dentists were more experienced (0-1 years, mean 20%, SD=16.5; 2-5 years, mean 20%, SD=16.9; 6-15 years, mean 18%, SD=15.9; >15 years, mean 14%, SD=13.7) ($p<0.001$). Dentists with higher (very/pretty good) levels of self-efficacy reported 17% (SD=15.5) of their patients being fearful, compared with 10% (SD=9.1) among dentists reporting low levels of self-efficacy ($p=0.001$). Dentists who experienced dental fear as a problem in dental care reported treating more fearful patients than those experiencing dental fear not to be a problem (mean 18%, SD=15.8 compared with mean 12%, SD=11.5) ($p<0.001$). No statistically significant differences were found regarding site of education.

Discussion

Dental fear may create psychological and practical problems, not only for the patient but also for the dental team members. However, only a few studies have reported on dental fear from a dentist perspective (11, 12, 22, 24, 33). We believe that the present study brings new knowledge to this field of research and gives a more balanced picture of dentists' experiences, attitudes and feelings regarding treating patients with dental fear.

Compared to most other related studies (6, 11, 12, 22, 33), the number of participating dentists was high and would have been even higher if e-mail addresses to all members of the Association of Public Health Dentists had been obtainable. However, supplying e-mail addresses to the association was not man-

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datory to members. Therefore, less than half of the total number of members was asked to participate in the study. However, the response rate in the study was acceptable; more than two thirds of the potential responders participated. Of the 31% who did not respond, certainly some did not receive the e-mails, due, for example, to non-functional e-mail accounts. However, the exact proportion is difficult to determine. About 12% of all registered dentists in Sweden participated in the study. Of the members of the Association of Public Health Dentists about 23% participated.

The anonymity in the survey was a limitation, which allows for only limited data to be available for investigating the representativeness of the sample. However, data on gender and age were available for all members of the Association of Public Health Dentists. Analyses showed no significant differences regarding age and gender of the members in total, and for those responding to the survey. Thus, the study sample seemed to be representative regarding gender and age for the members of the Association.

Another limitation, shared with most questionnaire studies, has to do with the validity of answers chosen from ready-made alternatives. Judging from the meaningful relationships between answers, we feel confident that the responses were not given haphazardly. For one of the questionnaire items, concerning the respondents´ feelings about treating fearful patients, we considered it favourable to allow the respondents to choose more than one alternative. When analysing the answers to this question we tried to avoid interpretation errors emanating from the specific response format used.

Dentists trained in countries other than Sweden were younger and less experienced. Therefore, in all analyses, except in Table 1, 'years of practice' was adjusted for.

Given the different levels of severity within the concept of dental fear, it is reasonable to assume that the respondents have had different interpretations of dental fear as a phenomenon. Some respondents may have interpreted the concept to refer to slightly fearful patens, while others have considered it to refer to phobic dental patients. In this respect, the prevalence of 16% is reasonable and in line with previously reported ranges for the prevalence of dental fear. This is of course, to some extent, a threat to the validity of the study. However, there is no reason to believe that these different interpretations are systematically distributed in the sample, and thus comparisons between groups are still valid.

The rating of dental fear as a problem was more common among dentists reporting that they themselves suffer from dental fear, compared with non-fearful colleagues. This might be explained by better perception of the signs of dental fear, with a more genuine understanding of the problem.

Female dentists reported themselves as being good at treating fearful patients more frequently than male dentists. This was surprising, as men usually report greater self-confidence in work situations than women (31). On the other hand, the somewhat caring nature of treating fearful patients may be closer to the traditional female role, which, in this case, would speak in favour of the female dentists' self-confidence. These female dentists reporting high self-efficacy also reported higher proportions of patients with dental fear than their male colleagues.

The results regarding dentists' attitudes to treating patients with dental fear are promising. The majority reported positive attitudes, such as 'making a contribution' and 'a positive challenge'. However, almost one of six dentists reported mainly negative attitudes. Also, one of ten reported only negative attitudes. Besides, nearly one out of ten reported low self-efficacy in this respect, and just as many of the responding dentists were reluctant to treat fearful patients. These findings are worrying as those dentists may cause more harm than good when treating fearful patients. The primary task of dentists in relation to dental fear should be to prevent the development of fear, and a secondary task, to cure patients with manifest dental fear. Health care in Sweden, including the dental health care service is regulated by law and should be equal for all patients. Negative attitudes and experiences among dentists concerning patients with dental fear may affect the quality of care and lead to future problems.

The qualitative approach to the dentists' attitudes of treating fearful patients revealed a diverse picture of the situation with little consistency. On the one hand, the dentists expressed attitudes related to humanistic and professional values (personal development, personal enrichment, benefit to patients, etc.), but also, on the other hand, feelings of insufficiency (unmet demands for revenues and treatment time). Some dentists responded that their employers punished them for being too engaged in the treatment of patients with dental fear. Unfortunately, this organizational problem exists, and should be regarded as a consequence of the current economic system in the Swedish dental health care service, where the treatment of patients with dental fear is not addi-

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tionally subsidized. This financial system creates stressful situations for patients and dental professionals, a poorer work environment and the risk that moderate dental fear could escalate into phobic behaviour in patients. Swedish general dental practitioners have a fixed salary, irrespective of revenues, although their salaries are related to expected annual proceeds. Thus, dentists treating many fearful patients are vulnerable in this context, as they are at risk of not achieving the expected production goals. However, this is not exclusively a Swedish phenomenon. For example, dentists in Northern Ireland have also reported having problems with time and financial pressures regarding fearful patients (9).

An interesting finding was that dentists with 2 to 15 years of experience reported fewer positive attitudes to treating fearful patients, especially compared with dentists working their first year. A possible explanation could be that after graduation it is common to practice one year under the supervision of an older colleague and with low demands for revenues. When the apprentice period is over the young dentist is expected to work more independently with increasing responsibility, speed and economic pressure in order to treat more patients, including fearful patients, each day. This may explain the elevated stress levels shown in Table 3.

In a study from the UK (12), 42% of the responding dentists enjoyed helping fearful patients. In the present study, a majority of the dentists reported experiencing positive attitudes when treating fearful patients. An American study (33) showed that a majority of the dentists experienced more than a little stress when treating very anxious patients (68%). In the UK study (12), an even higher proportion of dentists reported feelings of stress (91%) when treating uncooperative (anxious) patients. In the present study, 20% of the dentists experienced stress in this respect. Similar findings were shown in another Swedish study by *Hakeberg et al.* (11), where 24% of the dentists reported that dental fear caused stress.

'Always/often' feeling stress before treating a fearful patient and the attitude 'stressful', were more often reported by dentists trained abroad compared with Swedish-trained dentists. It is difficult to identify the reason why dentists trained abroad feel more stress. Dental fear is not a specific Swedish-Nordic phenomenon, but is present in cultures worldwide (2, 4, 7, 20, 25, 28). Although dental anxiety is a worldwide problem, there may be different attitudes to treatment as has been shown in other fields of the health service regarding cultural background factors (17, 23, 26). It is possible that dental schools in some countries allocate fewer resources to the field of dental fear. Such cultural differences may explain the differences in attitudes found in the present study between the group trained abroad and the Swedish group, and when comparing our results with the US and UK studies (12, 33).

Social and cultural transfer occurs when foreign students graduate from dental schools at Swedish universities and vice versa for Swedish dental students trained abroad (13). Within the European Union (EU) people are free to move and dentists do not need to apply for new authorization. Since 2010, dentists from third countries (countries that are not members of the EU or affiliated to the European Employment Strategy) may apply for Swedish authorization after a supplementary examination at a Swedish dental institution (60 higher educational credits). Thus, dentists may be trained in one cultural context but are expected to be able to work in another. This is an interesting topic that ought to be further investigated.

Dentists who see dental fear as a problem, and dentists who experience own discomfort/dental fear, report having a larger proportion of patients with dental fear. There is a risk that this result is confounded by an attention factor: these dentists may overestimate the number of patients with fear and, on the other hand, dentists who do not recognize the problem may fail to discover some cases and thus underestimate the proportion. Unfortunately, the present design does not permit a conclusive analysis of this issue.

To conclude, the majority of the responding dentists stated that dental fear is a problem in routine dental care, that treating patients with dental fear is a positive challenge and that they feel that they make a contribution. They also reported that treating patients with dental fear is associated with hard work and poor revenues, and little appreciation by employers. Female dentists reported higher self-efficacy when treating patients with dental fear than their male colleagues and the proportion of male dentists who would rather be excused from treating patients with dental fear was double that among their female colleagues. Dentists trained in the EU reported stress more often and less feeling of contributing when treating fearful patients compared with colleagues trained in Sweden. Thus, dentists' views of treating fearful patients are mainly positive. However, it is problematic that quite a large proportion of dentists report stress and that some dentists who

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treat many fearful patients feel that their employers do not appreciate their efforts. In the long run, this may entail a risk of dentists becoming reluctant to treat patients with dental fear. Consequently, the quality of care may be affected and lead to future problems for both patients and dental health care professionals.

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Corresponding author:
Dr Carl-Otto Brahm
Department of Oral and Maxillofacial Surgery,
Länssjukhuset Ryhov,
SE-55185 Jönköping, Sweden
E-mail: Carl-Otto.Brahm@gu.se

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Rinsing with alcohol-free or alcohol-based chlorhexidine solutions after periodontal surgery. A double-blind, randomized, cross-over, pilot study

HELENA OLSSON, BARBRO ASKLÖW, EVA JOHANSSON, CHRISTER SLOTTE

Abstract

◎ The aim of this randomized, double-blind, cross-over pilot study was to evaluate the effect on plaque formation and patient experience of rinsing after periodontal surgery using chlorhexidine solution with or without alcohol.

Twenty patients refrained from tooth brushing after surgery and used two mouth rinses. Ten patients used alcohol-based (AB) 0.1% and another ten used alcohol-free (AF) 0.12% chlorhexidine (CHX). Sutures were removed after 2 weeks and teeth were cleaned; thereafter, the two groups shifted solution. Plaque at operated teeth was recorded at 2 and 4 weeks (Quigley-Hein Index). Patient experience was assessed with a visual analogue scale (0–10).

Mean (SD) plaque indices at 2 and 4 weeks were 1.0 (0.8) and 1.1 (1.0) for AB CHX and 1.1 (0.7) and 0.8 (0.7) for AF CHX, respectively (no significant differences between solutions). At 2 weeks, between-group differences in taste experience of the solutions differed non-significantly: 6.1 (2.8) for AB and 6.0 (2.3) for AF. At 4 weeks, values were 4.6 (2.5) for AB and 6.9 (3.3) for AF—patients tended to prefer AF (p=0.050). Taste change over the study period was equal for both groups: -3.7 (3.3) for AB and 3.4 (2.3) for AF at 2 weeks and slightly higher at 4 weeks 4.9 (2.8) and 4.5 (2.5) for AB and AF, respectively. Smarting was low in both groups: 2.2 (3.2) and 1.3 (2.2) for AB and 1.0 (1.5) and 1.9 (2.0) for AF at 2 and 4 weeks, respectively.

To conclude, alcohol-free and alcohol-based chlorhexidine showed the same plaque inhibitory effect in periodontal patients after periodontal surgery. Both rinses were well tolerated by the patients.

Key words

Chlorhexidine digluconate, periodontitis, plaque control, postoperative follow-up

The Institute for Postgraduate Dental Education, Jönköping, Sweden

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Munsköljning med alkoholfri eller alkoholbaserad klorhexidinlösning efter parodontalkirurgi. En dubbel-blind, randomiserad, cross-over-studie

HELENA OLSSON, BARBRO ASKLÖW, EVA JOHANSSON, CHRISTER SLOTTE

Sammanfattning

◎Sedan många år har klorhexidin använts vid parodontal behandling i situationer som kräver utsättande av mekanisk tandrengöring. Munsköljning med olika koncentrationer av klorhexidin är standardprocedur efter t.ex. parodontalkirurgi. Klorhexidinets biverkningar i form av smakförändringar, munsveda och missfärgningar kan ha betydelse för patienten följsamhet. Få studier har utvärderat denna effekt vid postoperativ sköljning. Under senare år har alkoholfria klorhexidinlösningar introducerats i syfte att reducera sidoeffekterna.
Syftet med föreliggande studie var att utvärdera effekten på plackbildningen samt patientens upplevelse av munsköljning med klorhexidin med eller utan alkohol efter parodontalkirurgi.

I denna randomiserade dubbelblinda cross-over pilotstudie ingick 20 patienter som efter parodontalkirurgi avstod från mekanisk tandrengöring och sköljde med två olika klorhexidinlösningar. 10 patienter började skölja med alkohobaserad (AB) 0.1 % lösning och de andra 10 med alkoholfri (AF) 0.12 % lösning . Efter 2 veckor avlägsnades suturer och professionell tandrengöring utfördes varefter patienterna bytte sköljlösningar. Plack registrerades vid opererade tänder vid 2 och 4 veckor (Quigley-Hein index) och patientens upplevelse mättes med en visuell analog skala (VAS; 0 – 10).

Medelvärdet(SD) för plack var 1.0 (0.8) och 1.1 (0.7) för AB respektive AF vid 2 veckor och 1.1 (1.0) för AB och 0.8 (0.7) för AF vid 4 veckor. Ingen signifikant skillnad förelåg mellan grupperna. Upplevelsen av lösningarnas smak var lika vid 2 veckor 6.1 (2.8) för AB och 6.0 (2.3) för AF. Vid 4 veckor var medelvärdena för smak 4.6 (2.5) för AB och 6.9 (3.3) för AF men en tendens fanns att föredra AF (p=0.050). Smakförändring uppfattades lika i båda grupperna—3.7 (3.3) för AB och 3.4 (2.3) för AF vid 2 veckor med något högre värden vid 4 veckor, 4.9 (2.8) och 4.5 (2.5) för AB respektive AF. Upplevelse av munsveda var låg i båda grupperna; för AB 2.2 (3.2) vid 2 veckor och 1.3 (2.2) vid 4 veckor och för AF 1.0 (1.5) och 1.9 (2.0) vid 2 respektive 4 veckor. Ingen signifikant skillnad mellan grupperna kunde konstateras.

Ingen skillnad förelåg heller mellan grupperna vad gällde patienternas upplevelse av missfärgningar.

Sammanfattningsvis visade studien ingen signifikant skillnad mellan alkoholbaserad 0.1% klorhexidinlösning och alkoholfri 0.12 % lösning med avseende på placknivå vid mätningar 2 och 4 veckor efter parodontalkirurgi. Båda lösningarna tolererades väl av patienterna.

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Introduction

The inhibitory effect of chlorhexidine (CHX) on dental plaque formation is undisputed and well documented (12, 19, 22). Since the introduction of CHX, one of its primary uses in periodontal treatment has been in situations requiring cessation of mechanical tooth cleaning. Animal and clinical studies have shown that optimal plaque control during healing after periodontal surgery is crucial for the final treatment result (18, 23, 26, 31, 32).

Rinsing with various concentrations of CHX solutions is a standard procedure after periodontal surgery (1, 27). But few studies have investigated the impact of patient compliance on the effect of postoperative CHX rinsing (7, 10, 27). Technique, duration, and frequency of daily rinsing most likely affect CHX's inhibitory effect on plaque formation (13, 29).

Side effects of CHX use such as taste change, smarting, and staining may have an impact on patient compliance (8). In recent years, alcohol-free CHX solutions have been introduced in an attempt to reduce side effects (17). Alcohol is used in rinsing solutions to dissolve other compounds (5), and the antiseptic effect of alcohol is disputed (28). Bolanowski et al. (3) found a linear correlation between alcohol concentration and pain reported by the patients after rinsing and also increased pain with increased rinsing time.

This double-blind, randomized cross-over pilot study evaluated two CHX solutions, with and without alcohol, in periodontal patients after surgery to determine (i) the plaque inhibitory effect on teeth and surgical sutures and (ii) patient experience regarding taste and smarting during rinsing.

Material and methods

Twenty consecutive patients—12 women and 8 men (mean age 63.1 years, range 39–77) referred to the Department of Periodontology at the Institute for Postgraduate Dental Education in Jönköping, Sweden for periodontal treatment—were recruited to the study. The patients had previously undergone initial non-surgical periodontal treatment and were scheduled for periodontal surgery. They received written and verbal information about the purpose and course of the study and signed informed-consent forms. The Regional Research Ethics Committee at Linköping University, Linköping, Sweden approved the study (M2008/85-31).

Inclusion criterion

- Periodontal surgery on at least three teeth

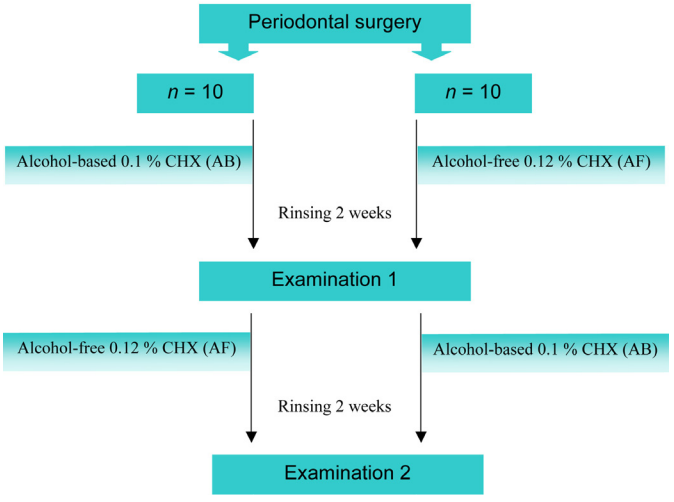
Exclusion criteria

- Smoking >20 cigarettes/day
- Systemic antibiotic medication
- Blood thinning medication

Fig. 1 illustrates the study design. Two rinsing solutions were used: alcohol-based (AB) 0.1% CHX (Hexident®, Meda AB, Solna, Sweden) containing 1.8% alcohol) and alcohol-free (AF) 0.12% CHX (GUM Paroex®, Sunstar, Mölndal, Sweden).

At study start, all participating individuals had

Figure 1. Study design. CHX=Chlorhexidine



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full-mouth plaque scores of <20% and no plaque in the areas scheduled for periodontal surgery. Patients were informed verbally and in text to do the following after their surgery:

- Refrain from tooth brushing in the operated area
- Use Zendium® dentifrice (Opus Health Care AB, Malmö, Sweden) twice daily for tooth brushing on non-operated teeth
- Rinse thoroughly with the CHX solution for 1 minute, twice daily, after tooth brushing

The patients then underwent flap surgery with or without osteoplasty by the periodontists at the department. The wound areas were carefully debrided, and the root surfaces thoroughly scaled and cleaned with hand curettes and a piezoelectric ultrasonic device (Piezon®, Electro Medical Systems SA, Nyon, Switzerland). The flaps were relocated with Vicryl® (Ethicon®, Norderstedt, Germany) sutures.

Randomization

Immediately after surgery, the patients were randomized into two groups of 10 patients each. All patients received Zendium® dentifrice and a rinsing solution, which was distributed in neutral, masked bottles by a dental hygienist who was unaware of the solution composition and not involved in the registration part of the study. Group 1 received AF CHX and group 2 received AB CHX. Sutures were removed after 2 weeks and the teeth were professionally cleaned with Prophy Paste CCS® RDA 170 (CCS AB, Borlänge, Sweden). Group 1 then switched to AB CHX and group 2 to AF CHX.

2- and 4-week assessments

Plaque was assessed at both postsurgical assessments by applying a disclosing solution (Diaplac®, Cederroth AB, Upplands Väsby, Sweden) to the operated teeth and then using the Quigley-Hein Index (25) at six tooth sites. Plaque on sutures was noted as no plaque, thin plaque, or moderate/abundant plaque. Staining on teeth was registered at the patient level as follows: 1 = no staining, 2 = spots of staining, 3 = abundant staining.

All recordings were done by one blinded examiner (author HO) unaware of which type of solution was used. Duplicate plaque measurements were made to assess measurement reproducibility. Intraexaminer intraclass correlation coefficient (ICC) was 0.92 (95% confidence interval [CI]: 0.88–0.95).

The patients answered a questionnaire concerning taste, change in taste, smarting, and tooth staining using a visual analogue scale (VAS) with the endpoints 0 = not at all (taste change, smarting, staining) or not at all good (taste) and 10 = very much (taste change, smarting, staining) or very good (taste).

Statistical analyses

All data were analysed with the Statistical Package for the Social Sciences (SPSS, version 17.0, SPSS Inc., Chicago, IL USA). Means and standard deviations (SD) were calculated for all variables. Nonparametric significance testing was done using Wilcoxon's signed rank test for paired comparison and the Mann-Whitney test for group comparison.

Sample size calculation: Presence of plaque was the main parameter. With 16 subjects in each group, it was estimated that a between-group difference of 5% (SD 5%) would be detectable with $\alpha = 1.96$ (p-value: 0.05), $ß = 0.20$, and a power of 80%.

Results

Mean (SD) plaque indices at 2 and 4 weeks were 1.0 (0.8) and 1.1 (1.0) for AB and 1.1 (0.7) and 0.8 (0.7) for AF, respectively (no significant differences between solutions, Table 1). The frequency distribution of plaque on the tooth surfaces shows that only about half of the sites in both groups were plaque-free at the two assessments with no significant differences between the groups (Fig. 2). The frequency distribution of plaque in the two groups at buccal, lingual or proximal, surfaces are shown in Fig 3a, b. No significant differences were found between the groups. In the AB group at 2 weeks (Fig. 3a), significantly more plaque was found on interproximal than on buccal and lingual surfaces with no significant differences between buccal and lingual surfaces. In the AF group, significantly more plaque was found on buccal and interproximal than on lingual surfaces. At 4 weeks in both groups (Fig. 3b), significantly more plaque was found on interproximal and buccal than on lingual surfaces, and buccal surfaces had significantly less plaque than interproximal surfaces.

Fig. 4 shows plaque levels on sutures after 2 weeks. In group 1 (AB, 0-2 weeks) only 20% (2 individuals) had plaque-free sutures. In group 2 (AF, 0-2 weeks), no individual had plaque-free sutures. This difference between the groups is non-significant.

After 2 and 4 weeks, mean (SD) staining values were 1.8 (0.6) and 1.8 (0.8) for AB and 1.7 (1.0) and 1.3 (0.8) for AF, respectively; all differences between the solutions were non-significant.

Table 1 lists the VAS assessments of patient expe-

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Figure 1. Plaque scores [Quigley&Hein Plaque Index (25)] and patient subjective ratings (Visual Analogue Scale 1 – 10) of taste, taste change, smarting and staining. Mean and Standard Deviation values.

	Group 1 Alcohol-based 0.1% CHX (2 weeks)		Group 2 Alcohol-free 0.12% CHX (2 weeks)		p-values*
n	10		10		
Plaque Index	1.0	(0.8)	1.1	(0.8)	NS
Taste	6.1	(2.8)	6.0	(2.3)	NS
Taste change	3.7	(3.2)	3.4	(2.3)	NS
Smarting	2.0	(3.2)	1.0	(1.5)	NS
Staining	4.7	(3.0)	4.6	(3.3)	NS
	Alcohol-free 0.12% CHX (4 weeks)		Alcohol-based 0.1% CHX (4 weeks)		p-values*
n	10		10		
Plaque Index	0.8	(0.8)	1.1	(1.0)	NS
Taste	6.9	(3.3)	4.6	(2.6)	0.05
Taste change	4.5	(2.5)	4.0	(2.8)	NS
Smarting	1.9	(2.0)	1.3	(2.2)	NS
Staining	3.5	(2.4)	4.0	(2.5)	NS

CHX = chlorhexidine
* Mann-Whitney test
NS = not significant

Figure 1. Frequency distribution of plaque on all experimental tooth surfaces after rinsing with alcohol-based (AB) or alcohol-free (AF) chlorhexidine solution at 2 and 4 weeks.
Quigley&Hein Plaque Index (25): 0=no plaque; 1=separate flecks of plaque at the cervical margin; 2=a thin continuous band of plaque at the cervical margin; 3=a band of plaque wider than one mm but covering less than 1/3 of crown; 4= plaque covering at least 1/3 but less than 2/3 of crown; 5= plaque covering at least 1/3 but less than 2/3 of crown.

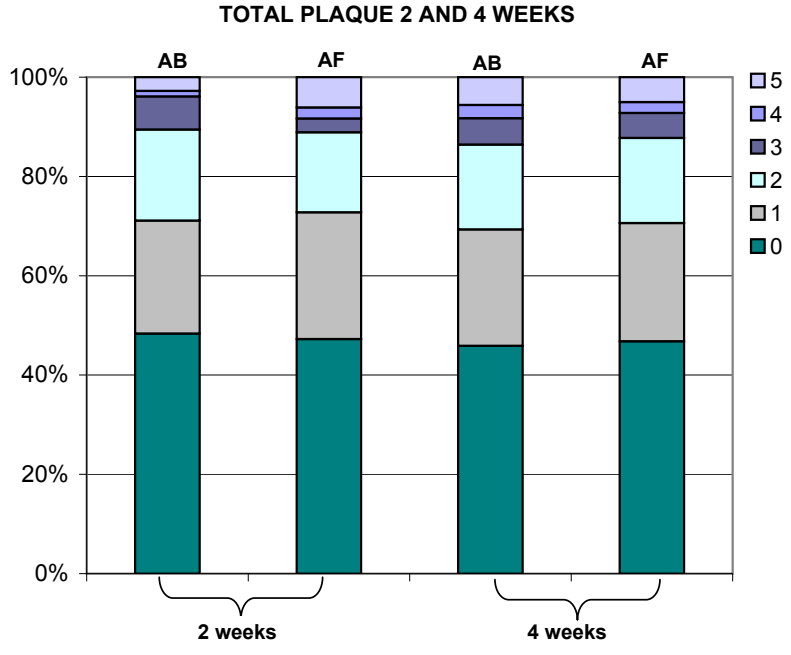

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Figure 3. Frequency distribution of plaque on experimental buccal, lingual, and proximal tooth surfaces after rinsing with alcohol-based (AB) or alcohol-free (AF) chlorhexidine solution.
Quigley&Hein Plaque Index (25): 0=no plaque; 1=separate flecks of plaque at the cervical margin; 2=a thin continuous band of plaque at the cervical margin; 3=a band of plaque wider than one mm but covering less than 1/3 of crown; 4= plaque covering at least 1/3 but less than 2/3 of crown; 5= plaque covering at least 1/3 but less than 2/3 of crown.

a) Assessments at 2 weeks
b) Assessments at 4 weeks

Figure 3.a

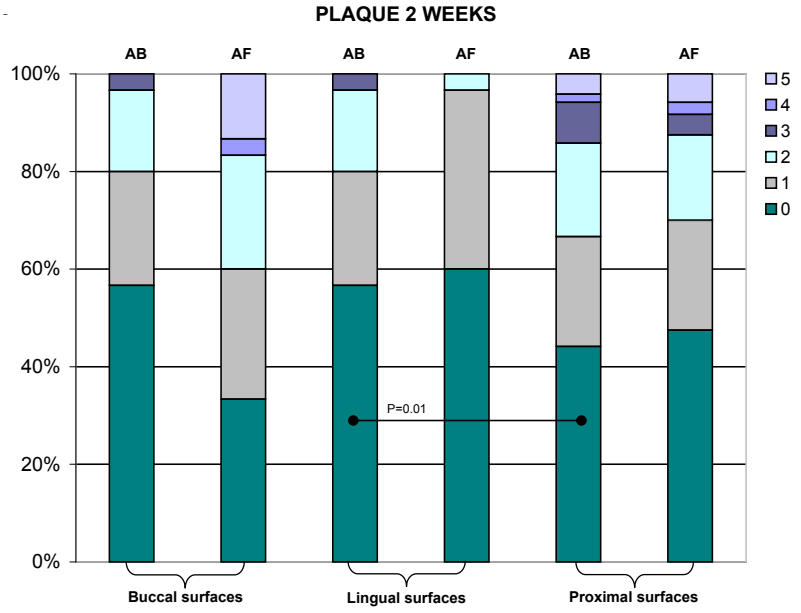

Figure 3.b

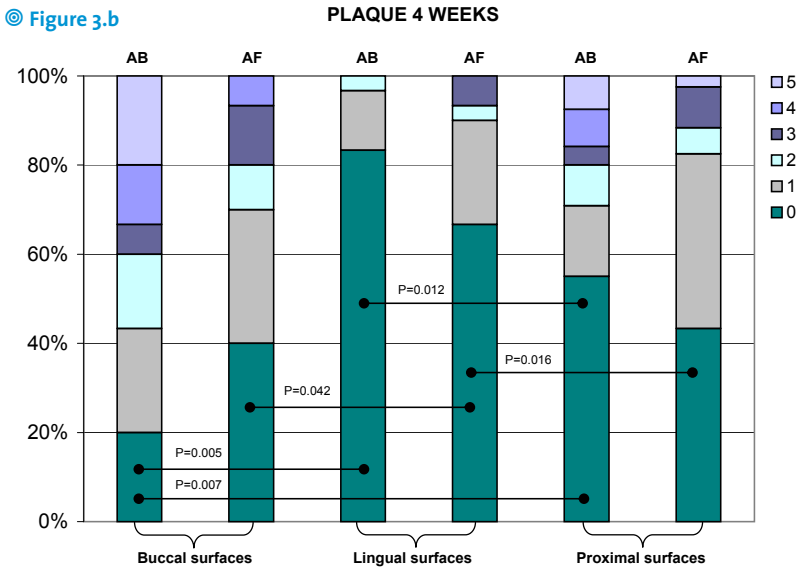

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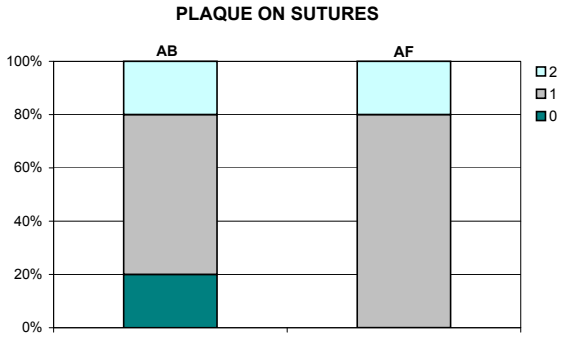
Figure 4. Frequency distribution of plaque on sutures after 2 weeks of rinsing with alcohol-based (AB) 0.1% chlorhexidine or alcohol-free (AF) 0.12% chlorhexidine solutions. 0= no plaque, 1=thin plaque, 3= moderate/abundant plaque.



rience. At 2 weeks, patients rated solution taste fairly equally [6.1 (2.8) for AB and 6.0 (2.3) for AF]. At 4 weeks, taste values in the AB group were 4.6 (2.5) and in the AF group, 6.9 (3.3); patients tended to prefer AF (P = 0.050). Taste change during the study period was equal for the groups -3.7 (3.3) for AB and 3.4 (2.3) for AF at 2 weeks and slightly higher at 4 weeks [4.9 (2.8) and 4.5 (2.5) for AB and AF, respectively]. Smarting at 2 and 4 weeks was low in both groups: 2.2 (3.2) and 1.3 (2.2) in the AB group and 1.0 (1.5) and 1.9 (2.0) in the AF group, respectively.

At 2 and 4 weeks, patients' assessments of tooth staining after rinsing were 4.7 (3.0) and 4.0 (2.5) for AB and 4.6 (3.3) and 3.5 (2.4) for AF, respectively. No significant between-group differences were found at either assessment for change in taste, smarting, or tooth staining.

Discussion

The present study found prevention of dental plaque formation when rinsing postoperatively with a CHX solution that did or did not contain alcohol to be of the same magnitude as found by others (17, 20, 30). No significant difference in plaque inhibitory effect between alcohol-based and alcohol-free solutions was found; this agrees with the findings of other investigators (17, 20, 30).

The patients in this study tolerated the side effects of CHX rinsing well. The only notable difference in patient experience between the two solutions was that the patients who rinsed with alcohol-based CHX in the first assessment period and then switched to alcohol-free CHX showed a tendency to prefer the taste of the alcohol-free solution. This finding is in line with the finding of *van Strydonck et al.*(30), who reported that patients preferred the taste of alcohol-free over alcohol-based CHX. The same study, however, reported the alcohol-free solution to have a poorer after-taste and longer duration than the alcohol-based solution. The patients in our study tolerated the after-taste of the alcohol-free solution better than the patients in the *van Strydonck et al.* study (30). Our use of a 0.1% solution instead of the 0.2% solution used by these authors, however, may explain this.

The frequency distribution of plaque showed that only 48%–56% of the sites were free of plaque at both assessments in both groups. Less plaque was found at lingual sites. Interproximally, plaque-free sites varied between 43% and 55% in the groups. The distribution of plaque on different surfaces found in this study corresponds to the pattern of dental plaque formation after refraining from mechanical cleaning that *Furuichi et al.* reported(9). They found least plaque at lingual sites and most plaque at interproximal sites. Researchers have reported that chlorhexidine penetration is less efficient interproximally (6, 24).

Plaque was frequently found on the surgical sutures in both groups. Plaque formation and retention on sutures and tissue reactions may be influenced by the type, size, and resorption profile of the suturing material (2, 14, 15, 21). Monofilament suture material retains less plaque than braided material (24), which may partly explain our finding since we used braided material. Another explanation, however, is that the patients did not follow instructions for rinsing technique and duration. Our finding that only about 50% of the tooth surfaces were plaque free after 4 weeks of CHX rinsing supports this. *Horwitz et al.* found that patients tend to use only 45% of the prescribed volume of CHX (11).

Stressing the benefit of postoperative rinsing to patients is essential. Evidence is strong that the patient remembers surprisingly little, usually less than 50% of the information given at ordination (16). Because verbal information may be incomplete, difficult to understand, or forgotten by the recipient, written information is an important complement. Studies have shown that patients request written information. Moreover, it increases understanding and adherence and improves the chance of a successful outcome (16).

The present pilot study had a cross-over design, but for obvious reasons, there was no wash-out period between the two mouth rinses. The absence of a wash-out period might have increased the risk of carry-over effects and influenced the results. Although concentrations of CHX in the saliva occur up

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to 24 hours after rinsing, levels are already 30-fold lower at 12 hours (4). To remove the risk of carry-over effects in comparisons of various antiseptic compounds after periodontal surgery, a parallel-group design may be more suitable; the parallel design, however, requires larger group sizes to achieve statistical power.

Conclusion

No significant differences between alcohol-based 0.1% chlorhexidine solution and alcohol-free 0.12% solution were found in plaque levels at 2 and 4 weeks after postoperative rinsing. Patients tolerated both solutions well regarding taste, taste change, staining, and smarting. Plaque was found on sutures to the same extent in both groups.

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Corresponding author:
Dr Helena Olsson
Department of Periodontology
The Institute for Postgraduate Dental Education
P.O. Box 1030
SE-551 11 Jönköping Sweden
E-mail: Helena.Olsson@lj.se

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Homocystinuria and oral health. A report of 14 cases

MARGITHA BJÖRKSVED[1], KRISTINA ARNRUP[2]

Abstract

◎ The aim of this study was to explore the oral health in Swedish individuals with the diagnosis of homozygote cystathionine β synthase–deficient homocystinuria (HC), a rare disorder of amino acid metabolism affecting connective tissue, in which the phenotypic abnormalities include dislocation of the optic lens, skeletal abnormalities, thromboembolic events, and sometimes mental retardation. Further aims were to evaluate the oral findings against previous oral observations in a medical case report, such as high narrow palate, mandibular prognathia, crowding and early eruption of teeth.

Every hospital in Sweden was contacted, with the inquiry of patients with diagnosis of HC, which resulted in 14 individuals participating in oral clinical examination.

The oral findings evaluated against previous medical case reports showed to be partly in accordance with previous observations.

Dental health showed to be compromised in a majority of cases. Together with the fact that methionine restriction (low-protein diet) is involved in the treatment of the condition and might result in a diet high in sugars, this points out the role of regular dental checkups and preventive oral care for individuals suffering from HC.

In addition, short dental roots were a finding not previously reported in the literature. All the studied cases had central maxillary incisors with short roots, when compared to reference values used.

Key words

Oral health, amino acid metabolism, extracellular matrix, connective tissue, oral manifestations

[1]Department of Orthodontics, Postgraduate Dental Education Centre, Örebro, Sweden and
Department of Orthodontics, Eskilstuna, Sweden
[2]Postgraduate Dental Education Centre, Örebro, Sweden and
School of Health and Medical Sciences, Örebro University, Örebro, Sweden and
Department of Behavioural and Community Dentistry, Institution of Odontology, the Sahlgrenska Academy, Göteborg University, Göteborg, Sweden

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Homocystinuri och oral hälsa. En studie av 14 individer

MARGITHA BJÖRKSVED, KRISTINA ARNRUP

Sammanfattning

◎Syftet med denna studie var att undersöka oral hälsa hos svenska individer med diagnosen homocystinuri pga. brist på enzymet cystationin β syntas (HC), en sällsynt ämnesomsättningsrubbning av svavelhaltiga aminosyror, som påverkar bindväven, med fenotypiska avvikelser såsom linsdislokation, skelettala avvikelser, blodproppar och ibland mental retardation. Ytterligare syften var att jämföra de orala fynden med tidigare orala observationer som beskrivits i medicinsk litteratur, såsom förekomst av högt smalt gomvalv, mandibulär prognati, trångställning och tidig eruption av tänder.
Alla sjukhus i Sverige kontaktades, med förfrågan om patienter med diagnosen HC, vilket resulterade i 14 individer som deltog i oral klinisk undersökning.

Orala fynd överensstämde delvis med de observationer som tidigare dokumenterats. En majoritet av individerna visade sig ha försämrad dental hälsa, vilket understryker vikten av regelbundna tandhälsoundersökningar och förebyggande behandling för individer som lider av HC. Detta är av särskild vikt då behandling av sjukdomen bl.a. kan bestå i att minska metionin intaget (proteinfattig diet), vilket kan bidra till sockerrik diet och därmed påverkan på den dentala hälsan.
Därtill var korta tandrötter ett fynd, som inte tidigare rapporterats. Alla individer i studien hade centrala överkäksincisiver med korta rötter, vid jämförelse med referensvärden.

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Introduction

Homocystinuria due to cystathionine β-synthase (CBS) deficiency, or so-called classic homocystinuria (HC), represents the second most common disorder of amino acid metabolism, with a reported frequency of 1 in 200 000–344 000 (21) and was first described by *Carson & Neill* in 1962 (3).

This disease is caused by homozygous defects in the gene encoding for the enzyme CBS in chromosome 21 (23) and has an autosomal recessive heredity (21). HC is classified as a secondary disorder of connective tissue (21), in which phenotypic abnormalities are due to defects in the extracellular matrix (19). The phenotypic abnormalities range from mild to severe (22), and include dislocation of the optic lens, skeletal abnormalities (such as osteoporosis, scoliosis and tall stature), thromboembolic events (which often prove to be lethal), and sometimes mental retardation (19, 21, 22).

The diagnosis is made by the presence of phenotypic abnormalities and the measurement of fasting plasma total homocysteine and methionine concentrations (21, 26). Direct enzyme assay confirms the diagnosis of CBS deficiency (26).

Treatment of the condition involves targeting different sites in the methionine cycle with supplementary vitamins B6 and B12, folate, betaine and methionine restriction, trying to minimize the effect of CBS-deficiency (19, 26).

Satisfactory pathophysiological explanations for the clinical manifestations found in different disorders affecting connective tissue are often lacking. This is the case in CBS-deficient homocystinuria, even though there have been many studies since the 1970s trying to clarify the pathogenesis. It was *McKusick* (18) who first proposed that excess homocysteine might interfere with the normal synthesis of collagen cross-links, thus accounting for the development of osteoporosis. Since then, there have been studies pointing out that excess homocysteine not only interferes with formation of collagen cross-links (15, 21) and prevents insolubility of fibrils (7, 29), but also that the possible molecular mechanisms of homocysteine toxicity are thought to be due to oxidant stress (5, 14, 27, 28), protein thiolation (5, 9, 16), and protein homocysteinylation (11), which contribute to the pathogenesis of the phenotypic abnormalities.

Whether these are the pathophysiological explanations for the oral manifestations described in homocystinuric cases in the medical literature (19, 24), we cannot be sure. Two case studies report on high narrow palate (similar to that in Marfan syndrome), mandibular prognathia (as an expression of general overgrowth), crowded and irregularly aligned teeth, early eruption of teeth (19) and white spots or hypoplasia in patients with homocystinuria (24).

The aim of this study was to investigate and describe the oral findings in individuals with HC in Sweden, and to compare the findings with the few oral observations reported in the medical literature. This study may also bring further knowledge about considerations needed in the dental treatment of individuals suffering from HC.

Material and methods

Study design and sample

All departments of medicine, internal medicine, eye, and rehabilitation in every hospital in Sweden were contacted by letter or telephone, with the inquiry of patients with diagnosis of homozygote CBS-deficient homocystinuria (HC), resulting in 15 individuals, nine females and six males, consenting to participate in the study. There were no identified homozygote CBS-deficient individuals who did not consent to participate in the study.

The participants were sent an information letter about the study, together with an answer form, where they could choose whether to participate in a clinical oral examination or with records from previous clinical examinations performed by their general dentist, or both. One of the 15 individuals was excluded from the study, because he wished to participate only with incomplete dental records from his general dentist in charge. The remaining 14 individuals participated voluntarily in a clinical oral examination by one of the authors of the study (M.B) at a dental clinic near their home, with access to excellent equipment and optimal lighting. A standardized oral examination protocol was used, and in the following study report, these individuals will be referred to as individuals A to N.

The study was approved by the research ethics committee of the Örebro County Council.

Records and registrations

The records consisted of anamnestic data, clinical data, panoramic radiograms, available cephalograms, photographs, and dental casts from clinical oral examinations. Registrations of occlusion and dental crowding were made from dental casts, and photographs and registrations of jaw morphology were made according to ocular examination at clinical oral examination and in dental casts.

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Occlusion was registered according to the Angle classification (1) and dental crowding was measured in dental casts according to the current clinical routine, where each jaw half is divided into two sections. The available space in each section was measured with a vernier calliper, in half millimeters. Individual N had removable dental prostheses in both jaws, why she was excluded from these registrations. The registrations of dental crowding were insufficient (presented in parenthesis) also in individuals J, K, and M, who had had permanent teeth extracted earlier.

Diagnosis of prognathic mandible and skeletal sagittal jaw relation was made by using the values of the SNB and the ANB angles, according to the Bergen cephalometric analysis (6). Individuals B, C, D, and H had available cephalograms taken in their childhood/adolescence, in which cases cephalometric analysis according to the Bergen cephalometric analysis (6) was carried out.

The presence of white spot or hypoplasia of enamel, in terms of the World Health Organization's definitions of enamel opacity and hypoplasia (30), was registered by ocular examination at clinical oral examination and in photographs.

Dental health, in this study determined by registration of number of filled tooth surfaces in permanent teeth (FS)—the third molar not included, was registered at clinical oral examination and in panoramic radiograms. The number of FS in relation to the number of existing surfaces in permanent teeth is also expressed as a percentage (FS %). These values were evaluated against available reference values in a healthy Swedish population (8).

Dental root crown ratio of the maxillary central incisors was calculated by dividing dental root length by dental crown length, measured in panoramic radiograms according to the method described by *Lind* (13), rounded to the second decimal. Individuals M and N were excluded from the measurement of root crown ratio because of dental prostheses in the maxillary central incisors. The calculations of dental root crown ratio for the maxillary central incisors were evaluated against available root crown ratio calculations in a healthy Finnish population (10).

All registrations in radiograms were studied using a pair of observation binoculars according to *Mattson* (17).

Results

Sample characteristics

The age at diagnosis of homozygote CBS-deficient homocystinuria (HC) in our 14 individuals, five males and nine females, varied between 4 and 45 years, and age at our clinical examination was between 10 and 66 years.

Phenotypic abnormalities, such as dislocation of the optic lens, skeletal abnormalities, and thromboembolic events, were common among the studied individuals and ranged from mild to severe.

All the studied individuals were prescribed medical treatment for HC, such as supplementary vitamin B6 (pyridoxine) and methionine restriction; other common medications for the disease were supplementary vitamin B12, folic acid and betaine.

Dentoalveolar and skeletal conditions

Angle class, presence of high narrow palate and crowding is presented in Table 1.

Three of the four individuals who had cephalograms where cephalometric measurements were performed got the diagnosis of prognathic mandible (Table 1).

Dental status

Three individuals had teeth with enamel opacity (white spot). No hypoplasia was found (Table 2).
The number of permanent teeth varied between 5 and 28, the FS values varied between 0 and 54 and the FS % varied between 0 and 100 (Table 2).
Short dental roots were found in all individuals when the value of root crown ratio in the upper central incisors was measured in panoramic radiograms. All individuals had a root crown ratio differing more than one standard deviation (>-1 SD) and only two had less than -2 SD, compared with the reference values used (Fig. 1).

Discussion

In Sweden, where the suggested frequency of homocystinuria due to CBS-deficiency (HC) is supposed to be in accordance with the suggested frequency in the world, being 1 in 200 000–344 000 (21), it is not likely that the 15 individuals identified by the diagnoses constituted all existing cases at that time. A reported heterogeneity in phenotypic expression according to the actual homozygote mutation in the gene encoding for CBS (25) suggests that an underestimation of the frequencies of HC may be expected. Although HC might be first diagnosed, and medication introduced, when severe symptoms lead patients to seek medical care, treatment from the newborn period might have a potential to prevent or delay clinical manifestations (22). Thus, in non-screening countries, the phenotypic manifestations

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Table 1. Dentoalveolar and skeletal conditions, including Angle class, high narrow palate, available space, and skeletal sagittal jaw relations

Individual	Age at study	Angle class	High narrow palate	Available space upper jaw	lower jaw	Skeletal sagittal relations	
				mm	mm	SNB	ANB
A	27	I	-	-2	-7		
B	42	II	-	-8	-7.5	86.5°	-2.5°
C	44	II	-	0	-13	88°	3°
D	10	II	-	-4.5	-7.5	75°	1.5°
E	48	I	-	0	-5		
F	31	II	-	-4.5	-5.5		
G	14	III	-	-16	-14	85°	0°
H	30	I	-	0	-0.5		
I	48	I	-	0	-1		
J	58	II	-	-2.5	(+1.5)		
K	39	II	-	0	(+3)		
L	30	I	-	-4	-3		
M	66	I	+	(+1)	(+7)		
N	61	I	-	No teeth	(-5)		

Available space is written in parentheses in the individuals that had had permanent teeth extracted.
Age when the cephalograms were taken were: Individual B: 14 yrs; C: 16 yrs; D: 9 yrs; G: 14 yrs.

Table 2. Dental status, including number of teeth, filled tooth surfaces (FS), filled tooth surfaces/existing tooth surfaces (FS %) and number of teeth with enamel opacity (white spot)

Individual	Age at study	Number of permanent teeth	FS	FS %	Teeth with enamel opacity
A	27	28	15	12	0
B	42	28	19	15	0
C	44	21	22	23	1
D	10	14	0	0	0
E	48	26	41	34	0
F	31	28	11	9	0
G	14	28	2	2	0
H	30	28	27	21	0
I	48	28	29	23	6
J	58	26	26	22	1
K	39	26	30	25	0
L	30	28	19	15	0
M	66	21	69	74	0
N	61	5	20	100	0

Values in bold are higher than the reference values used (19).
The reference values for FS and FS % by age are:
30-year-olds: 9.7 and 7.8 (individuals A, F, H, L)
40-year-olds: 20.7 and 17.2 (individuals B, C, K)
50-year-olds: 36.1 and 30.3 (individual I)
60-year-olds: 52 and 49.3 (individuals J, N)
70-year-olds: 50.6 and 54.8 (individual M)
Reference values for the 10- and 15-year-old group were missing.

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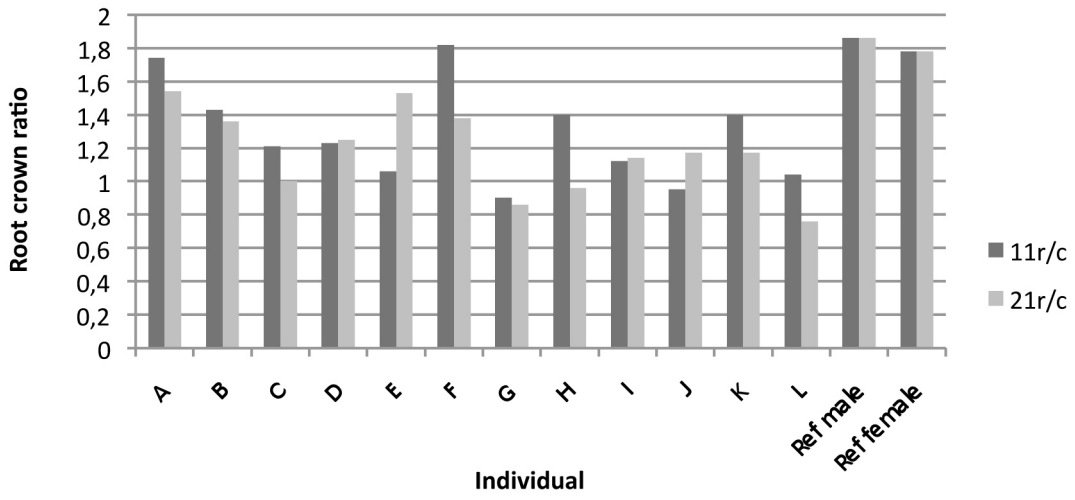
Figure 1. Dental root-crown ratio Measured in upper central incisors, tooth 11 (black) and tooth 21 (gray)



(including oral symptoms) of a connective tissue disorder may be of importance in the identification and early diagnostic process of HC.

The dentoalveolar and skeletal conditions were, in our cases, only partly in accordance with previous case reports (19, 24). There was a great heterogeneity according to the amount of crowding among the studied individuals, even though the majority of cases had presence of crowding ≥2 mm, which is more than expected, according to reference norm values. When looking at dental status, the picture is heterogeneous, but there were more cases with compromised dental health than without, based on the values of FS % evaluated against the reference values used (8). One might agree that there is a role for information about the importance of regular dental checkups and preventive oral care for individuals suffering from homocystinuria, as has been pointed out by the studies lacking confirmation about compromised oral health (4, 20).

Our finding of short dental roots in the upper central incisors has not been previously described in the literature on HC. It was the unexpected findings of short dental roots at examination of the radiograms that suggested a demand for measurement of dental root length in the individuals in this study. There was no obvious connection between root crown ratio and age at diagnosis, duration of treatment, or age at examination. The reference root crown ratios were from healthy men and women with the mean ages of 18 years and 18.6 years respectively, though, which was younger than most of our studied individuals. However, root lengths for all tooth types have been evaluated between 25 and 45 years of age, in both males and females, with no significant age changes reported (2).

Our studied individuals with short-rooted teeth did not allow analysis of the root lengths at their emergence, nor their development after that. The aetiology of the short roots in the individuals in our study could be aberrations during dental development or later shortening, or both. The aetiology might be of environmental or systemic origin, but barely local, because there were more teeth affected than the central incisors.

With regard to environmental factors such as trauma and/or orthodontic forces (12) as possible causes of short dental roots in the studied individuals, one individual (C) had a history of trauma to one of the upper central incisors and orthodontic treatment with fixed appliances. Four additional individuals (A, D, K, and G) had a history of interceptive orthodontic treatment, not known to cause dental damage or root shortening under normal conditions. If neither age nor environmental factors seem to be the most likely reason for short dental roots in the studied individuals, there is reason to discuss and explore the systemic causes.

An obvious limitation of the study was the limited number of subjects of varying ages, although 14 cases are many regarding how few diagnosed individuals there actually are. Other limitations of the

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study were the limited number of cephalograms and dental records from previous clinical examinations at tooth shedding ages, only available for 4 and 6 individuals, respectively.

To summarize, the examined CBS-deficient homocystinuric individuals expressed a heterogeneous pattern of oral manifestations of more or less obvious connective tissue origin. Referring to clinical dental practice, it might be concluded that dental checkups and preventive oral care for these patients is important, because of the risk of compromised dental health. Regarding the discovery of short dental roots, it might be suggested that root length should be carefully evaluated before dental treatment in individuals suffering from HC.

Research to survey the oral conditions in HC should be maintained. It may contribute to awareness of possible manifestations, early diagnosis and improved treatment to the individuals suffering from the disorder. This study brings attention to the pathogenesis/presence of short dental roots and the heterogeneity of oral manifestations in HC. If the oral manifestations are of a systemic origin, depending on excess of homocysteine affecting the extracellular matrix and connective tissue, remains to be explored.

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Corresponding author:
Dr Margitha Björksved,
Department of orthodontics
Kungsg. 21 A
SE-631 88 Eskilstuna, Sweden
E-mail: margitha.bjorksved@dll.se

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