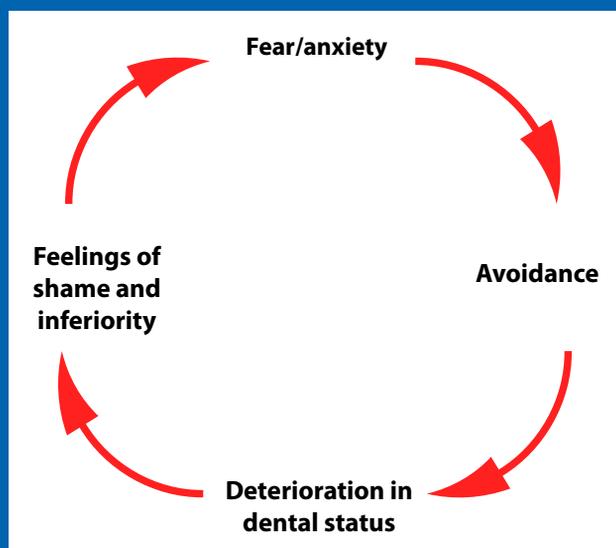


Swedish Dental Journal

Scientific Journal of The Swedish Dental Association



Psychosocial and dental factors in the maintenance of severe dental fear

page 121

No. **3/10**
Vol.34 Pages 121-176

CONTENTS

Psychosocial and dental factors in the maintenance of severe dental fear

Wide Bohman, Lundgren, Berggren, Carlsson **121**

Scanning electron microscopic and X-ray micro analysis on tooth enamel exposed to alkaline agents

Taube, Steiniger, Nietzsche, Norén **129**

Eating disorders and signs and symptoms of temporomandibular disorders: A matched case-control study

Johansson, Johansson, Unell, Norring, Carlsson **139**

Temporomandibular disorder pain in adult Saudi Arabians referred for specialised dental treatment

Al-Harthy, Al-Bishri, Ekberg, Nilner **149**

Duration of orthodontic treatment in conjunction with orthognathic surgery

Slavnic, Marcusson **159**

Management structures and beliefs in a professional organisation. An example from Swedish Public Dental Health Services

Ordell, Söderfeldt **167**

Swedish Dental Journal

Scientific journal
of the Swedish Dental Association
and the Swedish Dental Society
ISSN: 0347-9994

Editor-in-chief

Professor Göran Koch, Jönköping

Associate Editors

Professor Gunnar Dahlén, Göteborg
Professor Björn Klinge, Stockholm
Professor Ulf Lerner, Umeå
Professor Lars Matsson, Malmö

Advisory Editorial Board

Assoc. prof. Michael Ahlqvist, Stockholm
Assoc. prof. Annika Björkner, Göteborg
Professor Dan Ericson, Malmö
Assoc. prof. Malin Ernberg, Stockholm
Professor Anders Gustafsson, Stockholm
Professor Eva Hellsging, Stockholm
Professor Anders Hugoson, Jönköping
Professor Ingegerd Johansson, Umeå
Professor Åke Larsson, Malmö
Professor Tomas Magnusson, Jönköping
Professor Margareta Molin Thorén, Umeå
Assoc. prof. Peter Nilsson, Jönköping
Professor Arne Petersson, Malmö
Odont. dr. Karin Sjögren, Göteborg
Professor Björn Söderfeldt, Malmö
Professor Svante Twetman, Köpenhamn
Professor Jan van Dijken, Umeå
Professor Ulf Örtengren, Tromsø/Göteborg

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
e-mail: SDJ.tit@tandlakarforbundet.se
Bank: Skandinaviska Enskilda Banken
Bankgiro: 404-4699 Postgiro: 45 86 34-3

Subscriptions

Sweden: SEK 900 Others: SEK 1 200
(Supplements are not included.)
For subscriptions delivered to addresses within
the European Union. Please notice: If you have
a VAT registration number you must provide
this. Otherwise, please add your local VAT to
the above price in SEK.

Printing office

Ljungbergs Tryckeri AB
264 22 Klippan

Instructions to authors

Introduction

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

The Manuscript

Three complete copies of the manuscript should be sent to the Editor-in-chief Professor Göran Koch at the Editorial address (see beside). The paper should be in English using English spelling, be typed double-spaced with one-inch margins. The format of the manuscript should be arranged as follows:

Title Page, Abstract, Sammanfattning (in Swedish including title), Introduction, Material and Methods, Results, Discussion, Acknowledgements, References, Figures Legends, and Tables.

The letter attached to the manuscript should be signed by all the authors.

When the paper has been accepted for publication the author will be asked to supply an updated final manuscript on disk together with two complete manuscripts.

The Title Page should contain in the following order: A concise and covering title, authors' full names (without titles), affiliation(s) of the author(s) including city and country, Key-words (according to Index Medicus and not more than 5), Running title and name and contact information of the corresponding author.

The Abstract should be short and concise and not exceeding 300 words. The Swedish Sammanfattning can be somewhat more extensive.

References

In the reference list the references should be arranged in alphabetical order and numbered consecutively by Arabic numerals. Indicate references in the running text by using the Arabic numeral within brackets.

Abbreviations should follow "List of Journals indexed in Index Medicus". (<http://www.nlm.nih.gov>). Examples of references are presented below.

Article:

Helm S, Seidler B. Timing of permanent tooth emergence in Danish children. *Community Dent Oral Epidemiol* 1974; 2:122-9

Book:

Andreasen JO, Petersen JK, Laskin DM, eds. Textbook and color atlas of tooth impactions. Copenhagen: Munksgaard, 1997

Illustrations should be numbered in sequence with Arabic numerals. Legends to all the illustrations should be on a separate sheet. Author's name and figure number should be written on the back of each illustration. No extra cost for color figures. Each Table should be written on a separate sheet. They should be numbered with Arabic numerals and each should have a heading.

Reprints are not generally available.

The main author will receive 20 numbers of the issue where the paper is published. A pdf of the article is also sent to the main author on request.

Galley proof will be sent to the author and should be returned to the Editor without delay.

Page charge will be due if the article is longer than 6 printed pages. For excess of pages the charge is 1 000 SEK per page.

Supplements can be arranged, the full cost being paid by the author. Contact the Editor.

Psychosocial and dental factors in the maintenance of severe dental fear

ULLA WIDE BOMAN¹, JESPER LUNDGREN², ULF BERGGRENT¹, SVEN G CARLSSON²

Abstract

© The aim was to study the relationship between psychosocial factors and dental status in adult subjects with severe dental fear (DF).

A consecutive sample of 148 adults (mean age 36.1 yrs, range 21-69 yrs) referred for dental fear treatment was investigated using an intake questionnaire on dental attendance and history, psychometric questionnaires on dental fear, general anxiety and depression and a radiographic examination.

The subjects had a mean DFMT (Decayed, Filled, Missed Teeth) score of 18.6 (SD = 5.6). A deterioration in dental status defined as the presence of root remnants was present in 57% of the subjects and was related to the negative consequences of dental fear, general anxiety and depression. Most subjects (84%) reported clinical levels of general anxiety and 46% reported clinical levels of depression.

In conclusion, subjects with severe DF often suffer from psychosocial consequences and distress. This is even more marked if their dental status has deteriorated. The findings support a biopsychosocial vicious circle understanding of the maintenance of DF.

Key words

Behavioural medicine, dental anxiety, depression, anxiety

¹Department of Behavioural and Community Dentistry, Institute of Odontology, Sahlgrenska Academy at University of Gothenburg, Göteborg, Sweden († Deceased May 2009)

²Department of Psychology, University of Gothenburg, Göteborg, Sweden

Psykosociala faktorer och tandstatus vid svår tandvårdsrädsla

ULLA WIDE BOMAN, JESPER LUNDGREN, ULF BERGGREN[†], SVEN G CARLSSON

Sammanfattning

◎ En av tjugo vuxna lider av svår tandvårdsrädsla och klarar inte att genomgå regelbunden tandvård. För tandvården och behandlaren innebär patientgruppen en stor påfrestning, med försök till behandling under svåra omständigheter, ofta avbrutna och inställda behandlingar. Personer med svår tandvårdsrädsla har ofta ett försämrat tandstatus och lider även socialt och känslomässigt av tillståndet. Syftet med denna studie var att närmare undersöka sambanden mellan psykosociala faktorer och objektivt tandstatus hos vuxna personer med svår tandvårdsrädsla.

Materialet bestod av ett konsekutivt urval av 148 vuxna (21-69 år, medelålder 36,1 år) som remitterats för behandling av svår tandvårdsrädsla. Deltagarna besvarade formulär avseende tidigare tandvård, tandvårdsrädsla, generell ångest och depression, och genomgick en röntgenundersökning. Deltagarnas tandstatus mätt med DFMT (decayed, filled, missing teeth) var i genomsnitt 18.6. Ett försämrat tandstatus definierat som minst en rotrest fanns hos 57% av deltagarna, och var relaterat till negativa konsekvenser av tandvårdsrädslan och till generell ångest och depression. En majoritet av deltagarna (84%) rapporterade hög nivå av generell ångest, och 46% rapporterade hög nivå av depression.

Personer som remitterats för behandling av svår tandvårdsrädsla lider ofta av dåligt tandstatus, och av tillståndets psykosociala konsekvenser. Många uppvisar tecken på nedsatt psykisk hälsa. Detta gäller särskilt personer med försämrat tandstatus efter långvarigt eftersatt behov av tandvård. Resultaten ligger i linje med en biopsykosocial modell där olika faktorer kan forma en ond cirkel som vidmakthåller den svåra tandvårdsrädslan.

Introduction

The prevalence of severe dental fear (DF) is around 4-7% among adults (11, 22, 25). DF is similar to specific phobias, because of the pronounced avoidance tendencies and because it interferes in several ways with the afflicted person's life (22). The condition often presents serious problems to the providers of dental care. Studies in population samples (3, 23) and clinical samples (2, 12) show that severe DF is related to poor dental health. Psychological and social problems may accompany long-standing DF, and increased levels of general anxiety, psychological symptoms and negative consequences in social relationships have been reported (1, 18, 21).

Berggren (5) presented a biopsychosocial vicious circle model (Figure 1) to describe how severe DF, together with its psychosocial concomitants, shape and maintain the complex odontological psychosocial disorder of severe DF over time (4, 5, 18, 21). According to this model, an individual's initial DF may lead to the avoidance of dental care. If the necessary treatment is neglected, deterioration in oral status will start and progress. The individual's increased awareness of dental health problems creates feelings of shame and inferiority in contacts with others, followed by increased DF, and so on. Armfield *et al.* (4) used a population-based telephone survey in an attempt to investigate this model empirically. Among respondents reporting the highest DF, Armfield *et al.* found a successive link to avoidance tendencies, dental problems and symptom-driven dental visits, thus supporting their vicious circle model (4).

The aim of the present study was to examine psy-

chological and social distress and dental status in individuals with severe DF, and more specifically how these aspects are related.

Material and methods

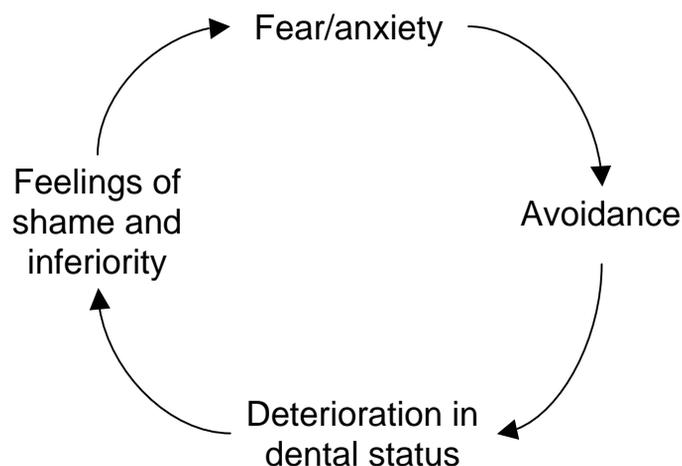
Subjects and procedures

The subjects were consecutively selected from adult patients applying for treatment of severe DF at a specialist Dental Fear Research and Treatment Clinic. A screening process enabled the sole inclusion of subjects who refused conventional dental treatment, were willing to enter the research project, including a radiographic examination, and understood Swedish well enough to answer questionnaires. Patients with a psychiatric disorder that would have an injurious effect on DF treatment were excluded. Thus, no patients with substance abuse disorder, psychotic disorders, severe depression or acute crises were included. The study sample comprised 148 subjects (90 women, 61%), with a mean age of 36.1 years (range 21-69 yrs) (Table 1). Due to an administrative error, data are missing for 8% of the subjects on one item on the intake questionnaire. These subjects did not differ in terms of the measured variables. The Ethics Committee at the University of Gothenburg approved the study. All the participants gave their written informed consent.

Assessments

The participants answered computerised questionnaires as part of their intake examination. Background variables were measured with a questionnaire developed at the clinic. The investigated variables were

© Fig 1. Vicious circle of dental fear, by Berggren (5)



gender, age, dental care attendance (regularity and years since last complete dental treatment) and DF in childhood (Visual Analogue Scale). Social and emotional consequences were assessed as the influence of DF on daily life. The subjects answered seven statements in a yes/no format. Social consequences: my dental fear has a negative impact on my work, relationship with the opposite sex, friends and family. Emotional consequences: my dental fear makes me feel angry, ashamed, depressed.

Dental anxiety was measured using the Dental Anxiety Scale (DAS) (8) and the Dental Fear Survey (DFS) (16). The DAS consists of four items describing imagined dental situations including “appointment tomorrow” and different treatment situations. Responses are scored from 1 (no anxiety) to 5 (extreme anxiety), giving total scores varying from 4 to 20. DAS scores of 8 to 9 in normal patients and of 14 or above among dental phobia patients have been reported (6, 9, 24). The DFS consists of 20 items covering anticipatory anxiety, physiological reactions and situational anxiety. Responses are scored from 1 (no anxiety) to 5 (high intensity of anxiety), giving a total score varying from 20 to 100 and the subscales anticipatory anxiety, physiological reactions and situational anxiety. The subscales have been confirmed by factor analysis (20). DFS scores are 35 to 45 in normal patients and above 70 in patients with extreme DF (24).

General anxiety and depression were measured with the Hospital Anxiety and Depression (HAD) scale, a scale developed for screening for clinically

significant anxiety and depression in medical non-psychiatric patients (26). The items focus on cognitive and emotional aspects of general anxiety and depression, since physical symptoms could be attributed primarily to medical disease or treatment relevant to medical patients. The scale consists of 14 items on a four-point scale, range 0-3, forming the two subscales of anxiety (HAD-A) and depression (HAD-D) and giving total scores varying from 0-21 on each subscale. A higher score is indicative of more distress. The HAD is a reliable and valid measurement of the presence and severity of anxiety and depression (7, 13, 19). A recent review article concludes that the 7/8 cut-off to detect anxiety and depression at clinical level has empirical support in both general population and clinical samples (7) and this cut-off will be used in the present study.

Dental status. A full-mouth radiographic examination was performed on each patient at the Clinic of Oral and Maxillofacial Radiology, Public Dental Service Västra Götaland. Three dentist students were involved in the examination and the registrations were calibrated by a radiology specialist and one of the authors (UB). In uncertain cases, the radiology specialist was consulted for consensus in registration. The variables that were registered were the number of missing teeth (third molars excluded), the number of decayed teeth and the number of filled teeth. The variable Root Remnant (RR) was included as an indicator of long-term avoidance of dental treatment in spite of obvious need. Root remnant was defined as the total destruction of the crown of the

© **Table 1.** Age, gender distribution, dental status and general anxiety (HAD-A) and depression (HAD-D) for the total group and a comparison between subjects without root remnants and with root remnants.

	Total group n = 148	Root remnants	
		No n = 63	Yes n = 85
Male / Female (%)	39 / 61	38 / 62	40 / 60
	mean (sd)	mean (sd)	mean (sd)
Age, yrs	36.1 (9.9)	33.7 (6.8)	38.0 (11.3)*
Decayed teeth	8.1 (5.2)	6.0 (4.4)	9.6 (5.2)**
Missing teeth	3.4 (4.0)	2.1 (2.9)	4.5 (4.3)**
Filled teeth	7.1 (4.8)	7.7 (4.9)	6.6 (4.7)
DMFT	18.6 (5.6)	15.7 (6.1)	20.7 (4.9)**
DAS	17.2 (2.6)	17.1 (2.5)	17.3 (2.7)
DFS	79.8 (12.5)	79.0 (11.9)	80.5 (13.0)
HAD-A	12.4 (5.0)	11.1 (4.8)	13.3 (4.9)**
HAD-D	7.1 (4.2)	5.8 (3.4)	8.0 (4.5)**

*p < 0.05

** p < 0.01

tooth due to an advanced carious lesion. DMFT was calculated by summing up the number of Decayed, Missing and Filled Teeth.

Statistical methods

Chi-square analyses were used to test for differences between frequencies. The non-parametric Mann-Whitney test was used to compare groups in terms of continuous variables. Spearman's rank correlation coefficient was used to examine the correlation between continuous variables. All data analysis was processed in SPSS version 17.0.

Results

The subjects reported high levels of dental fear (Table 1) and a high degree of avoidance behaviour: 32% of the subjects never attended dental care, 55% attended dental care irregularly or when they had acute symptoms, while 13% reported more regular attendance although they were unable to complete treatment. The median time since the last full dental treatment was seven years, and 26% had not had full dental treatment for more than 15 years. A large majority, 92%, reported at least one negative emotional consequence of DF, and 64% reported at least one social consequence.

According to the 7/8 cut-off score of HAD, the subjects reported a high level of general anxiety ($M = 12.4$), and depression just below the clinical range

($M = 7.1$) (Table 1). One hundred twenty-four subjects (84%) reported a high level of general anxiety, and 68 subjects (47%) reported a high level of depression. Examination of co-occurrence of general anxiety and depression showed that a minority (15%) of the subjects reported low general anxiety as well as low depression, 39% reported high general anxiety and low depression and 44% reported high levels of both general anxiety and depression (2 subjects reported low general anxiety and high depression).

Subjects with high general anxiety reported more DF than those with low general anxiety (DAS $M = 17.5$, $SD = 2.5$ vs. $M = 15.9$, $SD = 2.9$, $p < 0.01$; DFS $M = 81.2$, $SD = 11.6$ vs. $M = 72.6$, $SD = 14.4$, $p < 0.01$). In contrast, DF ratings did not differ between subjects with low and high levels of depression. Depression, on the other hand, was related to negative social and emotional consequences of DF in all the investigated areas, while general anxiety was related in fewer areas (Table 2). Age was not related to DF, general anxiety or depression. Women reported more DF and general anxiety than did men (data not shown).

Dental status

The study group had a mean DMFT score of 18.6; see Table 1, where the numbers of decayed, missing and filled teeth are also presented. A higher age was related to poorer dental status measured as DMFT

© Table 2. Reported consequences of dental fear, % affirmative answers.

Three comparisons: 1) subjects with low vs. high levels of depression,

2) subjects with low vs. high levels of general anxiety and 3) subjects without vs. with root remnants.

	Depression		General Anxiety		Root remnant	
	low %	high %	low %	high %	No %	Yes %
Social consequences^a						
<i>Dental fear interferes with:</i>						
Relationship with family	17	30**	27	36	28	40
Dating relationships	18	26*	23	34	18	43**
Relationship with friends	23	36**	18	48**	22	61**
Work	14	21*	14	28	20	30
Emotional consequences^b						
<i>Dental fear makes me:</i>						
Angry	15	39**	25	26	18	32*
Ashamed	51	70*	38	64*	51	68
Depressed	44	66**	42	56	41	63**

* < 0.05 , ** < 0.01 , ^an = 136, ^bn = 147

($r = 0.30$, $p < 0.01$). Dental status did not differ between men and women (data not shown).

Of the total group, 85 subjects (57%) had a dental status with at least one root remnant (RR) (range 1-12, $M = 3.0$, $SD = 2.5$), and these subjects were compared with the 63 subjects without RR (Table 1). Subjects with RR were older but did not differ in gender distribution from those with no RR. Subjects with RR had avoided dental care for a longer period (13 yrs vs. 7 yrs), reported never visiting a dentist to a higher degree (39% vs. 23%, $p < 0.05$), and reported having been more fearful of dental treatment as children ($M = 75.3$ $SD = 30.1$ vs. $M = 60.9$, $SD = 33.1$, $p < 0.001$), compared with subjects with no RR. Subjects with RR had an overall poorer dental status, as measured with DFMT, although they had slightly fewer (not statistically significant) filled teeth. They reported higher levels of general anxiety and depression than subjects with no RR (Table 1), and also more negative social and emotional consequences of DF (Table 2). The presence of RR was not, however, related to the present level of DF (Table 1).

Discussion

In this clinical sample of adults with severe DF, the majority had a dental status consistent with the avoidance of dental care in spite of a long-standing need for treatment. These subjects reported more negative social and emotional consequences of DF and higher ratings for general psychological distress (general anxiety and depression) compared with subjects with less deterioration in their dental status. This is an important finding, as there are few studies of the relationship between psychological variables and objective dental status in patients with severe DF.

The dental health of the total group was poorer than that of the general population. A Swedish epidemiological study from 2005 presents the mean numbers of decayed and filled teeth (DFT) for different age groups: 20 yrs $M = 5.9$; 30 yrs $M = 7.8$; 40 yrs $M = 11.5$; 50 yrs $M = 15.0$ and 60 yrs $M = 17.0$ (14). The mean DFT score of 15.2 for subjects in the present study (with mean age 36.1 yrs) is thus similar to that of the 50-year age group in the reference data. Poorer dental status in individuals with severe DF has been reported previously (2, 3, 12, 23).

It has been argued that DMFT may not be a sufficient measure of dental status in individuals with severe DF (23). DMFT represents the total number of decayed, missed and filled teeth, and an increased number of decayed and missing teeth may be "hidden" by a decreased number of filled teeth, as indivi-

duals with severe DF often undergo less restorative treatment. To examine further the dental status in the study sample we therefore included the variable root remnant (RR) as an indicator of long-term avoidance of dental care in spite of long-standing treatment needs. More than half of the subjects in this study had at least one root remnant. This result further emphasises the poor dental status in the group and shows, at the same time, the previously reported variability in dental status among individuals with severe DF (2). Subjects with RR also reported more general psychological distress and negative consequences of DF compared with subjects with no RR. The variable RR could be a useful complement in studies of dental status in patients with severe DF. These results underscore the fact that individuals with severe DF often suffer from poor oral health and psychological distress.

Most subjects in this study reported negative social and emotional consequences of DF, and many subjects also reported high psychological distress in terms of general anxiety and depression. An interesting finding is that depression was more strongly related than general anxiety to negative consequences of DF, which, to our knowledge, has previously only been demonstrated in one small study (10). One interpretation could be that higher ratings of depression indicate an overall worsening status of the individual, when negative consequences of DF affect larger parts of the individual's life. In fact, as mentioned above, subjects with long-term avoidance of dental care in spite of need for dental care presented with more negative social and emotional consequences of DF and psychological distress than those with less seriously affected dental status.

The introduction presented Berggren's vicious circle model of the shaping and maintenance of severe DF (5) (Figure 1). Based on intuitive understanding and clinical observations, we suggest that our data are compatible with this vicious circle. More specifically, our results indicate that general psychological distress (general anxiety and depression) plays a part in the process of maintaining severe DF, as well as the deterioration of dental status. We are of course aware that the cross-sectional design of this study does not permit conclusions relating to causality. Nonetheless, we find the perspective of circularity valuable, while also recognising that this model remains to be tested in longitudinal studies and in larger samples allowing for statistical analyses of latent variables.

Clinical implications: Our results support previous findings that severe DF affects life in many ways and that many subjects suffer considerable distress. Effective behavioural interventions for the treatment of severe DF are available (17). It is important to provide adequate treatment for these patients, to improve their dental status and general well-being. The use of a short, reliable questionnaire could add valuable information for therapy planning, as additional psychological distress may compromise the behavioural treatment of DF (15).

In conclusion; in this large clinical sample of subjects with severe dental fear, long-term avoidance in spite of need for dental care was related to more social and emotional consequences of dental fear and more psychological distress.

Acknowledgements

This study was supported by the Swedish Research Council grants K2003-99TX-14703-01A and -27VX-14704-01A. We wish to thank Agneta Lith and Magnus Hakeberg for their valuable help.

References

1. Abrahamsson KH, Berggren U, Carlsson SG. Psychosocial aspects of dental and general fears in dental phobic patients. *Acta Odontol Scand* 2000;58:37-43.
2. Agdal ML, Raadal M, Skaret E, Kvale G. Oral health and oral treatment needs in patients fulfilling the DSM-IV criteria for dental phobia: Possible influence on the outcome of cognitive behavioral therapy. *Acta Odontol Scand* 2008;66:1-6.
3. Armfield JM, Slade GD, Spencer AJ. Dental fear and adult oral health in Australia. *Community Dent Oral Epidemiol* 2009;37:220-30.
4. Armfield JM, Stewart JF, Spencer AJ. The vicious cycle of dental fear: exploring the interplay between oral health, service utilization and dental fear. *BMC Oral Health* 2007;7:1.
5. Berggren U. Dental Fear and Avoidance. A study of etiology, consequences and treatment. Thesis. Faculty of Odontology, Göteborg University, 1984.
6. Berggren U, Carlsson SG. Usefulness of two psychometric scales in Swedish patients with severe dental fear. *Community Dent Oral Epidemiol* 1985;13:70-4.
7. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale. An updated literature review. *J Psychosom Res* 2002;52:69-77.
8. Corah N. Development of a dental anxiety scale. *J Dent Res* 1969;48:596.
9. Corah N, Gale E, Illig S. Assessment of a dental anxiety scale. *J Am Dent Assoc* 1978;97:816-9.
10. Goodall EM, Skelly A M File SE. Predictors of dental anxiety and effects of treatment with nitrous oxide and midazolam in dentally phobic patients. *Hum Psychopharmacol* 1994;9:237-44.
11. Hakeberg M, Berggren U, Carlsson SG. Prevalence of dental anxiety in an adult population in a major urban area in Sweden. *Community Dent Oral Epidemiol* 1992;20:97-101.
12. Hakeberg M, Berggren U, Grondahl HG. A radiographic study of dental health in adult patients with dental anxiety. *Community Dent Oral Epidemiol* 1993;21:27-30.
13. Herrmann C. International experiences with the Hospital Anxiety and Depression Scale--a review of validation data and clinical results. *J Psychosom Res* 1997;42:17-41.
14. Hugoson A, Koch G, Gothberg C, Helkimo AN, Lundin SA, Norderyd O, Sjodin B, Sondell K. Oral health of individuals aged 3-80 years in Jonkoping, Sweden during 30 years (1973-2003). II. Review of clinical and radiographic findings. *Swed Dent J* 2005;29:139-55.
15. Kleinhauz M, Eli I, Baht R, Shamay D. Correlates of success and failure in behavior therapy for dental fear. *J Dent Res* 1992;71:1832-5.
16. Kleinknecht RA, Klepac RK, Alexander LD. Origins and characteristics of fear of dentistry. *J Am Dent Assoc* 1973;86:842-8.
17. Kvale G, Berggren U, Milgrom P. Dental fear in adults: a meta-analysis of behavioral interventions. *Community Dent Oral Epidemiol* 2004;32:250-64.
18. Locker D. Psychosocial consequences of dental fear and anxiety. *Community Dent Oral Epidemiol* 2003;31:144-51.
19. Lowe B, Spitzer RL, Grafe K, Kroenke K, Quenter A, Zipfel S, Buchholz C, Witte S, Herzog W. Comparative validity of three screening questionnaires for DSM-IV depressive disorders and physicians' diagnoses. *Journal of affective disorders* 2004;78:131-40.
20. McGlynn FD, McNeil DW, Gallagher SL, Vrana S. Factor structure, stability, and internal consistency of the Dental Fear Survey. *Behav Assessment* 1987;9:57-66.
21. Moore R, Brodsgaard I, Rosenberg N. The contribution of embarrassment to phobic dental anxiety: a qualitative research study. *BMC Psychiatry* 2004;4:10.
22. Oosterink FM, de Jongh A, Hoogstraten J. Prevalence of dental fear and phobia relative to other fear and phobia subtypes. *Eur J Oral Sci* 2009;117:135-43.
23. Schuller AA, Willumsen T, Holst D. Are there differences in oral health and oral health behavior between individuals with high and low dental fear? *Community Dent Oral Epidemiol* 2003;31:116-21.
24. Schuur AH, Hoogstraten J. Appraisal of dental anxiety and fear questionnaires: a review. *Community Dent Oral Epidemiol* 1993;21:329-39.
25. Vassend O. Anxiety, pain and discomfort associated with dental treatment. *Behav Res Ther* 1993;31:659-66.
26. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983;67:361-70.

Address:

Dr Ulla Wide Boman,
Department of Behavioural and Community Dentistry,
Institute of Odontology, Sahlgrenska Academy at University
of Gothenburg
Box 450, SE-405 30 Göteborg, Sweden
E-mail: ulla.wide-boman@vgregion.se

134. Temporomandibular disorders and mandibular function in relation to Class II malocclusion and orthodontic treatment.
Thor Henrikson (1999) 400 SEK
135. On oral disease, illness and impairment among 50-year olds in two Swedish counties.
Lennart Unell (1999) 400 SEK
136. Cancelled.
137. Prosthodontics and the general dentist.
Mats Kronström (1999) 400 SEK
138. Conventional spiral and low dose computed mandibular tomography in dental implant planning.
Annika Ekestubbe (1999) 400 SEK
139. Some characteristics of solid-state and photo-stimulable phosphor detectors for intra-oral radiography.
Eva Borg (1999) 400 SEK
140. On dental trauma in children and adolescents.
Ulf Glendor (2000) 400 SEK
141. On composite resin materials. Ulf Örtengren (2000) 400 SEK
142. Studies on oral health in mentally retarded adults.
Pia Gabre (2000) 400 SEK
143. Integrated jaw and neck function in man.
Hamayun Zafar (2000) 400 SEK
144. Endodontic retreatment. Aspects of decision making and clinical outcome.
Thomas Kvist (2000) 400 SEK
145. Adult patients with treated complete cleft lip and palate: Methodological and clinical studies. Agneta Marcusson (2001) 400 SEK
146. Verbal communication in prosthetic dentistry.
Katarina Sondell (2001) 400 SEK
147. Frequency of radiographic caries examinations and development of dental caries. Agneta Lith (2001) 400 SEK
148. Mutans streptococci – in families and on tooth sites.
Ing-Mari Redmo Emanuelsson (2001) 400 SEK
149. Enamel hypomineralization in permanent first molars. A clinical, histomorphological and biochemical study. Birgitta Jälevik (2001) 400 SEK
150. Effects of masticatory muscle function and bite-raising on mandibular morphology in the growing rat. Andrea Bresin (2001) 400 SEK
151. Masticatory muscle function and transverse dentofacial growth.
Christos Katsaros (2001) 400 SEK
152. On the absorption behaviour of saliva and purified salivary proteins at solid/liquid interfaces. Liselotte Lindh (2002) 400 SEK



The supplements can be ordered from Swedish Dental Journal, Box 1217, SE-111 82 Stockholm, Sweden. Subscription of the supplements can be arranged.

Scanning electron microscopic and X-ray micro analysis on tooth enamel exposed to alkaline agents

FABIAN TAUBE¹, FRANK STEINIGER², SANDOR NIETZSCHE², JÖRGEN G. NORÉN³

Abstract

© The background of this study comprises two clinical cases, where patients exposed to aerosols of an alkaline and surface active cleaning agent developed loss of enamel substance on their teeth, further resulting in loss of teeth and partially destroyed soft tissues. The alkaline cleaning agent consisted of potassium hydroxide and various surfactants. The purpose of this study was to investigate possible changes in morphology and composition in human teeth enamel exposed to alkaline solutions, by means of X-ray micro analysis (XRMA), FTIR-spectroscopic analyses and scanning electron microscopy (SEM). Extracted premolars, exposed to potassium hydroxide solutions and alkaline cleaning solution, were analyzed by means of XRMA and SEM. Enamel powder, exposed to cleaning solution, was analyzed by means of FTIR. The SEM analysis revealed an increased porosity of the enamel surface and partial loss of enamel substance after exposure to alkaline solutions. The XRMA analyses revealed a decrease in carbon concentration while phosphorous and calcium showed no marked changes. The FTIR analyses showed no significant changes in peak heights or peak positions for phosphate, carbonate or hydroxide. It was concluded that human teeth enamel exposed to alkaline solutions showed loss of organic substance, marked pores in enamel surface and loss of substance in the enamel surface.

Key words

Alkaline, dental erosion, exposure, FTIR, occupational, SEM, XRMA

¹Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital, Gothenburg, Sweden

²Centre of Electron Microscopy, Friedrich-Schiller-University Jena, Germany

³Department of Pedodontics, Institute of Odontology, Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden

Svepelektronmikroskopisk och röntgenmikroanalytisk undersökning av emalj som exponerats för alkaliska lösningar

FABIAN TAUBE, FRANK STEINIGER, SANDOR NIETZSCHE, JÖRGEN G. NORÉN

Sammanfattning

⊙ Bakgrunden till studien består av två kliniska fall där patienterna exponerats för alkaliska aerosoler från ett ytaktivt rengöringsmedel och utvecklat skador på tänderna, tandförluster och delvis skadade mjukvävnader. Rengöringsmedlet bestod av kaliumhydroxid och olika ytaktiva ämnen. Avsikten med studien var att undersöka morfologiska och kemiska förändringar av human tandemalj exponerade för alkaliska lösningar med hjälp av röntgenmikroanalys (XRMA), FTIR-spektroskopiska analyser och svepelektronmikroskopi (SEM). Extraherade premolärer exponerades för lösningar av kaliumhydroxid och ett alkaliskt rengöringsmedel under olika tidsperioder, vilka sedan analyserades med XRMA och SEM. Pulveriserad emalj som exponerats för rengöringsmedlet under 15 respektive 48 timmar analyserades med FTIR. SEM analysen visade en porös emaljyta efter exponering av alkaliska lösningar. XRMA analysen visade att koncentrationen av kol minskade i emaljen medan koncentrationen av fosfor och kalcium inte uppvisade några större förändringar. FTIR analysen visade inte några tydliga förändringar varken för fosfat, karbonat eller hydroxid, dvs. sammansättningen av apatitmineralet var oförändrad. Sammanfattningsvis uppvisade tänder exponerade för alkaliska lösningar förlust av organisk substans, tydliga porer i emaljytan och substansförluster i emaljens ytskikt.

Introduction

The background of this study comprises two clinical cases, where two workers in the car reconditioning industry developed erosive damage on their teeth, resulting in loss of teeth and partially destroyed soft tissues. As described in our earlier study (21), the workers had been exposed to aerosols of an alkaline cleaning agent for about 2-3 hours per day for two and a half years. The cleaning agents, hereafter denoted ACS, were based on potassium hydroxide and various surface active components.

Research on dental erosion has so far been focused on risk factors and consumption of acidic food and beverage (1, 13, 18, 19). Studies on specific occupational dental erosion are rare. Prevalence studies have been made on workers exposed to sulfuric or hydrochloric acid in battery industry and surface treatment industry in Africa, Asia and in the United States. A few studies have also been performed in Europe (2, 23). Increased prevalence for dental erosion was found among battery workers and workers in the galvanizing industry (23). In a recent Swedish study, individuals professionally working with silicon based glue were investigated and a significant increase in erosion among workers exposed to vapor of acetic acid was found (7). Swimmers, wine tasters and ammunition manufactures have also been suggested to have an increased prevalence for erosion; however, data are yet too limited to draw any definitive conclusions about the prevalence of occupational dental erosion for these occupations (23).

During erosion, acid and/or surface active agents have been found to interact with the surface of the mineral crystals, but only after they diffused through the plaque, the pellicle, and the protein/lipid coating of the individual crystals themselves. Alkaline solutions seem to have a strong capability in removing such organic matter (12). Exposure to aerosols consisting of alkaline and/or surface active agents might therefore result in enamel damage, in terms of loss of inorganic apatite mineral and organic components.

The present study draws on our preceding study, in which chemical properties of enamel surfaces exposed to alkaline solutions were investigated by means of spectroscopic methods (21). The purpose of the present study was to investigate morphological and compositional changes on human teeth enamel exposed to alkaline solutions by means of scanning electron microscopy (SEM) and X-ray micro analysis (XRMA). Additional FTIR- spectroscopic studies has also been undertaken.

Material and Methods

Chemicals

Potassium hydroxide solutions with concentrations of around 9 moles of OH⁻/dm³ (9M) were prepared by successively adding KOH-pastilles (Merck p.a.) to distilled water (Millipore) in a plastic bottle, while stirring. The final pH value in the equilibrated solution was measured to around 15 at room temperature.

The alkaline cleaning agent (ACA) was provided from the distributor, and had a pH value of around 14 at room temperature. For both solutions, pH was measured with a Jenway pH/mV Meter (model 3510, Essex, UK) general purpose glass bodied combination pH electrode, Jenway (3 M KCl), with 2 point calibration, 2 standard buffers for different pH. It should be mentioned that pH-measurements in very alkaline solutions are to be considered approximate.

Enamel samples and sample preparation

Premolars extracted for orthodontic reasons without any signs of developmental disturbances or caries in the enamel were collected for the analyses. The roots were cut off from the crowns which were mechanically cleaned from plaque with pumice in water and exposed to approximately 20 ml of the alkaline solutions in a plastic jar with a lid.

The SEM analysis was carried out on in total ten crowns; two untreated, four exposed to alkaline cleaning agent and four exposed to KOH solutions for 1, 2, 8 and 20 hours in room temperature, respectively. For the XRMA analyses, five tooth crowns were exposed to alkaline cleaning agent and five tooth crowns exposed to KOH solutions for 1, 2, 4 and 8 hours, respectively. After exposure, the teeth were thoroughly rinsed in de-ionized water and air dried. For the XRMA analyses, 2 unexposed teeth served as controls.

Another 4 teeth were used for complementary FTIR-spectroscopic studies. Small amounts of enamel powder samples, achieved by removing the outermost layer of enamel from selected tooth surfaces with a diamond drill, were placed in sealed Eppendorf Tubes with potassium hydroxide or alkaline cleaning agent added, giving a total volume of 1.5 ml. During exposure, the Eppendorf Tubes were slowly shaken automatically. After exposure times of 15 and 48 hrs in KOH and cleaning agent respectively, the four powder samples was repeatedly washed with distilled water (Millipore) and centrifuged (DW41 Micro centrifuge, 6000 rpm). Prior to the analyses, enamel powder was dried in air at room temperature.

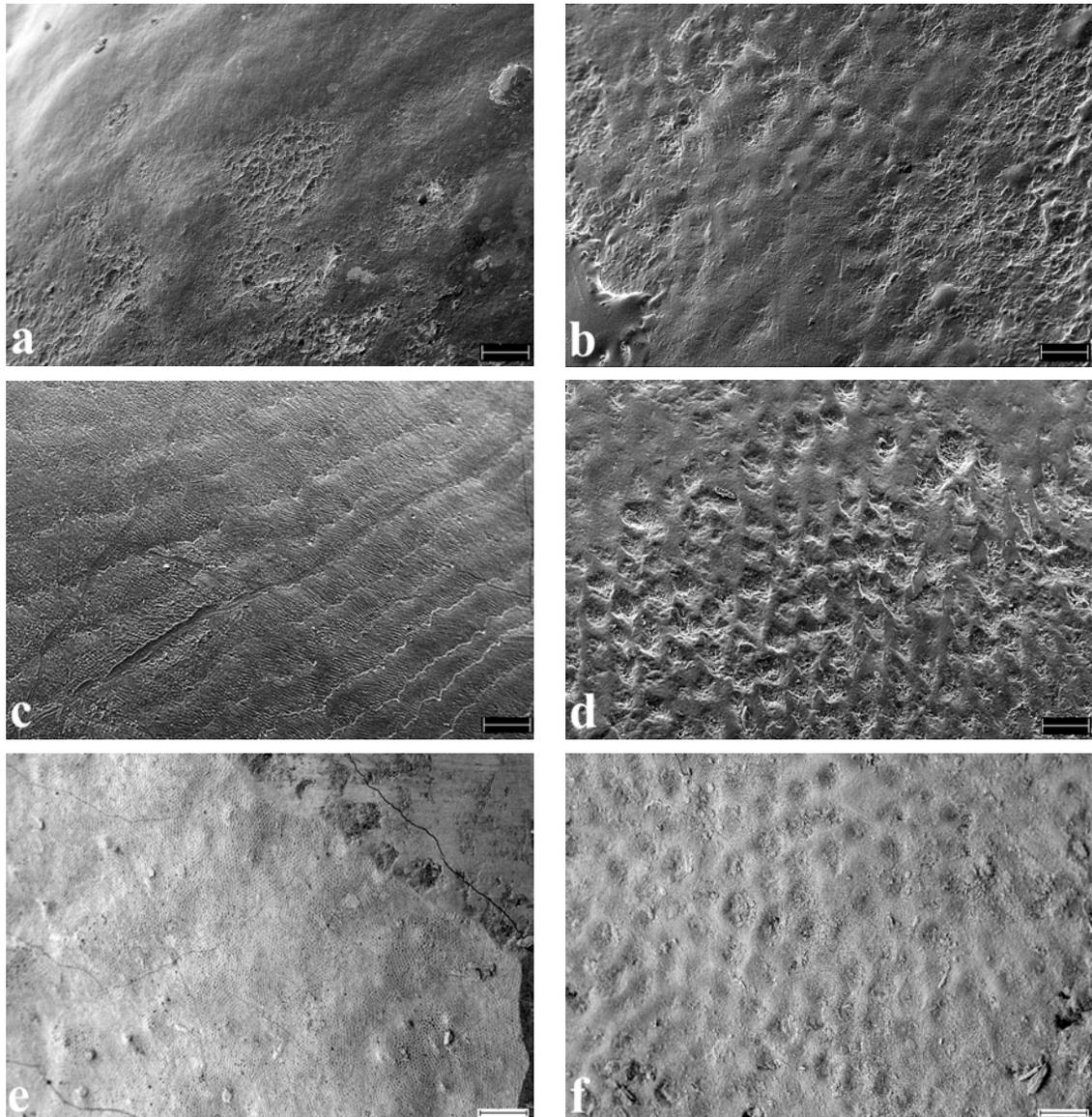
*Scanning electron microscopy and X-ray
micro analysis*

The tooth samples were mounted on sample holders with carbon glue and coated with gold by vapor deposition for SEM, and with carbon for XRMA

analyses. The tooth samples were mounted on the holders in a way that ensured a correct angle for the XRMA in the instrument. The SEM examination was performed in a field emission scanning electron microscope (Gemini IMB, LEO 1530, Germany). The

© **Figure 1.** SEM images of untreated enamel surface and after treatment for 1 hour with KOH and ACS.

- a. Control enamel surface (magn. 100x; bar=100 μ m).
- b. Control enamel surface (magn. 1000x; bar=10 μ m).
- c. Enamel surface after treatment with KOH solution (magn. 100x; bar=100 μ m).
- d. Enamel surface after treatment with KOH solution (magn. 1000x; bar=10 μ m).
- e. Enamel surface after treatment with ACS (magn. 100x; bar=100 μ m).
- f. Enamel surface after treatment with ACS (magn. 1000x; bar=10 μ m).



enamel surface of the samples were analyzed with XRMA for the composition of C, Ca, P, and O in a Philips SEM 515 at 12 keV; EDAX DX4, ECON-detector (Philips, Eindhoven, The Netherlands). For all measurements, the X-rays were detected by a window (150x200 μm) in a magnification of 650 and a tilt angle of 30 degrees. The penetration depth of the electron beam was estimated to 1.5 μm . On each tooth, four measurements were performed on four randomly chosen locations. The relative amounts of C, Ca, P, and O were calculated with a computerized program (Point Electronic DISS 2).

FTIR-spectroscopic analyses

The enamel powder samples were mixed with KBr to a concentration of 0.5% and scanned 128 times with a resolution of 2.0 cm^{-1} . The presented data is an average value. A sample holder filled KBr powder was used as a reference and the spectra were derived

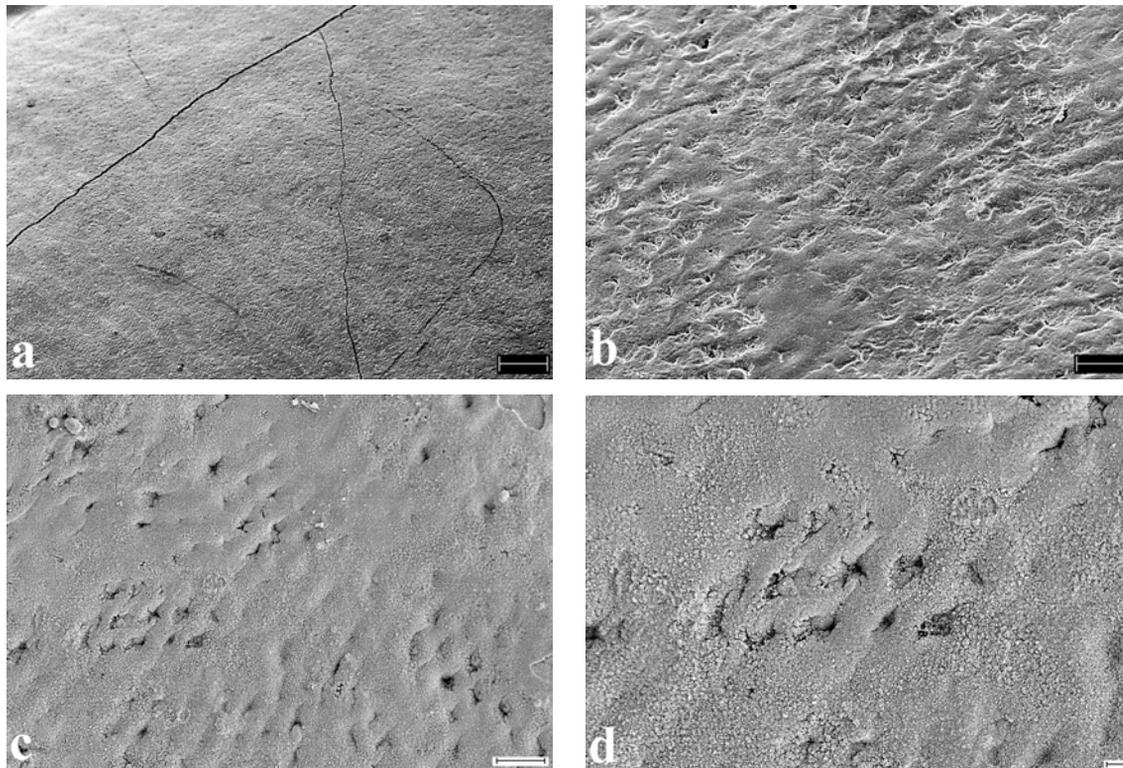
by taking the logarithm of the ratio between the reference and the sample spectrum. The spectrometer used was a Nicolet Magna-IR 560 equipped with a KBr beam splitter, a DTGS (deuterated triglycerine sulfate) detector and an insert cell for diffuse reflectance spectroscopy. The measurements ranged between 400 and 4000 cm^{-1} . The compartment of the spectrometer was constantly purged with dry CO_2 -free air. The diffuse reflectance technique was utilized, in which the incident beam was allowed to be reflected off the ground sample towards an overhead mirror upon which the diffusely scattered rays were collected and measured in the detector.

Ethical considerations

This study was approved by the Health Research Ethics Board of the University of Gothenburg. Teeth from patients requiring the extraction of maxillary first premolars, as part of their orthodontic treat-

© **Figure 2.** SEM images of enamel surfaces after treatment for 2 and 8 hours with KOH solution.

- Enamel surface after treatment for 2 hours (magn. 100x; bar=100 μm).
- Enamel surface after treatment for 2 hours (magn. 1000x; bar=10 μm).
- Enamel surface after treatment for 8 hours (magn. 1000x; bar=10 μm).
- Enamel surface after treatment for 8 hours (magn. 2000x; bar=2 μm).



ment, were used. The extracted teeth were stored in saline prior to exposure and final analysis with the techniques used.

Results

Morphological studies of enamel surfaces

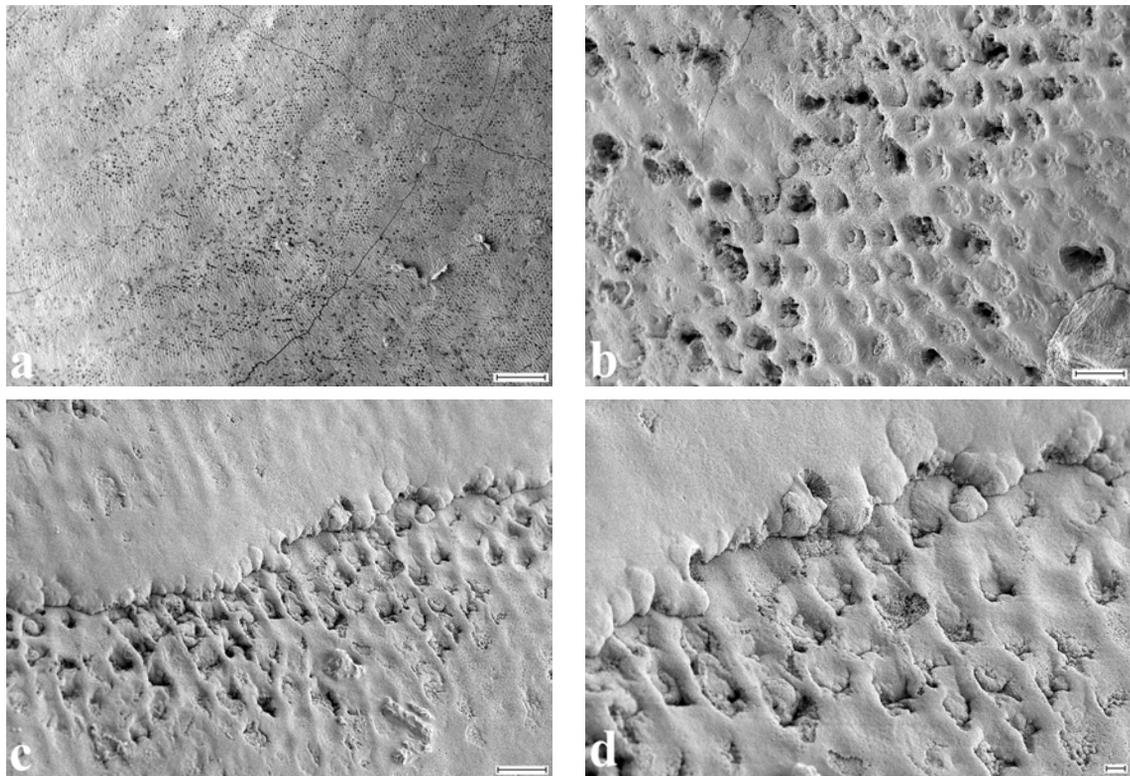
In Figure 1a and b, SEM-images on untreated enamel surface appeared smooth with scratches and in higher magnification the perikymata with prism endings could be seen.

After one hour of exposure to KOH, the enamel surface appeared evenly etched and the prisms, perpendicular to the surface appeared as pores in the surface (Figs. 1c & d). After two hours of exposure, the enamel surface became more eroded and the prism pattern became more evident (Figs. 2a & b). Eight hours of exposure increased the porous character of the enamel surface and the prism ends became deeper (Figs. 3a & b). Loss of substance became apparent after 20 hours exposure with larger areas of enamel loss.

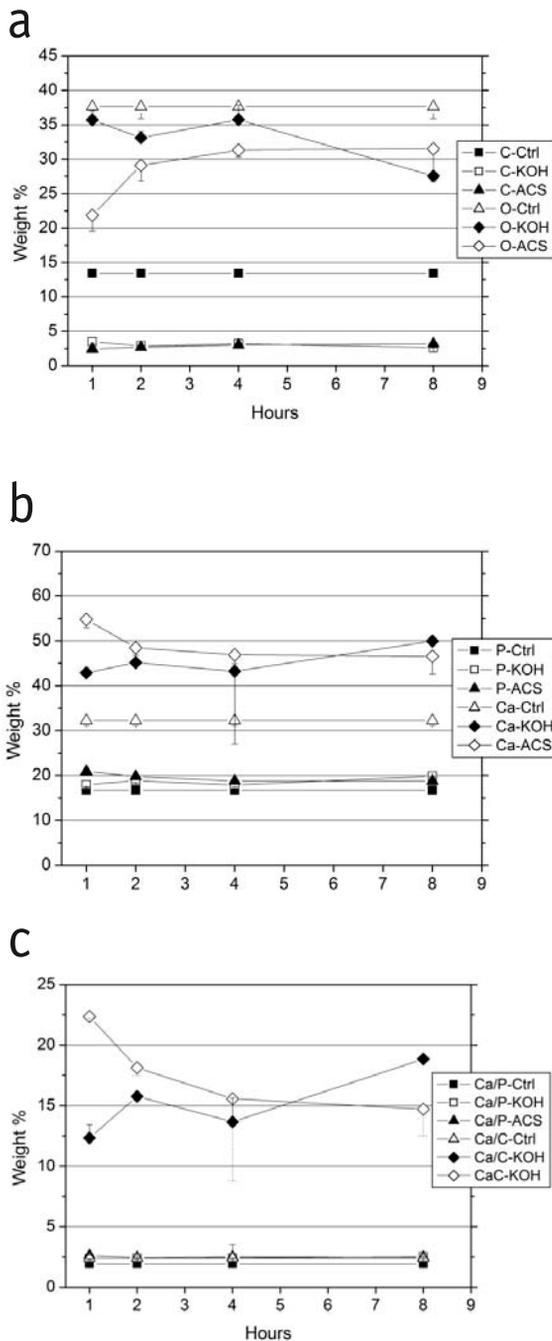
After one hour of exposure to ACS, the enamel surface kept its normal appearance with perikymata, however, with an increased appearance of pores mainly located along the perikymata (Fig. 1e). In higher magnifications, an etch pattern was seen at the prism ends (Fig. 1f). After two hours of exposure, the pores became larger in diameter and a mixture of etch and loss of substance was seen on the enamel surface. The entire surface appeared more or less porous to its character (Figs. 2c & d). After eight hours of exposure, the same pattern was seen, however, with more extensive loss of parts of the enamel surface, resulting in deeper craters in prism ends (Figs. 3c & d). After 20 hours of exposure, the enamel surface started to show signs of loss of enamel substance in the surface. In general, the morphological changes seen in the enamel surface were more marked compared to surfaces exposed to the KOH-solution.

© **Figure 3.** SEM images of enamel surfaces after treatment for 2 and 8 hours with ACS.

- Enamel surface after treatment for 2 hours (magn. 100x; bar=100 µm).
- Enamel surface after treatment for 2 hours (magn. 1000x; bar=10 µm).
- Enamel surface after treatment for 8 hours (magn. 1000x; bar=10 µm).
- Enamel surface after treatment for 8 hours (magn. 2000x; bar=2 µm).



© **Figure 4** Charts for the mean values and standard deviations measured with XRMA in enamel after treatment with KOH ACS=Alkaline cleaning solution and Ctrl=untreated enamel, after 1, 2, 4 and 8 hours exposure, respectively. The standard deviations are given as standing bars for the controls and hanging bars for the tests. a) C=Carbon and O=oxygen. b) P=phosphorous and Ca=calcium. c) The ratios Ca/P and Ca/C.



Elemental composition of enamel by XRMA

Carbon and oxygen

As illustrated in figure 4a, irrespective of media and length of exposure, the carbon concentration decreased to a near constant level, from around 14 weight %, down to 2-3 weight %, indicating a fast initial removal of organics within the first hour of exposure. In case of oxygen, there is a smaller, but clear decrease upon exposure. However, there is no clear correlation with time of exposure. For enamel samples exposed to ACS, a marked decrease was found after one hour of exposure. After two and four hours of exposure, the oxygen content increased and remained constant.

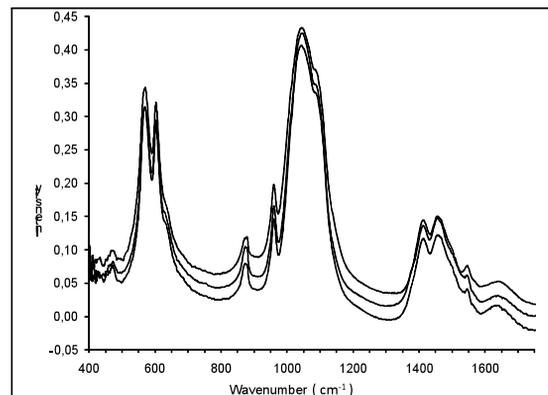
Phosphorous and calcium

As can be seen in figure 4b, no significant changes were seen in the relative content of phosphorous after exposure to KOH or ACS, compared with controls. The small variations in phosphate content might be explained by the natural variation in surface composition between various teeth. The significant increase in relative calcium content is an effect of decrease in relative carbon content as seen in figure 4a. The pattern of the non-linear trend seems to be correlated with the trend in oxygen content, as seen in figure 4a.

The ratios Ca/P and Ca/C

There was no alteration in the Ca/P ratio as a function of exposure to either KOH or ACS (Fig. 4c). However, as a consequence of the correlation mentio-

© **Figure 5** FTIR spectra of novel human enamel powder and powder exposed to KOH-solutions at 15 and 48 hours, respectively.



ned earlier, the Ca/C ratio was considerably higher after exposure to KOH or ACS (Fig. 4c). The highest values were found after one hour in ACS, followed by a decrease, which reached its lowest value after four hours of exposure. After eight hours an increase was seen. Exposure to ACS resulted in similar changes, however, with the lowest values after 1 hours of exposure.

FTIR-spectra of enamel apatite mineral

In Figure 5, the peaks at about 1040 and 958 cm^{-1} correspond to the ν_3 antisymmetric PO stretching mode and the ν_1 symmetric stretching mode of the phosphate, PO_4^{3-} , group, respectively (5, 6). The absorption bands at around 1410-1420 and 1450-1460 cm^{-1} are attributed to the ν_3 mode of the carbonate group, CO_3^{2-} , at two different sites (5, 6, 15, 16). The absorption bands in the region of 1532 and 1673 cm^{-1} have been attributed to amide bending vibrational modes of proteins, in the organic matrix (20).

As for the enamel apatite powder samples exposed to ACS in the preceding paper (21), no significant changes could be detected in enamel apatite powder exposed to KOH-solutions, either in peak heights or peak positions, indicating that there is no detectable decrease or change in symmetry of phosphate, carbonate and hydroxide in the enamel.

Discussion

This study shows that enamel exposed to alkaline solutions, at pH values around 14-15, affects the enamel surface and results in significant loss of organic material, already within one hour of exposure.

The surface appearance found in the SEM analyses differs from that found after acid etching (17). The surface can best be described as having a general roughening, with areas with a more distinct appearance of the prisms and with minor surface changes. Upon increased exposure times, there was a tendency towards an appearance with less distinct prisms, followed by a loss of enamel substance. The effect of exposure to alkaline solutions appears to be a degradation of the enamel surface. Even if the surface appearance in the early stages of exposure to alkaline solutions resembled those after acid etching, i.e. an orientation dependent etch pit penetration and dissolution of apatite, the mechanisms apparently are different (8-9). It is possible that the alkaline solutions used in this study act in dissolving organic contents, including parts of the protein rich matrix surrounding the prisms. As a result, apatite prisms may be lost from the enamel surface without any

chemical alterations of the inorganic apatite itself. The FTIR measurements performed in this study give no evidence on chemical alterations of the apatite crystals. Thus, the fast initial decrease in carbon content after one hour exposure may be a result of removal of remnants of the pellicle at the surface enamel and also organic content of the enamel.

Since neither the XRMA analysis nor the FTIR-spectroscopic analyses could reveal any detectable decrease in phosphate in the enamel, it seems that any erosion of the apatite mineral is nonselective.

In our preceding study, elemental composition of enamel surfaces exposed to alkaline solutions was analyzed by means of XPS (21). Here a clear trend of a decrease in carbon content at the surface of enamel as a function of time of exposure was found. Furthermore, the rate of the decrease was initially higher when enamel surfaces were exposed to ACS compared to when exposed to KOH solutions with similar alkalinity. While XPS only measures to some 3-5 nm in depth, XRMA measures to a depth of about 1.5 μm . Possibly, the trend seen for carbon in both methods reflect that surface reactions with a depth of only a few nm are the most important reactions in explaining the chemical and morphological changes seen under the present conditions. Also, the more marked morphological changes seen at enamel surfaces exposed to the ACS do comply with the findings from the XPS-analyses i.e. that the presence of surfactants in the ACS add to a faster initial degradation of the dental biofilm, at least under the conditions studied, i.e. at pH 14-15. Possibly, the surfactants in the ACS used in the present study act in a similar fashion as sodium lauryl sulfate (SLS) in removing plaque and pellicle (3).

The non-linear trend of the oxygen content and the small variations in phosphate may to some extent be explained by the natural variation in both surface and subsurface composition between different teeth (10, 14, 22).

Clinical significance

Plaque is known to significantly inhibit dental erosion on enamel (4). Of even more importance may be the acquired pellicle, since it has a protective effect against acid erosion by acting as a diffusion barrier (11, 25). Exposure to aerosols with capability to remove any organic layer may therefore increase the risk of dental erosion from acidic foods and beverages. In an in vitro study, abraded enamel samples, exposed to demineralization processes, were found to form deeper lesion depths and a greater loss of

mechanical properties compared with un-abraded samples (24). Therefore, special attention and preventive measurements are necessary for patients exposed to alkaline solutions and/or various surfactants.

Acknowledgements

Magnus Bergwall foundation and Swedish Research Foundation for Work life and Social Science (FAS) should be acknowledged for their financial support. Rikard Ylmén, Department of Inorganic Environmental Chemistry, Chalmers, Gothenburg, Sweden, should be acknowledged for his contribution with FTIR measurements

References

1. Asher C, Read MJ. Early enamel erosion in children associated with the excessive consumption of citric acid. *Br Dent J*. 1987; 162: 384-7.
2. Bamise CT, Esan TA, Ajayi JO, Olagundoye O, Oziegbe EO. Dental erosion in a road-side battery technician: case report and a review of the literature. *Oral Health Prev Dent*. 2008;6:249-53.
3. Carlén A, Rüdiger SG, Loggner I, Olsson J. Bacteria-binding plasma proteins in pellicles formed on hydroxyapatite in vitro and on teeth in vivo. *Oral Microbiol Immunol*. 2003;18:203-7.
4. Cheung A, Zid Z, Hunt D, McIntyre J. The potential for dental plaque to protect against erosion using an in vivo-in vitro model--a pilot study. *Aust Dent J*. 2005;50:228-34.
5. Fowler BO. Infrared studies of apatites. I. Vibrational assignments for calcium, strontium, and barium hydroxyapatites utilizing isotopic substitution. *Inorg Chem* 1974;13:194-207
6. Jarlbring M, Gunneriusson L, Forsling W. Characterisation of the protolytic properties of synthetic carbonate free fluorapatite. *J Colloid Interface Sci*. 2005;285:206-11.
7. Johansson AK, Johansson A, Stan V, Ohlson CG. Silicone sealers, acetic acid vapours and dental erosion: a work-related risk? *Swed Dent J*. 2005;29:61-9.
8. Jongebloed WL, Molenaar I, Arends J. Orientation-dependent etchpit penetration and dissolution of fluorapatite. *Caries Res*. 1973;7:154-65.
9. Jongebloed WL, van den Berg PJ, Arends J. The dissolution of single crystals of hydroxyapatite in citric and lactic acids. *Calcif Tissue Res*. 1974;15:1-9.
10. Jälevik B, Odellius H, Dietz W, Norén J. Secondary ion mass spectrometry and X-ray microanalysis of hypomineralized enamel in human permanent first molars. *Arch Oral Biol*. 2001;46:239-47.
11. Lendenmann U, Grogan J, Oppenheim FG. Saliva and dental pellicle--a review. *Adv Dent Res*. 2000;14:22-8.
12. Pacios MG, de la Casa ML, de los Angeles Bulacio M, López ME. Calcium hydroxide's association with different vehicles: In vitro action on some dentinal components. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2003;96:96-101.
13. Rytömaa I, Meurman JH, Koskinen J, Laakso T, Gharazi L, Turunen R. In vitro erosion of bovine enamel caused by acidic drinks and other foodstuffs. *Scand J Dent Res*. 1988; 96: 324-33.
14. Sabel N, Dietz W, Lundgren T, Nietzsche S, Odellius H, Rythén M, Rizell S, Robertson A, Norén JG, Klingberg G. Elemental composition of normal primary tooth enamel analyzed with XRMA and SIMS. Accepted for publication in *Swedish dental Journal* 2009.
15. Shemesh A. Crystallinity and diagenesis of sedimentary apatites. *Geochim Cosmochim Acta*. 1990;54:2433-8.
16. Shimoda S, Aoba T, Moreno EC, Miake Y. Effect of solution composition on morphological and structural features of carbonated calcium apatites. *J Dent Res*. 1990;69:1731-40.
17. Silverstone LM, Saxton CA, Dogon IL, Fejerskov O. Variation in the pattern of acid etching of human dental enamel examined by scanning electron microscopy. *Caries Res*. 1975;9:373-87.
18. Smith BG, Knight JK. A comparison of patterns of tooth wear with aetiological factors. *Br Dent J*. 1984; 157: 16-9.
19. Smith AJ, Shaw L. Baby fruit juices and tooth erosion. *Br Dent J*. 1987; 162: 65-7.
20. Tarasevich BJ, Lea S, Bernt W, Engelhard M, Shaw WJ. Adsorption of amelogenin onto self-assembled and fluorapatite surfaces. *J Phys Chem B*. 2009; 113: 1833-42.
21. Taube F, Ylmén R, Shchukarev A, Nietzsche S, Norén JG. Morphological and chemical characterization of tooth enamel exposed to alkaline agents. *Journal of Dentistry*, 2010; 38:72-81.
22. Weatherell JA, Robinson C, Hallsworth AS. Variations in the chemical composition of human enamel. *J Dent Res*. 1974;53:180-92.
23. Wiegand A, Attin T. Occupational dental erosion from exposure to acids: a review. *Occup Med*. 2007;57:169-76.
24. Xue J, Li W, Swain MV. In vitro demineralization of human enamel natural and abraded surfaces: A micromechanical and SEM investigation. *J Dent*. 2009;37:264-72
25. Zero DT, Lussi A. Erosion--chemical and biological factors of importance to the dental practitioner. *Int Dent J*. 2005;55:285-90

Address:

Dr Jörgen G. Norén
Department of Pedodontics
Institute of Odontology
Sahlgrenska Academy
University of Gothenburg
Box 450
SE-405 30 Göteborg, Sweden
E-mail: jorgen.noren@odontologi.gu.se

153. Benzodiazepine sedation in paediatric dentistry.
Boel Jensen (2002) 400 SEK
154. Odontoblast phosphate and calcium transport in dentinogenesis.
Patrik Lundquist (2002) 400 SEK
155. On self-perceived oral health in Swedish adolescents.
Anna-Lena Östberg (2002) 400 SEK
156. On dental erosion and associated factors.
Ann-Katrin Johansson (2002) 400 SEK
157. Secular changes in tooth size and dental arch dimensions in the mixed dentition. Rune Lindsten (2002) 400 SEK
158. Assessing caries risk – using the Cariogram Model
Gunnel Hänsel Petersson (2003) 400 SEK
159. Diagnostic accuracy of tuned aperture computed tomography (TACT®)
Madhu K. Nair (2003) 400 SEK
160. Bonding of resin to dentin. Interactions between materials, substrate and operators. Thomas Jacobsen (2003) 400 SEK
161. Autogenous free tooth transplantation by a two-stage operation technique. Gunnar Nethander (2003) 400 SEK
162. Oral health among the elderly in Norway
Birgitte Moesgaard Henriksen (2003) 400 SEK
163. A mandibular protruding device in obstructive sleep apnea and snoring.
Anette Fransson (2003) 400 SEK
164. Temporomandibular disorders in adolescents.
Kerstin Wahlund (2003) 400 SEK
165. Craniofacial growth related to masticatory muscle function in the ferret.
Tailun He (2004) 400 SEK
166. HLA, mutans streptococci and salivary IgA – is there a relation?
Marie Louise Lundin Wallengren (2004) 400 SEK
167. The miswak (chewing stick) and oral health. Studies on oral hygiene practices of urban Saudi Arabians. Meshari Al-Otaibi (2004) 400 SEK
168. Sleep apnoea in patients with stable congestive heart failure.
Mahmoud Eskafi (2004) 400 SEK
169. On titanium frameworks and alternative impression techniques in implant dentistry
Anders Örtorp (2005) 400 SEK
170. Variability of the cranial and dental phenotype in Williams syndrome
Stefan Axelsson (2005) 400 SEK
171. Acute inflammation in peritoneal dialysis: experimental studies in rats
Characterization of regulatory mechanisms
Farhan Bazargani (2005) 400 SEK
172. The effect of low level laser irradiation on implant-tissue interaction
Maawan Khadra (2005) 400 SEK



The supplements can be ordered from Swedish Dental Journal, Box 1217, SE-111 82 Stockholm, Sweden. Subscription of the supplements can be arranged.

Eating disorders and signs and symptoms of temporomandibular disorders

A matched case-control study

ANN-KATRIN JOHANSSON¹, ANDERS JOHANSSON², LENNART UNELL³,
CLAES NORRING⁴, GUNNAR E CARLSSON⁵

Abstract

© The aim of the study was to examine signs and symptoms related to temporomandibular disorders (TMD) in patients with eating disorders (ED) and to compare the prevalence with that in sex- and age-matched controls. During a 12-month period, all patients (n=65) who accepted and initiated psychiatric/medical outpatient treatment in an Eating Disorder Clinic/Erikbergsgården, Örebro, Sweden were invited to participate in the study. Of the ED patients, 54 (83 %) accepted participation. ED patients and controls underwent a comprehensive TMD questionnaire and clinical examination.

Reported symptoms such as headache, facial pain, jaw tiredness, tongue thrusting, and lump feeling in the throat as well as dizziness, concentration difficulties and sleep disturbances were all significantly more prevalent among ED patients compared to controls. There was also a significantly higher prevalence of clinical TMD signs in the ED patients.

Analyses within the ED group showed that those who reported self-induced vomiting reported significantly more heavy feeling in the head, nausea and snoring. Those with binge eating reported significantly more heavy feeling in the head, facial pain, dizzy feeling and concentration difficulties. No significant differences regarding subjective symptoms and clinical signs of TMD were found within the ED group with respect to duration of ED.

In conclusion, orofacial pain and TMD related signs and symptoms are significantly more common in ED patients than in matched control subjects. Special emphasis should be made to those who reports vomiting and/or binge eating behaviors.

Key words

Eating disorders, dizziness, headache, orofacial pain, prevalence

¹Department of Clinical Dentistry - Cariology, Faculty of Medicine and Dentistry, University of Bergen, Bergen, Norway

²Department of Clinical Dentistry - Prosthodontics, Faculty of Medicine and Dentistry, University of Bergen, Bergen, Norway

³Postgraduate Dental Education Centre and Örebro County Council, Örebro, Sweden

⁴Stockholm Center for Eating Disorders, Stockholm County Council, and Centre for Psychiatry Research, Karolinska Institutet, Stockholm, Sweden

⁵Institute of Odontology, Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden

Ätstörningar och symtom på käkfunktionsstörning: En matchad fall- och kontrollstudie

ANN-KATRIN JOHANSSON, ANDERS JOHANSSON, LENNART UNELL, CLAES NORRING, GUNNAR E CARLSSON

Sammanfattning

◎ Syftet med studien var att undersöka kliniska och självrapporterade symtom på käkfunktionsstörning (temporomandibulära besvär, TMD) hos patienter med ätstörningar (ED) jämfört med ålders- och könsmatchade kontroller. Alla patienter (n=65) som under en 12 månaders period accepterade och påbörjade psykiatrisk/ medicinsk dagvård på ätstörningsenheten i Örebro Eriksbergsgården, Sverige inviterades att delta i studien. 54 (83 %) av ED-patienterna accepterade att delta. ED-patienter och kontroller genomgick en bettfysiologisk klinisk undersökning och svarade på ett frågeformulär. Rapporterade symtom såsom huvudvärk, ansiktssmärta, trötthetskänsla i käkarna, tungpressning, klumpkänsla i halsen liksom yrsel, koncentrationssvårigheter och sömnstörningar var alla signifikant mer vanliga hos ED-patienter jämfört med kontroller. Kliniska symtom på TMD var också signifikant mer vanliga i ED-gruppen. Analys inom ED visade att de som rapporterade självinducerad kräkning hade signifikant mer tyngdkänsla i huvud, kvälningar och snarkning. Individer som rapporterade hetsätning uppgav signifikant mer trötthetskänsla i käkarna, ansiktssmärta, yrsel och koncentrationssvårigheter.

Sammanfattningsvis är orofacial smärta och TMD-relaterade symtom signifikant vanligare hos patienter med ätstörningar jämfört med matchade kontroller. Speciell uppmärksamhet ska ägnas de patienter som rapporterar självinducerad kräkning och/ eller hetsätning.

Introduction

Eating disorders (ED) are psychosomatic diseases, which are associated with numerous severe physiologic and somatic complications. Oral health problems and disabilities (e.g. dental caries and erosion, impaired salivary function, parotid gland enlargement) are common findings with ED and many of the oral signs or symptoms, either singly or in combinations, are relatively specific for this group of patients (19, 33). Treatment, therefore, needs to take a multi-disciplinary approach, and would ideally include not only psychiatric and medical teams, but also dental healthcare providers (28).

ED are classified under three main diagnoses, viz. anorexia nervosa (AN), bulimia nervosa (BN), and eating disorder not otherwise specified (EDNOS) (2). Common to all ED is a specific psychopathology of over-evaluation of eating, shape and weight, and their control (11). In addition, AN is characterized mainly by underweight and food restriction and BN by binge eating and inappropriate compensatory behaviors, viz. self-induced vomiting, use of laxatives and excessive exercise. The EDNOS category is heterogeneous and not clearly defined (32). ED are also characterized by considerable diagnostic flux, with two-thirds of patients having their ED diagnosis changed within 30 months and only a minority no longer diagnosed (27). In combination with the indefiniteness of the EDNOS category, the diagnostic instability lies at the root of the current intense debate about the classification and definitions of ED (36). ED also shows a considerable co-morbidity with other psychiatric disorders, mainly affective and anxiety disorders and substance abuse (3).

In a long-term perspective (> 30 years) an increase in the incidence of ED is likely (16). Current knowledge estimate the incidence of AN to 8 new cases/year per 100,000 people, with the corresponding figure for BN being 12 (20). Norwegian studies have estimated the total lifetime prevalence of ED to 8.7 % among the general female population (5). Severe and sometimes mortal somatic complications such as heart and lung problems, hypoglycemia and suicide are relatively common in ED. AN is one of the psychiatric disorders with the highest mortality rate (17).

In the dental literature on ED, the interest during the last decades has focused on the associated erosion of teeth (19, 23, 33, 35), whereas facial pain and other aspects of oral health have received less attention (8, 10, 14). However, oral manifestations of ED may have a negative impact on several aspects of oral

health and their treatment and prevention can be important for the overall management and prognosis of ED patients (4, 25). There is lack of knowledge and clinical experience of ED among dentists, and education in this area of dental practice is needed to improve the quality of care, e.g. primary, secondary and tertiary prevention, which dentists can provide to ED patients (22).

Orofacial pain and signs and symptoms of temporomandibular disorders (TMD), characterized as musculoskeletal pain conditions in the face and/or the temporomandibular joint, have been demonstrated in practically all examined populations, though the variation in prevalence has been wide (6, 24). Lately, several studies have described co-morbidity between TMD and chronic symptoms, such as headache and neck pain, general health and psychosomatic conditions (1, 21, 34, 38).

A few studies have suggested that ED patients may have an increased prevalence of chronic orofacial pain and associated symptoms but without conclusive explanations to possible mechanisms for these findings (10, 14). Self-induced vomiting, a type of purging behavior, binge eating and duration of the ED could also be factors which promote orofacial pain symptoms. It would therefore be of interest to further explore the possible coexistence between ED and signs and symptoms associated with TMD.

The aim of the present study was thus to examine signs and symptoms related to TMD in patients with ED and to compare the prevalence with that in sex- and age-matched controls. It was hypothesized that ED patients would exhibit more signs and symptoms than controls.

Material and Methods

Patient group

During a 12-month period (1 January, 2005 to 31 December, 2005) a total of 65 patients accepted and initiated psychiatric/medical outpatient treatment for ED at the Eating Disorder Clinic, Eriksbergsgården, Örebro County Council, Örebro, Sweden. The ED diagnoses were made by the expert team at the clinic consisting of medical doctors, psychiatrists and psychologists. All 65 patients were invited to participate in the study and of these 54 (83 %) accepted to participate in connection with their first somatic examination.

The mean age of the 54 participants was 22 years (range 10–50 years) and 50 of them (93 %) were female. The ED diagnosis and other relevant data

for each patient were retrieved from the medical file. The distribution of ED diagnoses among the patients was: AN 28 %, BN 14 % and EDNOS 58 %. The mean duration of the ED was 4.5 years (range 0.3–35 yrs) and 61 % of the patients had been sick for more than one year.

Eleven of the 65 initially selected patients did not accept to participate in the study (\bar{X} = 20.5 yrs, range 14–38, all women). Among the non-participants there were 4 AN and 7 EDNOS. The reason for not accepting to be examined was: consider herself not to have any dental problem (1), failed to come to the appointment (1), did not have the time (3), did not want (6), e.g. long travel time, did not like to answer questions etc. There was no statistically significant difference regarding age, gender and ED diagnoses between the non-participants and the study ED group.

Control group

A control group of 54 subjects matched for sex and age was selected from the ordinary revision patients at a Public Dental Health Clinic, Hertig Karl, Örebro County Council, Örebro. The selection was carried out from the consecutive list of patients which were to be given an appointment for ordinary check-up. The matching of the controls was based on gender and date of birth. The sex- and age-matched controls were examined during the spring of 2006.

Exclusion criteria: In order to identify and exclude patients with risk for having ED among the controls, the Symptom Index of the Eating Disorder Inventory-2 (EDI-2) was used in each control subject (29). The EDI-2 is a 91-item questionnaire that is widely used in the study of eating disorders, and generates 11 subscales: three subscales of central symptoms (the symptom index, i.e. drive for thinness, bulimia, body dissatisfaction) and eight subscales of psychological correlates of eating disorders (the psychological index, i.e. ineffectiveness, interpersonal distrust, interoceptive awareness, asceticism, perfectionism, social insecurity, maturity fears and impulse regulation). In the present study only the symptom index was used. Among the 54 controls first selected, 2 subjects with risk for ED were found i.e. a score above 14 according to the EDI-2 index. These were excluded from the control group and two additional controls were selected, evaluated with EDI-2 and found to be suitable for inclusion.

The study was approved by the Ethics Committee in the Örebro region, and informed consent was

obtained from all patients and controls. In cases of children, parental consent was also obtained. As an incentive for participation in the study, all control subjects were offered cinema tickets and/or a free ordinary dental recall examination.

Questionnaire

A questionnaire was constructed in collaboration with the staff at the ED-clinic and comprised 196 questions on general and oral health. The same questionnaire was given to the controls except for 20 questions specifically related to ED. Included in the questionnaire for both groups were 23 questions related to TMD (Table 1). The complete questionnaire was tested on a group of 5 subjects, re-evaluated and improved. Both ED patients and controls were supervised / helped if needed, by a specially trained

© **Table 1.** Questions on TMD and related symptoms included in the questionnaire. Response alternatives were: A = never or seldom; B = one or several times a month; C = one to several times a week; D = everyday.

Orofacial symptoms

- Do you have pain in the face or jaws?
- Do you have pain during movements of the lower jaw or when chewing
- Do you have difficulties in wide opening or biting over large items?
- Do you have a feeling of tiredness in the jaws?
- Do you experience clicking from your TMJ's?
- Do you experience grating sounds from your TMJ's
- Does your lower jaw lock
- Do you bite or grind your teeth daytime
- Do you press or grind your teeth nighttime?
- Do you thrust the tongue against the teeth or the palate daytime?
- Do you thrust the tongue against the teeth or the palate nighttime?
- Do you experience problems when chewing?
- Do you feel tense in the jaws when you wake up in the morning?

General symptoms

- Do you have headache?
- Do you experience heavy feeling in the head?
- Do you have a feeling of a lump in the throat?
- Do you have nausea?
- Do you feel dizzy?
- Do you have concentration difficulties?
- Do you have ringing in the ears?
- Do you have difficulties to sleep?
- Do you snore?

dental assistant, to complete the questionnaires. The examiners were blinded from the result from the medical history (including for example ED diagnosis) and the results from the questionnaires for both ED-patients and controls.

Clinical examination

The clinical examination of the patients was performed at the specialist clinic for ED in an ordinary medical examination room with mobile dental equipment. The controls were examined using the operating light from the same mobile equipment in an ordinary dental clinic. A comprehensive clinical TMD examination was carried out both in ED patients and controls by a TMD specialist (AJ), focusing on signs of pain and/or dysfunction of the temporomandibular joints (TMJs), the masticatory muscles and jaw movements (7). *Helkimo's* Anamnestic and Clinical Dysfunction Indices (18) were calculated based on the questionnaire and the clinical examination.

Diagnosis

Diagnosis was made according to the epidemiological variable TMD-S subsequently termed TMD pain (30). The TMD pain diagnosis is made according to a positive response to either or both of the two questions: 1) Do you have pain in your temples, face, jaw joint, or jaws once a week or more? or 2) Do you have pain when you open your mouth wide or chew, once a week or more? (31). In order to calculate TMD pain, the questions on headache, facial pain and pain on mandibular movement/chewing were dichotomized into two categories: 1) Pain one or several times a month, seldom or never; and 2) Pain one to several times a week or daily.

Statistical methods

Differences between ED patients and controls were analyzed with the Wilcoxon Signed Ranks Test (Statistical Package for Social Sciences, SPSS ver. 15). Differences within the ED group were tested with the Mann-Whitney Test; p-values < 0.05 were considered statistically significant. Duration of ED was dichotomized to ≤ 1 year and > 1 year. Only those who reported present vomiting were included in the vomiting group. Binge eating was classified according to an affirmative answer to the question "Do you sometimes lose control over what and how much you eat?" Separate analysis within the ED group was made with respect to self-reported vomiting, binge eating and duration of ED.

Results

Questionnaire

Facial pain, jaw tiredness, tongue thrusting, and lump feeling in the throat, headache and a number of general symptoms were reported more frequently by the ED patients than the controls (Tables 2 and 3). Approximately half of the ED patients compared to only some 10 % of the controls complained of frequent dizziness, sleep disturbance and concentration difficulties.

TMD pain was diagnosed in 28 ED patients (48 %) and 11 controls (20 %) ($p = 0.04$). Maximum opening capacity of the mouth was significantly lower among ED patients ($\bar{x} = 52$ mm, $SD = 5.6$) compared to controls ($\bar{x} = 54$ mm, $SD = 5.4$) ($p = 0.043$). TMD signs and symptoms according to the *Helkimo* indices were significantly higher in the ED patients compared to the controls (AI, $p = 0.05$; DI, $p = 0.009$) (Fig. 1).

© **Table 2.** Table 2. Distribution in % of reported orofacial symptoms among 54 subjects with ED and 54 controls matched for sex and age. A = never or seldom; B = one or several times a month; C = one to several times a week; D = everyday.

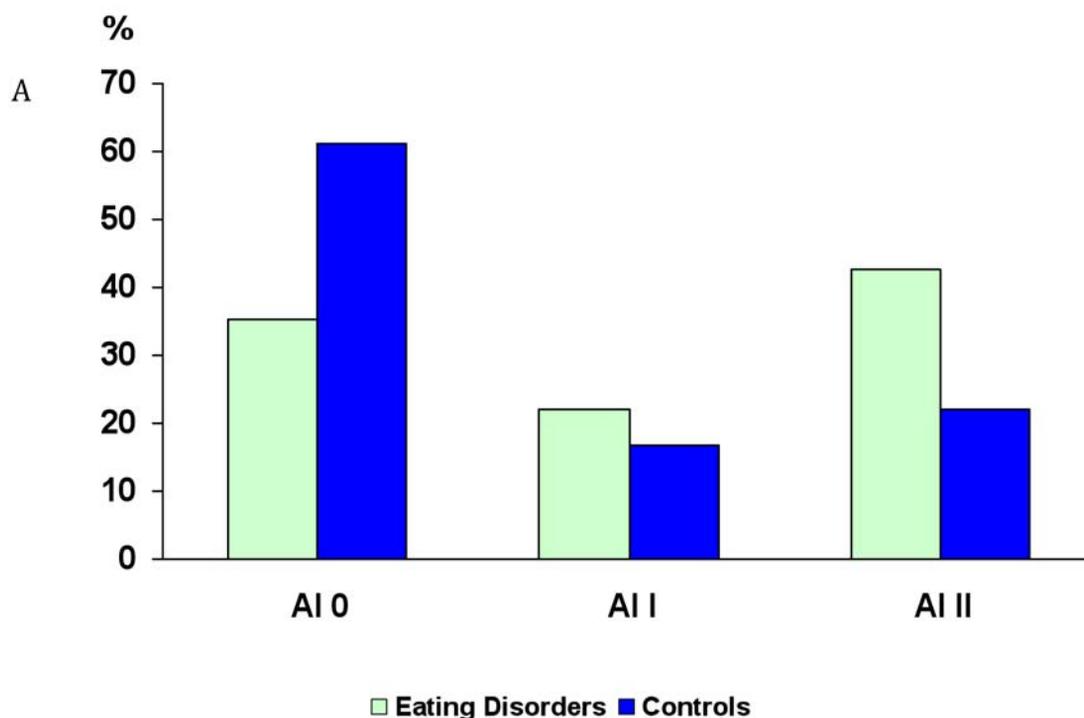
Orofacial Symptoms	Group	A	B	C	D	P
Facial pain	ED	59	28	4	9	0.004
	Control	87	9	4	0	
Pain on mandibular movement	ED	82	6	7	6	NS
	Control	91	7	0	2	
Difficulties in wide opening	ED	85	6	6	4	NS
	Control	89	4	2	6	
Tiredness in the jaws	ED	59	20	9	11	0.01
	Control	80	11	7	2	
Clicking from TMJ's	ED	64	25	2	9	NS
	Control	74	17	4	6	
Grating sounds from TMJ's	ED	91	4	2	4	NS
	Control	98	2	0	0	
Locking of TMJ	ED	96	4	0	0	NS
	Control	87	8	2	4	
Tense in the jaws in the morning	ED	68	11	11	9	NS
	Control	74	17	4	6	
Function/Parafunctions						
Bruxism – daytime	ED	61	17	7	15	NS
	Control	68	13	13	6	
Bruxism – nighttime	ED	65	4	17	15	NS
	Control	72	11	9	8	
Tongue thrusting daytime	ED	50	15	17	19	0.01
	Control	68	15	11	6	
Tongue thrusting at night	ED	65	17	6	13	0.001
	Control	89	8	4	0	
Chewing problems	ED	85	2	9	4	NS
	Control	93	6	0	2	

Analyses within the ED group showed that those who reported vomiting (n = 18) compared to those who did not (n = 36) reported significantly more heavy feeling in the head (p=0.025), nausea (p=0.01) and snoring (p=0.019). Those who reported binge eating (n=31) compared to those who did not (n=23) reported significantly more heavy feeling in the head (p=0.043), facial pain (p=0.047), dizzy feeling (p=0.042) and concentration difficulties (p=0.002). No significant differences regarding subjective symptoms and clinical signs of TMD were found within the ED group with respect to duration of ED more (n=33) or less/equal to 1 year (n=21).

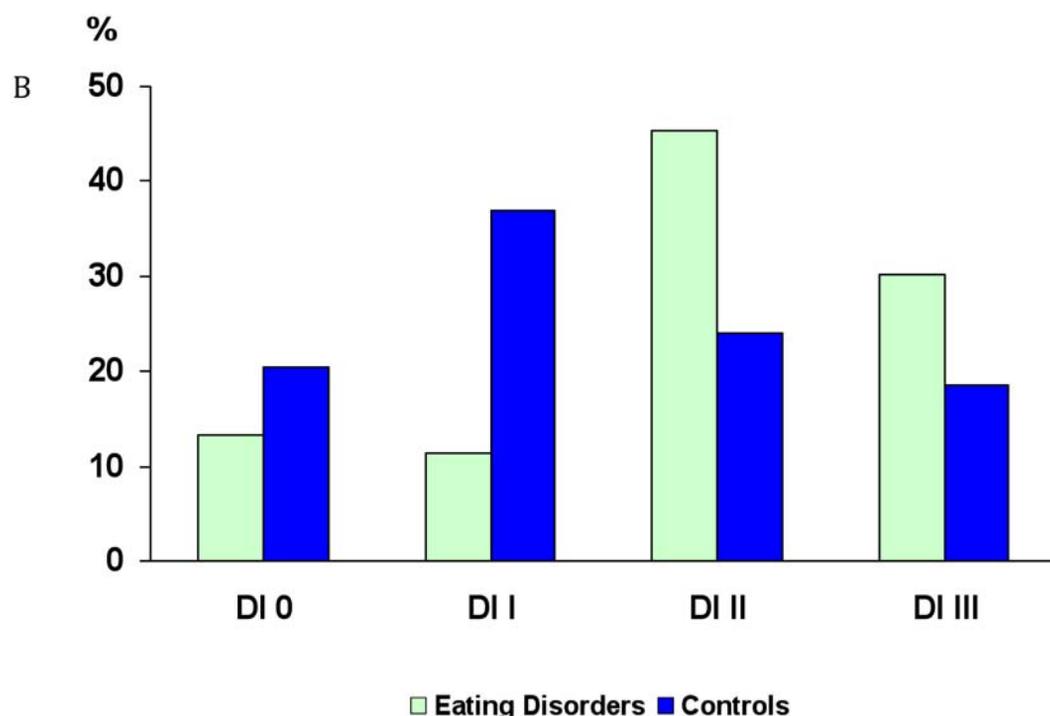
© **Table 3.** Distribution in % of reported general symptoms among 54 subjects with ED and 54 controls matched for sex and age. A = never or seldom; B = one or several times a month; C = one to several times a week; D = everyday.

General symptoms	Group	A	B	C	D	P
Headache	ED	35	19	35	11	0.02
	Control	39	43	19	0	
Heavy feeling in the head	ED	24	26	33	17	0.001
	Control	46	33	20	0	
Lump feeling in throat	ED	52	28	9	11	0.006
	Control	83	9	4	4	
Nausea	ED	63	15	11	11	0.047
	Control	80	11	4	6	
Dizziness	ED	22	28	32	19	0.001
	Control	63	26	7	4	
Concentration difficulties	ED	22	17	26	35	0.001
	Control	57	32	7	4	
Ringing in the ears	ED	54	24	9	13	NS
	Control	69	20	2	9	
Sleep disturbance	ED	26	30	26	19	0.001
	Control	54	33	9	4	
Snoring	ED	63	24	6	7	NS
	Control	76	9	6	9	

© **Figure 1 A.** Distribution of the anamnestic index (AI) (18) in 54 patients with eating disorders (ED) and 54 controls matched for sex and age. AI 0 = no symptoms; AI I = mild symptoms; AI II = severe symptoms (A).



© **Figure 1 B.** Distribution of the clinical dysfunction index (DI) (18) in 54 patients with eating disorders (ED) and 54 controls matched for sex and age. DI 0 = clinically symptom free; DI I = mild dysfunction; DI II = moderate dysfunction; DI III = severe dysfunction (B).



Discussion

The ED patients had a higher prevalence of facial pain and signs and symptoms of TMD than sex- and age-matched controls. The results corroborated recent findings of the coexistence of signs and symptoms associated with chronic facial pain among ED patients (10, 14). Thus, to the list of conditions demonstrating co-morbidity between TMD signs and symptoms such as headache, neck pain, impaired general health and psychosomatic conditions (1, 21, 34, 38), ED might also be added.

Facial pain and jaw tiredness were significantly more common in ED patients compared to controls but there was no difference in TMJ-related symptoms such as clicking/grating sounds or locking of

TMJ. It is therefore likely that the TMD symptoms presented by the ED patients are of muscular origin.

Reported bruxism did not differ significantly between the groups but tongue thrusting, another form of parafunction, was significantly more often reported by ED patients than controls. As tongue thrusting is common in individuals with symptoms of somatization, anxiety and depression (12), it would be expected to be more frequent in ED patients as was the case in this study.

A recent Israeli study (10) also observed more pain symptoms in ED patients compared to controls. That study also found significant difference regarding clinical signs of TMD between ED patients who vomited and those who did not. Our study did

also find certain differences in patients with specific behaviors, i.e. self-reported vomiting and binge eating, in relation to TMD and general symptoms but not in relation to the duration of ED. The somewhat different results between the studies might be explained by the different composition of the samples regarding ED diagnoses and the fact that the patients in the Israeli study were hospitalized and thus probably more severely ill than the patients in our study. From our results, it may therefore be concluded that ED patients generally have a higher risk (or tendency for comorbidity) for TMD and related problems and that purging behaviors, like vomiting, and binge eating possibly further enhance that risk/comorbidity.

Since ED's are psychosomatic diseases, psychological factors are one important part of the etiology (16). The high prevalence of sleep disturbances and concentration difficulties reported by the patients indicate psychological problems.

The studied ED patients constitute 83 % of the potential sample. With respect to the severe problems these patients often have, the participation rate can be considered acceptable. There was no difference as regards age, gender or ED diagnoses between participating and non-participating patients. It is probable that the examined group is largely representative for the total group of ED patients at the clinic and its catchment area in the middle of Sweden.

Approximately half of the ED patients and a quarter of the controls had a diagnosis of TMD pain diagnosis based on questions of frequency of headache, facial pain and pain on mandibular movement. A positive response to any of these symptoms occurring one or more times weekly has been shown to have a high validity when comparing TMD pain with the Research Diagnostic Criteria for TMD (RDC/TMD) (9); the short-term sensitivity and specificity were 0.98 and 0.90, respectively (30). The original TMD pain diagnosis was based on the previously-mentioned two questions (30). In our study, the question on headache did not distinguish between temple location and other locations and could therefore give an overestimation. In the clinical examination by the TMD specialist, location of headache was checked and the majority of subjects who reported headache indicated the temple region. It has also been shown that there is evidence for a diagnostic and behavioral overlap between headache and TMD (13, 37). Therefore our data on TMD pain should be comparable regarding validity. The Helkimo indices also presented significantly higher prevalences of TMD signs and symptoms in the ED patients than in the controls

The relatively high prevalence of TMD signs and symptoms also in the control group might partly be explained by the fact that young women comprised the great majority, a group that has demonstrated high prevalence of TMD signs and symptoms in epidemiological studies (24, 26).

The hypothesis that ED patients would present more TMD-related signs and symptoms compared to controls matched for sex and age was verified, which indicates that patients with ED should also be examined for orofacial pain and associated signs and symptoms. Special emphasis should be made to those who report purging behaviors and/or binge eating. Adequate treatment of these signs and symptoms may be important for the overall management of ED patients (4).

From this study, it may be concluded that ED patients generally have a higher risk (or tendency for comorbidity) for TMD and related problems and that purging behaviors, like vomiting, and binge eating possibly further enhance that risk/comorbidity.

Acknowledgements

This study was supported by the Örebro County Council, Sweden. We would like to express our thanks to the personnel at the Eating Disorder Clinic and to Kristina Ekman, Örebro County Council for their assistance.

References

1. Aaron LA, Burke MM, Buchwald D. Overlapping conditions among patients with chronic fatigue syndrome, fibromyalgia, and temporomandibular disorder. *Arch Intern Med* 2000;160:221-7.
2. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV)*. Washington, DC, APA, 1994.
3. American Psychiatric Association. *Practice Guideline for the Treatment of Patients with Eating Disorders, Third Edition*. Washington, DC, APA, 2006.
4. Aranha AC, Eduardo CDE P, Cordás TA. Eating disorders. Part I: Psychiatric diagnosis and dental implications. *J Contemp Dent Pract* 2008;9:73-81.
5. Bræin G, Vedul-Kjelsås E, Götestam KG. Forekomst av spiseforstyrrelser i generell kvinnelig befolkning – 10 års follow up 1994-2004. Abstract presented at the 6th Nordic Conference on Eating Disorders, Århus, Denmark, 2006.
6. Carlsson GE. Epidemiology and treatment need for temporomandibular disorders. *J Orofac Pain* 1999;13:232-7.
7. Carlsson GE, Magnusson T. Management of temporomandibular disorders in the general dental practice. Chicago: Quintessence; 1999.

8. Coughlin JW, Edwards R, Buenaver L, Redgrave G, Guarda AS, Haythornthwaite J. Pain, catastrophizing, and depressive symptomatology in eating disorders. *Clin J Pain* 2008;24:406-14.
9. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord* 1992;6:301-55.
10. Emodi-Perlman A, Yoffe T, Rosenberg N, Eli I, Alter Z, Winocur E. Prevalence of psychologic, dental, and temporomandibular signs and symptoms among chronic eating disorders patients: a comparative control study. *J Orofac Pain* 2008;22:201-8.
11. Fairburn CG, Cooper Z, Shafran R. Cognitive behavior therapy for eating disorders: a "transdiagnostic" theory and treatment. *Behav Res Ther* 2003;41:509-28.
12. Gao J, Chen L, Zhou J, Peng J. A case-control study on etiological factors involved in patients with burning mouth syndrome. *J Oral Pathol Med* 2009;38:24-8.
13. Glaros AG, Urban D, Locke J. Headache and temporomandibular disorders: evidence for diagnostic and behavioural overlap. *Cephalalgia* 2007;27:542-9.
14. Goldberg MB, Katzman DK, Woodside DB, Baker GI. Do eating disorders and chronic facial pain coexist? A preliminary study. *J Can Dent Assoc* 2006;72:51.
15. Goulet JP. Validity of the Research Diagnostic Criteria for Temporomandibular Disorders Axis I in clinical and research settings. *Critical Commentary 1. J Orofac Pain* 2009;23:17-9.
16. Grilo CM. *Eating and Weight Disorders*. New York: Psychology Press, 2006.
17. Harris EC, Barraclough B. Excess mortality of mental disorders. *Brit J Psychiat* 1998;173:11-53.
18. Helkimo M. Epidemiological surveys of dysfunction of the masticatory system. In: Zarb GA, Carlsson GE (eds). *Temporomandibular joint-function and dysfunction*. Copenhagen: Munksgaard, 1979; 75-192.
19. Hellström I. Oral complications in anorexia nervosa. *Scand J Dent Res* 1977;85:71-86.
20. Hoek HW, van Hoeken D. Review of the prevalence and incidence of eating disorder. *Int J Eating Dis* 2003;34:383-96.
21. Johansson A, Unell L, Carlsson GE, Söderfeldt B, Halling A. Differences in four reported symptoms related to temporomandibular disorders in a cohort of 50-year-old subjects followed up after 10 years. *Acta Odontol Scand* 2008;66:50-7.
22. Johansson AK, Nohlert E, Johansson A, Norring C, Tegelberg A. Dentists and eating disorders--knowledge, attitudes, management and experience. *Swed Dent J* 2009;33:1-9.
23. Kjældgaard M, Van Der Ster G, Lago C, Angmar-Månsson B, Johansson AK. Åtstörningar. In: Johansson AK, Carlsson GE (Eds). *Dental erosion. Bakgrund och kliniska aspekter*. Stockholm: Förlagshuset Gothia 2006;115-38.
24. LeResche L. Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med* 1997;8:291-305.
25. Lo Russo L, Campisi G, Di Fede O, Di Liberto C, Panzarella V, Lo Muzio L. Oral manifestations of eating disorders: a critical review. *Oral Dis* 2008;14:479-84.
26. Magnusson T, Egermark I, Carlsson GE. A prospective investigation over two decades on signs and symptoms of temporomandibular disorders and associated variables. A final summary. *Acta Odontol Scand* 2005;63:99-109.
27. Milos G, Spindler A, Schnyder U, Fairburn CG. Instability of eating disorder diagnoses: prospective study. *Brit J Psychiat* 2005;187:573-8.
28. National Institute For Clinical Excellence (NICE). *Eating Disorders: Core interventions in the treatment and management of anorexia nervosa, bulimia nervosa, and related eating disorders*. National Clinical Practice Guideline Number CG9. London: National Institute for Clinical Excellence, 2004.
29. Nevenon L, Clinton D, Norring C. Validating the EDI-2 in three Swedish female samples: eating disorders patients, psychiatric outpatients and normal controls. *Nord J Psychiatry* 2006;60:44-50.
30. Nilsson IM, List T, Drangsholt M. The reliability and validity of self-reported temporomandibular disorder pain in adolescents. *J Orofac Pain* 2006;20:138-44.
31. Nilsson IM. Reliability, validity, incidence and impact of temporomandibular pain disorders in adolescents. *Swed Dent J* 2007; Suppl.(183):7-86.
32. Norring C, Palmer B (Eds). *EDNOS – Eating Disorders Not Otherwise Specified: Scientific and clinical Perspectives on the other Eating Disorders*. London: Routledge, 2005.
33. Öhrn R, Enzell K, Angmar-Månsson B. Oral status of 81 subjects with eating disorders. *Eur J Oral Sci* 1999;107:157-63.
34. Österberg T, Carlsson GE. Relationship between symptoms of temporomandibular disorders and dental status, general health and psychosomatic factors in two cohorts of 70-year-old subjects. *Gerodontology* 2007;24:129-35.
35. Rytömaa I, Järvinen V, Kanerva R, Heinonen OP. Bulimia and tooth erosion. *Acta Odontol Scand* 1998;56:36-40.
36. Striegel-Moore R, Wonderlich S (Eds). *Special Issue on Diagnosis and Classification*. *Int J Eating Dis* 2007;40:S1-S129 (Supplement).
37. Svensson P. Muscle pain in the head: overlap between temporomandibular disorders and tension-type headaches. *Curr Opin Neurol* 2007;20:320-5.
38. Wiesinger B, Walker H, Englund E, Wänman A. Back pain in relation to musculoskeletal disorders in the jaw-face: a matched case-control study. *Pain* 2007;131:311-9.

Address:

Dr Ann-Katrin Johansson
 Department of Clinical Dentistry – Cariology
 Faculty of Medicine and Dentistry, University of Bergen
 Årstadveien 17, 5009 Bergen, Norway
 E-mail: Ann-Katrin.Johansson@iko.uib.no

173. All-ceramic fixed partial dentures
Per Vult von Steyern (2005) 400 SEK
174. Smoking and vertical periodontal bone loss
Mustafa Baljon (2005) 400 SEK
175. Mandibular Third Molar Removal
Rolf Liedholm (2005) 400 SEK
176. Tobacco smoking and periodontal health in a Saudi Arabian population.
Suzan Natto (2005) 400 SEK
177. Mandibular alveolar bone mass, structure and thickness
in relation to skeletal bone density in dentate women
Grethe Jonasson (2005) 400 SEK
178. On caries prevalence and school-based fluoride programmes
in Swedish adolescents
Ulla Moberg Sköld (2005) 400 SEK
179. Risk factors for oral and oropharyngeal squamous cell carcinoma
Kerstin Rosenquist (2005) 400 SEK
180. Studies on periodontitis and analyses of individuals at risk for
periodontal diseases
Henrik Jansson (2006) 400 SEK
181. Chronic orofacial pain. Understanding patients from two perspectives:
the clinical view and the patient's experience
Eva Wolf (2006) 400 SEK
182. Good work for dentists – ideal and reality for female unpromoted general
practice dentists in a region of Sweden Karin Hjalmers (2006) 400 SEK
183. Reliability, validity, incidence, and impact of temporomandibular
pain disorders in adolescents.
Ing-Marie Nilsson (2007) 400 SEK
184. Quality aspects of digital radiography in general dental practices
Kristina Hellén-Halme (2007) 400 SEK
185. Prosthodontics, care utilization and oral health-related quality of life
Ingrid Collin Bagewitz (2007) 400 SEK
186. Individual prediction of treatment outcome in patients with
temporomandibular disorders. A quality improvement model.
Bertil Sundqvist (2007) 400 SEK
187. The biological role of the female sex hormone estrogen
in the periodontium - studies on human periodontal ligament cells
Daniel Jönsson (2007) 400 SEK
188. Long time follow up of implant therapy and treatment of peri-implantitis
Ann-Marie Roos-Jansåker (2007) 400 SEK
189. Epidemiological aspects on apical periodontitis
Fredrik Frisk (2007)



The supplements
can be ordered from
Swedish Dental Journal,
Box 1217,
SE-111 82 Stockholm,
Sweden.
Subscription
of the supplements
can be arranged.

Temporomandibular disorder pain in adult Saudi Arabians referred for specialised dental treatment

MOHAMMAD AL-HARTHY^{1,2}, AWWAD AL-BISHRI¹, EWACARIN EKBERG², MARIA NILNER²

Abstract

© The aim of this study was to determine the frequency of Temporomandibular Disorders (TMD) pain in Saudi Arabians, aged 20–40, who were referred to the Specialist Dental Centre in Makkah. The material included 325 patients (135 males, 190 females) who answered a history questionnaire. Patients reporting TMD pain in the last month were offered a clinical examination. History questionnaires and clinical examinations were done according to the Arabic version of the Research Diagnostic Criteria for TMD (RDC/TMD).

Fifty-eight patients (18%) reported TMD pain; 46 were clinically examined. Mean age of clinically examined TMD pain patients was 30 ± 7 years with a male-female ratio of 1:6 ($P < 0.001$). All TMD pain patients had a diagnosis of myofascial pain, and 65% had diagnoses of arthralgia or osteoarthritis. Headaches or migraines in the last 6 months and headaches in the last month were reported in high frequencies in the TMD pain group, 93% and 71% respectively, with differences ($P < 0.001$) between the TMD pain and non-TMD pain groups. Graded Chronic Pain Scale assessments classified 45% of the TMD pain patients in grade I, 53% in grade II, 2% in grade III, and 0% in grade IV. Severe depression scores were found in 38% of the TMD pain patients and severe somatisation scores in 60% with differences ($P < 0.001$) between the TMD pain and non-TMD pain groups.

In conclusion, the study found a frequency of TMD pain in this Saudi Arabian cohort of 18%. The TMD pain group presented high scores of depression and somatisation but low disability grades on the Graded Chronic Pain Scale.

Key words

Temporomandibular disorders, RDC/TMD, Saudi Arabia, epidemiology

¹Specialist Dental Centre, Al-Noor Specialist Hospital, Holy Makkah, Saudi Arabia

²Department of Stomatognathic Physiology, Faculty of Odontology, Malmö University, Malmö, Sweden

Temporomandibulär dysfunktion och smärta hos vuxna saudiaraber remitterade för specialisttandvård

MOHAMMAD AL-HARTHY, AWWAD AL-BISHRI, EWACARIN EKBERG, MARIA NILNER

Sammanfattning

◎ Syftet med denna studie var att fastställa frekvensen av Temporomandibulär Dysfunktion (TMD) och smärta hos saudiaraber i åldern 20 - 40, som remitterats till specialisttandvårdskliniken i Mecka. Materialet bestod av 325 remitterade patienter (135 män, 190 kvinnor) som besvarade ett anamnestiskt frågeformulär och patienter som rapporterade TMD-smärta erbjöds kliniskt undersökning. Frågeformuläret och den kliniska undersökningen utfördes enligt i den arabiska versionen av *Research Diagnostic Criteria* för TMD (RDC/TMD).

Resultaten visade 58 patienter (18%) som rapporterade TMD-smärta, varav 46 undersöktes kliniskt. Medelåldern på de undersökta patienterna var 30 ± 7 år och relationen män och kvinnor var 1:6 ($P < 0.001$). Alla patienter med TMD-smärta hade diagnosen myofasciell smärta och 65% hade dessutom diagnoserna artralgi eller osteoartrit. Både huvudvärk eller migrän de senaste 6 månaderna och huvudvärk den senaste månaden rapporterades i höga frekvenser i gruppen med TMD-smärta, 93% och 71% med skillnader ($P < 0.001$) mellan gruppen med och utan TMD-smärta. Smärta enligt *Graded Chronic Pain Scale* rapporterades vara grad I i 45%, grad II i 53%, grad III i 2% och inga i grad IV. I 38% hos TMD-patienterna med smärta fanns höga värden på skalan för depression och 60% hade höga värden på skalan för somatisering med skillnader ($P < 0.001$) mellan gruppen med och utan TMD-smärta.

Sammanfattningsvis, visade studien en frekvens av TMD-smärta i den saudiarabiska kohorten, på 18%. I gruppen med TMD-smärta fanns höga värden på depression, somatisering men låga värden enligt *Graded Chronic Pain Scale*.

Introduction

The American Dental Association suggested the term *temporomandibular disorders* (TMD) to describe a cluster of related disorders characterised by (i) pain in the pre-auricular area, the temporomandibular joint (TMJ), or the muscles of mastication and (ii) limitation or deviation in the mandibular range of motion and noises in the TMJ during mandibular function (16). Epidemiological studies on TMD have been done in several countries worldwide. TMD pain appears to be 1.5–2 times more common in women than men (30, 47) and is a condition in young and middle-aged adults (30, 31, 47) and in children and adolescents (34, 39, 48). Several epidemiological studies of TMD were done in Saudi Arabia (2, 4–7, 19–24, 27, 37, 40, 51). These studies mainly examined signs and symptoms in relation to parafunctional habits and/or occlusal characteristics. Most of these studies included children and adolescents, 1 study focused on a population of male dental students, ages 20–29. About one-third had signs and symptoms of TMD, but no TMD diagnoses were described in that study (40).

In Saudi Arabia, dental health care services are divided into 3 levels: (i) primary health care provided by dental clinics in primary health care centres, (ii) dental departments in public hospitals, and (iii) specialist care provided by 1 specialised dental centre in every city. Level 3 receives patients who need more specialised dental care; they are referred from the dental departments in the public hospitals. The Saudi Council for Health Specialties accredits the Makkah Specialised Dental Centre as a training centre for specialist training of Saudi board students in restorative dentistry. The Dental Centre has all dental specialties except TMD/orofacial pain. In Saudi Arabia, no specialised clinic covers management of TMD and orofacial pain; the patients receive care from various specialties such as oral surgery, prosthodontics, and orthodontics.

In the past, examining signs and symptoms was the preferred way to study epidemiology of TMD without diagnoses of subgroups of TMD. Absence of taxonomic homogeneity among various studies limits comparisons of data from many epidemiological studies (17, 18). *The Research Diagnostic Criteria for TMD* (RDC/TMD) (17) were introduced as an initial step to address these shortcomings. They were intended primarily for research purposes, allowing standardised methods for gathering relevant data and making possible comparison of findings among diverse clinical investigators (17). Use of reliable di-

agnoses is critical in establishing a clinical condition and a rational approach to treatment, and the RDC/TMD constitute the most widely used TMD diagnostic system for doing clinical research (28). The RDC/TMD diagnostic system is the only available TMD diagnostic system that is empirically based, uses operationally defined measurement criteria to generate computer-derived diagnostic algorithms for the most common TMD forms, and provides specifications for conducting a standardised clinical physical examination. It has been formally translated/back-translated into 18 languages and is the common diagnostic method used by the 45-member consortium of RDC/TMD-based international researchers (26, 28). The RDC/TMD demonstrates sufficiently high reliability for the most common TMD diagnoses, supporting its use in clinical research and decision-making (28).

The authors of this study are unaware of any TMD diagnosis studies in Saudi Arabia that are based on the RDC/TMD (17). Consequently, this study used the Arabic version of the RDC/TMD – Axis I and Axis II – to examine the frequency of TMD pain in Saudi Arabians aged 20–40 who were referred to the Specialist Dental Centre in Makkah, Saudi Arabia. The hypotheses were that (i) subdiagnoses of TMD could be found among this group of dental patients and (ii) differences would exist regarding gender and psychosocial situation in the TMD pain and non-TMD pain groups.

Material and methods

Study population

In October and November 2005 (3 days a week) at the Specialist Dental Centre in Al-Noor Specialist Hospital in Makkah, 335 consecutive Saudi dental patients were invited to participate in the study. They were referred from primary and secondary health care clinics due to need for specialised care but not due to TMD pain. The director of health affairs in Makkah, Saudi Arabia granted ethical approval for the study. All patients were informed about the study and gave their informed consent. They were informed that if they did not participate it would not influence their care at the Centre.

All patients were selected per these criteria:

Inclusion criteria:

- Ages 20–40 years
- Able to communicate in an interview

Exclusion criterion:

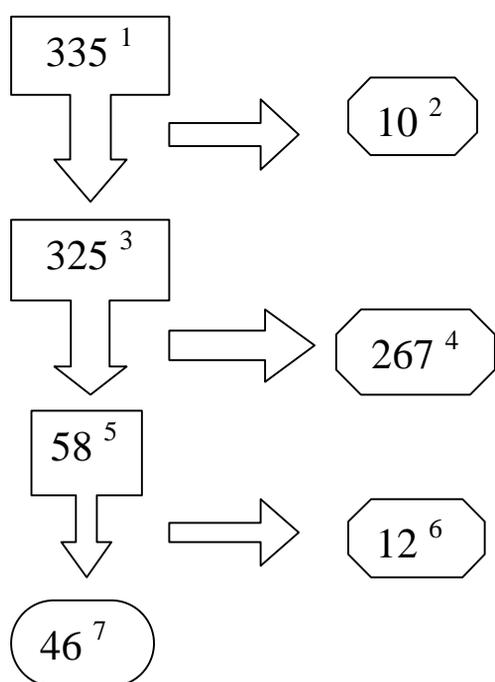
- Acute dental pain

Of the 335 patients, 10 were excluded (did not meet

criteria). Among the 325 patients, 58 reported TMD pain per question 3 in the RDC/TMD history questionnaire (17): Have you had pain in the face, jaw, temple, in front of the ear or in the ear in the past month? Twelve of the 58 patients were not clinically examined because they either had no time or were not interested, so 46 patients were diagnosed per RDC/TMD after clinical examination. Figure 1 describes patient selection for the study.

© **Figure 1.** Flow chart of patient selection process:

1. Consecutive patients between 20 and 40 years old.
2. Patients excluded due to acute dental pain.
3. Patients completing history questionnaires.
4. Patients not fulfilling the inclusion criterion of TMD pain (non-TMD pain group).
5. Patients fulfilling criterion of TMD pain (TMD pain group).
6. Clinical examination drop-outs due to either no time or no interest.
7. Patients completing the RDC/TMD clinical examination.



Methods

Two trained dentists interviewed the 335 patients using the Arabic version of the original history questionnaire of the RDC/TMD (26). The interview occurred in a separate room. For cultural reasons, a

female dentist was trained to interview the women who were accompanied by their husbands or male relatives. The clinical examination was done by a calibrated dentist per the RDC/TMD protocol.

Physical findings were measured according to RDC/TMD Axis I by means of clinical assessment of TMD signs and symptoms. Pain intensity was assessed with a numeric rating scale (NRS) (range 0–10). The RDC/TMD (i) divides the most common forms of TMD into the 3 groups of diagnoses myofascial pain, disc displacements, and other joint conditions such as arthralgia, arthritis, and arthrosis and (ii) allows multiple diagnoses to be made for a given patient (17). Rate of agreement between the principle examiner and the calibrated dentist was calculated using kappa statistic (κ) (8). Values of κ for subdiagnoses were $\kappa = 0.79$ (good) for group I diagnoses; $\kappa = 0.91$ (very good) for group II diagnoses; and $\kappa = 0.48$ (moderate) for group III diagnoses.

RDC/TMD Axis II was used to assess psychological status, yielding a profile of chronic pain dysfunction, depression, somatisation, and orofacial disability (17). Psychological status was assessed with the depression score and the somatisation score from subscales of the *Symptom Checklist-90-Revised* (SCL-90-R) in which scores of all items answered are added and divided by the number of items answered (14). Orofacial disability was assessed with the Graded Chronic Pain Scale (GCPS), which yields a score of 0–IV (0 = No TMD pain in the prior 6 months, IV = High disability-severely limiting) (46).

In this study, 2 Axis II questions about sexual activities were deleted to make the history questionnaire acceptable in the Saudi (Arabic-Muslim) culture. Another 2 questions about thinking of death or dying (question 20-f) and awakening early in the morning (question 20-aa) were modified. Question 20-f was modified to ask about excessive thoughts of death or dying, where thought is not based on religious sentiments. Question 20-aa was modified to ask about awakening early in the morning before dawn prayer time (an hour before sunrise).

Statistical analysis

Data were gathered and analysed using the Statistical Package for the Social Sciences (SPSS) version 13.0 for Windows. The chi-square test or Fisher's exact test was used for comparison of several variables on a nominal scale to determine whether differences between the TMD pain and non-TMD pain groups were significant. The alpha level of $P < 0.05$ was used to indicate statistical significance.

© **Table 1.** Distribution of years of education and marital status in the TMD pain (n=58) and non-TMD pain (n=267) groups.

	TMD pain group				Non-TMD pain group				Total	
	Males (n = 12)		Females (n = 46)		Males (n = 123)		Females (n = 144)		(n=325)	
	n	%	n	%	n	%	n	%	n	%
Years of education:										
0–6	0	0	16	35	10	8	31	21	57	17
7–12	5	42	11	24	37	30	47	33	100	31
> 12	7	58	19	41	76	62	66	46	168	52
Marital status:										
Married	5	42	26	57	60	49	80	56	171	53
Non-married†	7	58	20	43	63	51	64	44	154	47

† Married spouse not living in household, widowed, divorced, and separated were (5%) included as non-married.

© **Table 2.** Distribution of reported headaches or migraines in the last 6 months and headache intensity in the last month in the TMD pain and non-TMD pain groups.

	TMD pain Group (n=58)		Non-TMD pain Group (n=267)		P value
	n	%	n	%	
Headaches or Migraine	54	93	182	68	<0.001 †
Headache intensity:					
not at all	4	7	88	33	<0.001 §
a little bit	13	22	104	39	<0.001 §
moderately	12	21	43	16	<0.001 §
quite a bit	11	19	15	5	<0.001 §
extremely	18	31	17	7	<0.001 §

† Chi-square test. § Fisher’s exact test.

© **Table 3.** Distribution of clinical findings in 46 patients with TMD pain.

Clinical findings	Males (n=7)	Females (n=39)	Total (n=46)	
	n	n	n	%
Mouth opening without pain:				
≥ 40 mm	5	19	24	52
< 40 mm	2	20	22	48
Maximum unassisted:				
<35 mm	7	36	43	93
≤ 35 mm	0	3	3	7
Reported pain during maximum assisted-opening in the:				
TMJ	2	26	28	61
Muscles	2	25	27	59
TMJ sounds:				
Clicking	0	16	16	35
Reciprocal clicking	0	6	6	13
Crepitation	1	7	8	17

Results

The 325 dental patients had a mean age of 29 ± 6. One hundred and thirty-five (42%) male patients had a mean age of 29 ± 6 and 190 (58%) female patients had a mean age of 29 ± 6. Most patients were Arabians (268 [83%]), followed by Asians (46 [14%]), and blacks (10 [3%]). Fifty-eight patients reported TMD pain and formed the TMD pain group: 79% were women and 21% men (P < 0.001). The non-TMD pain group (n=267) comprised 54% women and 46% men without significant differences between the groups.

Table 1 shows distribution of years of education and marital status. Five per cent had no education; all were females. Most patients were either married-living in household (171 [53%]) or never married (139 [43%]). Fifteen patients (5%) were separated, divorced, widowed, or married, but the spouse was not in the household. There were no significant between-group differences in education or marital status.

Headaches or migraines in the past 6 months were reported by 81% females and 61% males, while moderate-to-extreme headaches in the past month were reported by 45% females and 22% males. Table 2 shows that significantly more patients reported headaches or migraines in the TMD pain group compared to the non-TMD pain group (P < 0.001).

A high frequency of all patients reported good-to-excellent general health (98%) and oral health (85%) without significant differences between genders.

The TMD pain patients rated their pain over the last 6 months on a 0–10 NRS:

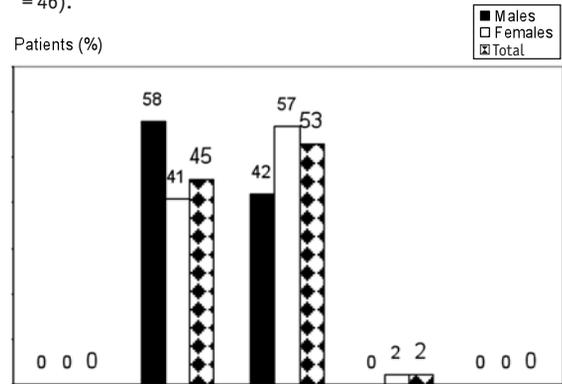
- 90% (52: 19% [10] males and 81% [42] females) rated their worst orofacial pain ≥ 5 (question 8).
- 93% (54: 19% [10] males and 81% [44] females) rated their usual orofacial pain between 1 and 6 (question 9).

Among the 46 clinically examined TMD pain patients, the male-female ratio was 1:6 ($P < 0.001$). The mean value of mouth opening without pain was 41 mm in both genders. Maximum unassisted opening less than 35 mm was found in only 3 females. Mean values for maximum unassisted opening were 49 mm for males and 48 mm for females. Clicking sounds in the TMJ were recorded in females. Crepitation sounds were recorded in females and were the only recorded TMJ sound among males. Table 3 lists the clinical findings.

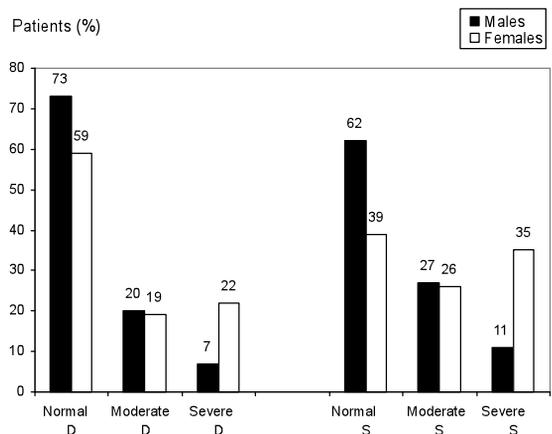
Most TMD pain patients were assessed as grade I or II on the GCPS (Fig 2). According to the RDC/TMD, a patient can be assigned 0–5 subdiagnoses (one group I diagnosis and for each joint, one diagnosis from group II and one from group III). All 46 patients had a myofascial pain diagnosis; 65% of the patients had a group III pain diagnosis and 22% had only myofascial pain; see Table 4.

As per SCL-90-R(14) for assessment of psychological status by providing scale scores for depression and somatisation, the mean (SD) values for depression and somatisation in the TMD pain group were $0.97 (\pm 0.69)$ and $1.37 (\pm 0.86)$ and in the non-TMD pain group $0.42 (\pm .51)$ and $0.52 (\pm 0.52)$, respectively. Significant differences were found between genders when comparing normal with moderate-to-severe scores of depression ($P < 0.01$) and for somatisation scores in all 325 patients ($P < 0.001$) (Fig 3). Values of moderate-to-severe scores for depression and somatisation were significantly higher in the TMD pain group than in the non-TMD pain group ($P < 0.001$); see Figure 4.

©Figure 2. Distribution of GCPS grades (score range 0–IV) with respect to gender in 58 TMD pain patients (males = 12, females = 46).



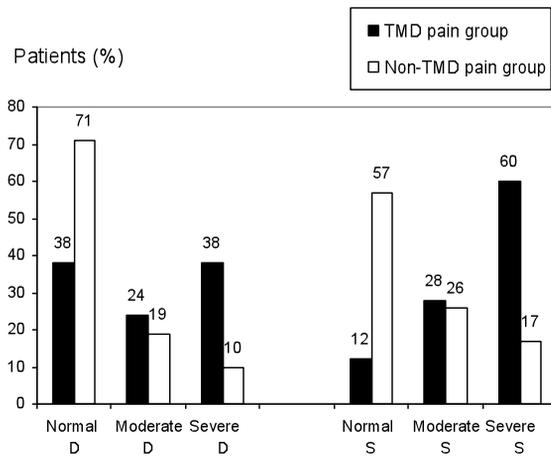
©Figure 3. Distribution of normal, moderate, and severe scores for depression (D) and somatisation (S) (including pain items) with respect to gender (males = 135, females = 190).



©Table 4. Distribution of subdiagnoses per RDC/TMD in 46 patients reporting TMD pain.

Subdiagnoses of TMD	Males (n=7)	Females (n=39)	Total (n=46)	
	n	n	n	n%
Myofascial pain (only)				
Without limited opening	3	4	7	15
With limited opening	2	1	3	7
Myofascial pain combined with:				
Arthralgia	1	25	26	56
Osteoarthritis	1	3	4	9
Osteoarthrosis	0	2	2	4
Disc displacement:				
with reduction	0	11	11	24
without reduction without limited opening	1	4	5	11

©Figure 4. Distribution of normal, moderate, and severe scores for depression (D) and somatisation (S) [including pain items] in TMD pain group and non-TMD pain group.



Discussion

This study found a frequency of TMD pain symptoms in 18% of the 325 patients referred for specialised dental—but not TMD pain—treatment, and those patients were suffering from at least 1 subdiagnosis of TMD. This figure (18%) is higher than has been reported in population studies (13, 16, 31) but not unexpected, because this was a patient and not a population study, and the age range of the patients was 20–40, which is the age at which TMD pain has its peak of frequency in the general population (15, 43). A previous study of patients seeking dental treatment reported similar figures (35). But comparison of this study's results with previous studies in Arabian countries is difficult due to differences in age groups, examination methods, and non-existent TMD subdiagnoses.

This study was performed under existing domestic circumstances—among others, low education, illiteracy, and cultural values. A population-based study would have been difficult to execute. These difficulties could be one reason why, in Saudi Arabia, epidemiological studies on TMD have been performed in schools, university settings, or dental clinics (2, 4–7, 19–24, 27, 37, 40, 51).

The male–female ratio in the clinically examined patients in the TMD pain group agreed with ratios from other TMD studies (9, 43, 50) namely, a ratio of 1:3–1:5. While differences in TMD prevalence between males and females is still not well understood, some theories have suggested biological, occupational, psychological, and social factors (1, 12). Interes-

tantly, some researchers stated that variations in estimated prevalence rate of reported pain symptoms suggest that various sociodemographic characteristics may be related to the onset, course, and outcome of particular types of orofacial pain. Besides gender, other factors to be included are age, race/ethnicity, psychosocial factors, and place of residence (31).

On the original Arabic RDC/TMD (17) history questionnaire, some questions were modified or deleted so as to be accepted in the Saudi (Arabic-Muslim) culture. In Islamic culture, any sexual relation is reserved exclusively for the confines of marriage. This issue, addressed in questions 19–g and 20–b, was excluded to prevent loss of cooperation and to avoid legal troubles for the health workers and the interviewer. The authors of this study believe that deletion of the item about sexual relation (20–b) in the SCL-90-R does not affect the total score for depression since the sum of the scores of all answered items is divided by the number of items answered (14).

Question 20–f was modified to ask about excessive thoughts of death, where thought is not based on religious sentiments, because thinking of death and life after death is recommended in Islamic culture. Question 20–aa was modified to ask about awakening early in the morning for reasons other than religious reasons. Muslims pray before dawn (an hour before sunrise), and this prayer is one of the 5 obligatory prayers distributed over specific times during the day and night. We believe these modifications did not affect the main idea of the questions and did not affect RDC/TMD diagnostic rules but instead made them more understandable and reasonable in such a culture. Note: a female dentist was trained to interview the females who were accompanied by husbands or male relatives so that the husbands or male relatives would not insist on attending the interview, which might have jeopardised the outcome of the interview.

General education in Saudi Arabia consists of kindergarten, 6 years of primary school, and 3 years each of junior high and high school. More patients in the pain and non-pain groups had > 12 years of education than those who had < 12 years of education without any significant differences. No differences in education were found in our study or in the *El-Amin et al* study (19). The differences in education presented by *Dworkin et al* (16) were found in material that included general and clinical patients.

Overall, married patients did not show higher values of TMD symptoms compared to non-married patients. And there were no significant differences

between married and non-married females in the TMD pain group. These findings do not agree with *Zulgarnain et al* (51), who found differences in TMD pain between married and non-married university female students in Saudi Arabia. But this study included a higher number of individuals, which made it possible to study the TMD symptoms in more detail.

In this study headaches or migraines in the last 6 months were frequently found in women (47%) and nearly twice as often as in men (25%). Our findings agree with other studies (9, 35) and with a discussion study regarding frequency of migraines without aura (12). But more information from patients is needed in the RDC/TMD history questionnaires regarding the nature, onset, location, and duration of headaches and migraines to confirm the diagnosis. This may explain the high figures of headaches or migraines reported by the patients in this study compared to reported findings of specific diagnosed headaches in a study on a Saudi population in another region of the country (3). In the TMD pain group, headaches within the last month were significantly higher than in the non-TMD pain group in this study. And this agrees with many studies that report high frequencies of headaches and consider headache to be a symptom of TMD (1, 9, 27, 35, 37, 38, 51). But in recent studies, it was concluded that TMD and tension-type headache disorders overlap and appear to share many of the same pathophysiological mechanisms (45). Headache patients and TMD patients overlap considerably in diagnosis and oral parafunctional behaviours (25).

Regarding RDC/TMD subdiagnosis groups, all patients in this study with TMD pain had myofascial pain, with or without limited opening. The high frequency of myofascial pain in this study agrees with other studies (11, 32, 36, 41). The next most-frequent TMD subdiagnosis after myofascial pain was arthralgia/osteoarthritis (65% in total). The high frequency of TMD pain group III diagnoses also agrees with other studies as well as the percentages of patients diagnosed with disc displacement with reduction (11, 32, 36, 41-43). The moderate reliability of group III TMD subdiagnoses ($\kappa = 0.48$) found in this study might explain one reason for the high number of TMD pain group III diagnoses. But this reliability agrees with previous reliability studies (28, 29, 33, 44).

In this study, the frequency of pain in the last month > 5 on the NRS was high, 90%. This finding shows that the TMD pain group consisted mostly of

patients with moderate and severe pain. A recently presented European survey of chronic pain defined an intensity below 5 on this scale as mild pain (10).

GCPS grades for females in the TMD pain group were mainly found to be grade II (57%), followed by grade I (41%). These grades found in Saudi Arabian females were not aligned with GCPS grades found for females in other studies (32, 43, 49, 50). In these studies, grades III and IV were also found. The GCPS includes number of days kept from usual activities (work, school, and house) due to orofacial pain, and the grades thus depend on these activities. So differences in findings between studies might be socio-economic, cultural, and/or political.

RDC/TMD Axis II components are reliable and valid indicators of depression, somatisation, and psychosocial dysfunction in response to pain. They do not provide psychiatric diagnoses. Rather, they provide initial scientific support to validate evidence-based clinical decision-making (18). Percentages of SCL-90-R (14) scores of moderate-to-severe depression and somatisation per RDC/TMD in the TMD pain group were higher than scores reported in studies of non-Arabian populations (32, 50). But the scores in this study were lower compared to the scores for Arabian females reported in the Reiter et al study (43). More stable socio-economic and political situations in Saudi Arabia could partly explain the difference. Both groups of Arabian females in the 2 populations reported higher scores of depression and somatisation compared to Swedish, American, and Asian populations (32, 43, 49). Various ethnic, cultural, and psychosocial backgrounds might explain this difference.

The high frequency of TMD pain found among the patients referred for specialised dental treatment should encourage dentists and oral health workers to include an evaluation of TMD pain in all patients referred for any specialised dental treatments. The scarcity of epidemiological studies of adults who suffer from orofacial pain and TMD in Saudi Arabia probably explains the lack of a TMD and orofacial pain specialty. Patients diagnosed with TMD pain were informed about the diagnoses and offered TMD treatment at the oral surgery clinic in the Specialist Dental Centre, Makkah.

In conclusion, findings of this study showed a high frequency of TMD pain in this Saudi Arabian cohort. High frequencies of both migraines and headaches were reported. All patients with TMD pain met the criteria for subdiagnoses of TMD. These results support the usefulness of RDC/TMD when

comparing data from various international TMD studies. To the author's knowledge, this is the first study that uses the RDC/TMD in Saudi Arabia and/or Arabian countries, and this makes it now possible to compare TMD prevalence with other studies of patient materials, especially of patient materials in other countries and cultures. The TMD pain group presented high scores of depression and somatisation but low disability grades concerning GCPS. More investigations are needed to assess in more detail the presence of TMD diagnoses and psychosocial status in Saudi Arabia, not least regarding cultural differences in TMD pain.

Acknowledgement

The authors extend warm thanks to Dr. Linda Mirza for her help in interviewing some female patients; to Dr. Mohammad Wahbi, former director of the Specialist Dental Centre at Al-Noor Hospital, for his assistance and cooperation before and during the study.

References

1. Abdel-Hakim AM. Stomatognathic dysfunction in the western desert of Egypt: an epidemiological survey. *J Oral Rehabil* 1983;10:461-8.
2. Abdel-Hakim AM, Alsalem A, Khan N. Stomatognathic dysfunctional symptoms in Saudi Arabian adolescents. *J Oral Rehabil* 1996;23:655-61.
3. Abduljabbar M, Ogunniyi A, al Balla S, Alballaa S, al-Dalaan A. Prevalence of primary headache syndrome in adults in the Qassim region of Saudi Arabia. *Headache* 1996;36:385-8.
4. Akeel R, Al-Jasser N. Temporomandibular disorders in Saudi females seeking orthodontic treatment. *J Oral Rehabil* 1999;26:757-62.
5. Alamoudi N. The correlation between occlusal characteristics and temporomandibular dysfunction in Saudi Arabian children. *J Clin Pediatr Dent* 2000;24:229-36.
6. Alamoudi N. Correlation between oral parafunction and temporomandibular disorders and emotional status among Saudi children. *J Clin Pediatr Dent* 2001;26:71-80.
7. Alamoudi N, Farsi N, Salako NO, Feteih R. Temporomandibular disorders among school children. *J Clin Pediatr Dent* 1998;22:323-8.
8. Altman D. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991.
9. Anastassaki A, Magnusson T. Patients referred to a specialist clinic because of suspected temporomandibular disorders: a survey of 3194 patients in respect of diagnoses, treatments, and treatment outcome. *Acta Odontol Scand* 2004;62:183-92.
10. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *Eur J Pain* 2006;10:287-333.
11. Celic R, Dworkin S, Jerolimov V, Maver-Biscanin M, Bago MJ. Prevalence of temporomandibular disorders diagnoses and psychologic status in Croatian patients. *Acta Stomatol Croat* 2004;38:333-9.
12. Dao TT, LeResche L. Gender differences in pain. *J Orofac Pain* 2000;14:169-84; discussion 84-95.
13. De Kanter RJ, Truin GJ, Burgersdijk RC, Van 't Hof MA, Battistuzzi PG, Kalsbeek H, Kayser AF. Prevalence in the Dutch adult population and a meta-analysis of signs and symptoms of temporomandibular disorder. *J Dent Res* 1993;72:1509-18.
14. Derogatis L. *SCL-90-R; administration, scoring and procedures manual II*. Towson (MD): Clinical Psychometric Research, 1983.
15. Drangsholt M, LeResche L. Temporomandibular disorder pain. In: Crombie IK, Croft DR, Linton SJ, LeResche L, Von Korff M (eds). *Epidemiology of Pain*. Seattle: IASP Press, 1999. pp.203-34.
16. Dworkin SF, Huggins KH, LeResche L, Von Korff M, Howard J, Truelove E, Sommers E. Epidemiology of signs and symptoms in temporomandibular disorders: clinical signs in cases and controls. *J Am Dent Assoc* 1990;120:273-81.
17. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord* 1992;6:301-55.
18. Dworkin SF, Sherman J, Mancl L, Ohrbach R, LeResche L, Truelove E. Reliability, validity, and clinical utility of the research diagnostic criteria for Temporomandibular Disorders Axis II Scales: depression, non-specific physical symptoms, and graded chronic pain. *J Orofac Pain* 2002;16:207-20.
19. El-Amin E-FI, Khalid MA-H, Ali SE-L. Temporomandibular Disorders in Al-Ahsa province, KSA: An epidemiologic study. *Saudi Dent J* 2001;13:133-8.
20. Farsi N. Temporomandibular dysfunction and the emotional status of 6-14 years old Saudi female children. *Saudi Dental J* 1999;11:114-9.
21. Farsi N, Alamoudi N, Feteih R, El-Kateb M. Association between temporomandibular disorders and oral parafunctions in Saudi children. *Odontostomatol Trop* 2004;27:9-14.
22. Farsi NM. Symptoms and signs of temporomandibular disorders and oral parafunctions among Saudi children. *J Oral Rehabil* 2003;30:1200-8.
23. Farsi NM, Alamoudi N. Relationship between premature loss of primary teeth and the development of temporomandibular disorders in children. *Int J Paediatr Dent* 2000;10:57-62.
24. Feteih RM. Signs and symptoms of temporomandibular disorders and oral parafunctions in urban Saudi Arabian adolescents: a research report. *Head Face Med* 2006;2:25.
25. Glaros AG, Urban D, Locke J. Headache and temporomandibular disorders: evidence for diagnostic and behavioural overlap. *Cephalalgia* 2007;27:542-9.
26. International Consortium for RDC/TMD-based Research, 2004. International Consortium for RDC/TMD-based Research. <http://www.rdc-tmdinternational.org/>. 2004.
27. Jagger RG, Wood C. Signs and symptoms of temporomandibular joint dysfunction in a Saudi Arabian population. *J Oral Rehabil* 1992;19:353-9.
28. John MT, Dworkin SF, Mancl LA. Reliability of clinical

- temporomandibular disorder diagnoses. *Pain* 2005;118:61-9.
29. Leher A, Graf K, PhoDuc JM, Rammelsberg P. Is there a difference in the reliable measurement of temporomandibular disorder signs between experienced and inexperienced examiners? *J Orofac Pain* 2005;19:58-64.
 30. LeResche L. Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med* 1997;8:291-305.
 31. Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc* 1993;124:115-21.
 32. List T, Dworkin SF. Comparing TMD diagnoses and clinical findings at Swedish and US TMD centers using research diagnostic criteria for temporomandibular disorders. *J Orofac Pain* 1996;10:240-53.
 33. List T, John MT, Dworkin SF, Svensson P. Recalibration improves inter-examiner reliability of TMD examination. *Acta Odontol Scand* 2006;64:146-52.
 34. List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: prevalence of pain, gender differences, and perceived treatment need. *J Orofac Pain* 1999;13:9-20.
 35. Magnusson T, Carlsson SE. Comparison between two groups of patients in respect of headache and mandibular dysfunction. *Swed Dent J* 1978;2:85-92.
 36. Manfredini D, Chiappe G, Bosco M. Research diagnostic criteria for temporomandibular disorders (RDC/TMD) axis I diagnoses in an Italian patient population. *J Oral Rehabil* 2006;33:551-8.
 37. Nassif NJ, Al-Salleeh F, Al-Admawi M. The prevalence and treatment needs of symptoms and signs of temporomandibular disorders among young adult males. *J Oral Rehabil* 2003;30:944-50.
 38. Nassif NJ, Talic YF. Classic symptoms in temporomandibular disorder patients: a comparative study. *Cranio* 2001;19:33-41.
 39. Nilsson IM, List T, Drangsholt M. Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. *J Orofac Pain* 2005;19:144-50.
 40. Nourallah H, Johansson A. Prevalence of signs and symptoms of temporomandibular disorders in a young male Saudi population. *J Oral Rehabil* 1995;22:343-7.
 41. Plesh O, Sinisi SE, Crawford PB, Gansky SA. Diagnoses based on the Research Diagnostic Criteria for Temporomandibular Disorders in a biracial population of young women. *J Orofac Pain* 2005;19:65-75.
 42. Rantala MA, Ahlberg J, Suvinen TI, Savolainen A, Kononen M. Symptoms, signs, and clinical diagnoses according to the research diagnostic criteria for temporomandibular disorders among Finnish multiprofessional media personnel. *J Orofac Pain* 2003;17:311-6.
 43. Reiter S, Eli I, Gavish A, Winocur E. Ethnic differences in temporomandibular disorders between Jewish and Arab populations in Israel according to RDC/TMD evaluation. *J Orofac Pain* 2006;20:36-42.
 44. Schmitter M, Ohlmann B, John MT, Hirsch C, Rammelsberg P. Research diagnostic criteria for temporomandibular disorders: a calibration and reliability study. *Cranio* 2005;23:212-8.
 45. Svensson P. Muscle pain in the head: overlap between temporomandibular disorders and. *Curr Opin Neurol* 2007 Jun;20(3):320-5.
 46. Von Korff M, Dworkin SF, Le Resche L. Graded chronic pain status: an epidemiologic evaluation. *Pain* 1990;40:279-91.
 47. Von Korff M, Dworkin SF, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. *Pain* 1988;32:173-83.
 48. Wahlund K, List T, Dworkin SF. Temporomandibular disorders in children and adolescents: reliability of a questionnaire, clinical examination, and diagnosis. *J Orofac Pain* 1998;12:42-51.
 49. Yap AU, Chua EK, Dworkin SF, Tan HH, Tan KB. Multiple pains and psychosocial functioning/psychologic distress in TMD patients. *Int J Prosthodont* 2002;15:461-6.
 50. Yap AU, Dworkin SF, Chua EK, List T, Tan KB, Tan HH. Prevalence of temporomandibular disorder subtypes, psychologic distress, and psychosocial dysfunction in Asian patients. *J Orofac Pain* 2003;17:21-8.
 51. Zulqarnain BJ, Khan N, Khattab S. Self-reported symptoms of temporomandibular dysfunction in a female university student population in Saudi Arabia. *J Oral Rehabil* 1998;25:946-53.

Address:

Dr Mohammad Hasan Al-Harthy
 Department of Stomatognathic Physiology
 Faculty of Odontology
 Malmö University
 Carl Gustafsväg 34
 SE- 205 06 Malmö, Sweden
 E-mail: m_alharthy@hotmail.com

Duration of orthodontic treatment in conjunction with orthognathic surgery

SNJEZANA SLAVNIC¹, AGNETA MARCUSSON²

Abstract

⊙ Patients considering undergoing combined orthodontic-orthognathic treatment for correction of malocclusion require appropriate information, particularly with respect to duration of treatment.

The primary aim of this study was to determine the duration of orthodontic treatment carried out in conjunction with orthognathic surgery and to analyze the influence of selected explanatory variables. A further aim was to compare the duration of orthodontic treatment in patients treated by orthodontists at Linköping University hospital orthodontic clinic and six regional orthodontic clinics.

This is a retrospective study, based on data from the orthodontic records of patients who had undergone orthognathic surgery at the University Hospital Maxillofacial Unit in Linköping, Sweden, from 2000 to 2005. The subjects comprised 207 out of 233 patients (107 women and 100 men), aged 15.8 - 56.9 years, median 24.2 years at the time of surgery: 26 patients were excluded, either diagnosed with a syndrome, or because it was impossible to follow up the entire treatment. 59 subjects had undergone orthodontic treatment at the University hospital orthodontic clinic and 148 at the 6 regional orthodontic clinics. The variables recorded were gender, malocclusion, the number of appointments (scheduled and emergency) and treatment setting.

The median value for pre-operative orthodontic treatment time was 19.2 months (range 2.4 - 68.4); for postoperative orthodontic treatment 4.6 months (range 0 - 18.8) and for total orthodontic treatment 27.8 months (range 5.9 - 79.1). For the University hospital orthodontic clinic, pre-operative (16.7 months) and total orthodontic treatment times (25 months) were significantly shorter than for the regional clinics; the duration of postoperative treatment was significantly longer (4.1 months). No other explanatory variables had a significant influence on the duration of orthodontic treatment. Compared with the regional orthodontic clinics, there were significantly fewer scheduled appointments at the University hospital orthodontic clinic, but no significant difference in emergency attendance.

Key words

Duration, orthodontic treatment, orthognathic surgery

¹ The Centre for Orthodontics and Paediatric Dentistry, S-601 82 Norrköping, Sweden

² Maxillofacial Unit, University Hospital, S-581 85 Linköping, Sweden

Hur lång tid tar den pre- och postoperativa ortodontin vid ortognatisk kirurgisk behandling?

SNJEZANA SLAVNIC, AGNETA MARCUSSON

Sammanfattning

◎ Syftet med studien var att fastställa längd för ortodontisk behandling vid ortognat kirurgi och faktorer som kunde påverka den samt att jämföra den ortodontiska behandlingens längd mellan 6 regionala ortodontikliniker och Käkliniken vid Universitets sjukhus i Linköping. Det är en retrospektiv studie baserad på ortodontisk journaldata av patienter som behandlades med ortognat kirurgi på Käkliniken vid Universitetssjukhuset i Linköping mellan år 2000 och 2005. Studien omfattar 207 av 233 patienter (107 kvinnor och 100 män) i ålder 15,8 – 56,9 år (median 24,2 år) vid tidpunkt för kirurgi. 26 patienter exkluderades p.g.a. syndromdiagnos eller andra orsaker som gjorde uppföljning av behandling omöjlig. 59 patienter fick sin ortodontibehandling utförd vid Käkliniken och 148 patienter behandlades vid 6 ortodontikliniker. Variabler som undersöktes var patientens kön, bettfel, antal besök (ordinarie och akuta) och kliniken där den ortodontiska behandlingen utfördes. Median värde för preoperativ ortodonti var 19,2 (spridning 2,4–68,4) månader, för postoperativ ortodonti 4,6 (spridning 0–18,8) månader och för total ortodonti 27,8 (spridning 5,9–79,1) månader. Preoperativ (16,7 mån) och total ortodonti (25 mån) var signifikant kortare medan postoperativ var signifikant längre (4,1 mån) på Käkliniken. Den sammanlagda tiden för ortodonti minskades avsevärt om behandlingen utfördes vid Käkliniken. Inga andra variabler hade ett betydande inflytande på den ortodontiska behandlingstiden. Käkliniken hade betydligt mindre antal regelbundna besök. Det var ingen signifikant skillnad i antalet akuta besök.

Introduction

Not all malocclusions can be treated satisfactorily by orthodontic intervention alone. Large skeletal deviations require orthognathic surgery in conjunction with pre- and post-operative orthodontic treatment. These are complex, time-consuming procedures, requiring patient compliance. Pre-operative orthodontic treatment is necessary to eliminate dental compensation and align and harmonize the dental arches. The goal of postoperative orthodontic treatment is to guide the teeth into a permanent position, by completing the leveling, settling the teeth into occlusion and compensating for any inaccuracy of the surgical outcome by minor antero-posterior movements (9).

A study by *Nurminen et al.* (8) of patients who had undergone combined orthodontic-orthognathic surgical treatment disclosed that 79% experienced considerable pain from the orthodontic appliances and as many as 1 / 3 perceived the orthodontic treatment to be the most difficult aspect of their treatment, mainly because of the long duration (8). Another study showed that orthodontic-orthognathic surgery patients considered that they were better informed about the orthodontic part of the treatment than the surgical part, but a significant number expressed dismay about the lengthy orthodontic treatment and the subsequent need for retainers (12).

Patients undergo orthodontic-orthognathic surgical treatment for a variety of reasons: to improve the alignment of their teeth (80%), to prevent future dental problems (69%) and to improve self-confidence (68%) (12). Patient dissatisfaction with treatment delivery is attributed primarily to poor communication (2). It is important that patients receive accurate, detailed information about the proposed treatment, in order to make an informed decision as to whether to consent to treatment (7).

Correct patient information on, among other things, the anticipated duration of orthodontic treatment, is an important prerequisite for successful outcome in terms of patient satisfaction and reasonable expectations. To date, few studies have addressed this important issue.

Proffit & Miguel (9) reported a median duration of orthodontic treatment ranging from 18-28 months, depending on whether the treatment had been carried out by orthodontists at a university hospital department of dentofacial orthopaedics or elsewhere and concluded that the two main explanatory variables with respect to duration of orthodontic treatment seemed to be the treatment setting and

the orthodontist's experience (9). *Dowling et al.* (3) reported a median value for duration of orthodontic treatment of 21.9 months. Pre-operative, postoperative and total orthodontic treatment duration were significantly shorter for orthodontists who were more experienced in combined orthodontic-orthognathic surgical treatment (3).

Conflicting results are reported with respect to the relationship between dental extractions and treatment time: some studies show significantly prolonged treatment time to be associated with extractions (3, 9) while others show that the treatment time remains unaffected (11).

For a variety of malocclusions, the mean duration of conventional orthodontic treatment with fixed appliances is reported to be 20 to 36 months (5, 6, 10, 11).

The aims of the present study were threefold: firstly, to determine preoperative, postoperative and total orthodontic treatment time for orthodontic-orthognathic surgical treatment; secondly, to investigate any correlation between orthodontic treatment time and explanatory variables such as sex, malocclusion, the number of scheduled appointments/emergency attendance and the treatment setting (University hospital orthodontic clinic or a regional orthodontic clinic); and thirdly to compare orthodontic treatment times at the University hospital orthodontic clinic and 6 regional orthodontic clinics.

Material and methods

This is a retrospective study of 207 out of a total of 233 patients (26 excluded) who underwent orthognathic surgery at the Maxillofacial Unit, Linköping University Hospital, Sweden, between the years 2000 and 2005. The following data were retrieved from copies of patient records at the orthodontic home clinics: type of malocclusion, age, gender, treatment setting, start / completion dates for pre-operative orthodontics, date of surgery, start / completion dates for postoperative orthodontics, and number of scheduled appointments / emergency attendance. Separation (for band application) denoted the start of pre-operative orthodontic treatment and the final presurgical adjustment denoted completion of this stage. The first post-operative orthodontic control denoted the start of the postoperative orthodontic treatment and completion of this stage was the date of debanding of the orthodontic appliances.

For simplicity, malocclusions were classified into 4 groups:

1. Angle Class III,
2. Angle Class II,
3. anterior open bite (Angle Class I, II or III),
4. other malocclusions such as lateral open bite, cross-bites (Angle Class I, II or III).

In order to determine the overall duration of pre- and postoperative and total orthodontic treatment, the presence of different malocclusions and other factors influencing the duration of orthodontic treatment, the data from all the clinics were pooled for analysis.

The data were further analyzed in order to disclose any differences between the university hospital orthodontic clinic and the other six clinics with respect to duration of orthodontic treatment and the number of scheduled appointments and emergency visits. For this analysis, data from the University hospital orthodontic clinic were compared with the pooled data from the six regional orthodontic clinics. For almost all patients treated at regional clinics, a consultant orthodontist from the University hospital orthodontic clinic had undertaken the examination and diagnosis and the treatment plan had then been decided in consultation with the treating orthodontists at the regional clinic.

Statistical analysis

Descriptive statistics such as median value, mean value, standard deviation and range were used. The Mann-Whitney U test was used because the data were not normally distributed. For data consisting of frequencies in discrete categories, the Chi-squared test was used to determine significance between the groups.

All statistical tests were two-tailed. The level of significance was set at $p < 0.05$. The statistical package SPSS (SPSS Inc. Chicago, IL USA) was used for analysis.

Results

The records of 233 patients were retrieved and in all 26 were excluded: 11 diagnosed with syndromes, 12 who had had undergone no pre-/postsurgical orthodontics at all (only arch fixation), one who had never proceeded with surgery and 3 who had received some of their treatment elsewhere. Thus the study material comprised the records of 207 subjects, of whom 58 had undergone pre- and post-operative

orthodontic treatment at the University hospital orthodontic clinic and 149 at one of the six regional orthodontic clinics: 107 were women (52%) and 100 were men (48%). The average age at the time of surgery was 24.2 (range 15.8 - 56.9) years. The distribution of malocclusions was similar in males and females. The predominant malocclusion was Angle Class III, in 49% of subjects (28% female and 21% male), followed by Angle class II in 38%: 17% female and 21% male. 12% of subjects (6% female and 6% male) had undergone treatment for anterior open bite. Other malocclusions were uncommon in the material (1%) and noted for only one female (Table 1). At the University hospital orthodontic clinic the subjects diagnosed with Angle Class III malocclusions comprised 25 subjects (43%), Angle Class II, 22 subjects (38%) and anterior open bite, 11 subjects (19%). Other malocclusions were not represented at all (0%). The pooled data from the six external orthodontic clinics comprised 76 subjects (51%) with Angle Class III malocclusions, 57 (39%) with Angle Class II and 14 (9%) with anterior open bite. Only 1 subject (1%) had been diagnosed with "other malocclusion" (Table 2).

The median duration of pre-operative orthodontic treatment for all subjects (University hospital orthodontic clinic + 6 regional clinics) was 19.2 months (range 2.4 - 68.4) and for postoperative orthodontic treatment, 4.6 months (range 0 - 18.8). The median value for duration of total orthodontic treatment was 27.8 months (range 5.9 - 79.1) (Figure 2).

© **Table 1.** Prevalence and gender distribution of malocclusions

Malocclusion	Total %	Female %	Male %
Angle Class III	49	28	21
Angle Class II	38	17	21
Anterior open bite	12	6	6
Others	1	1	0

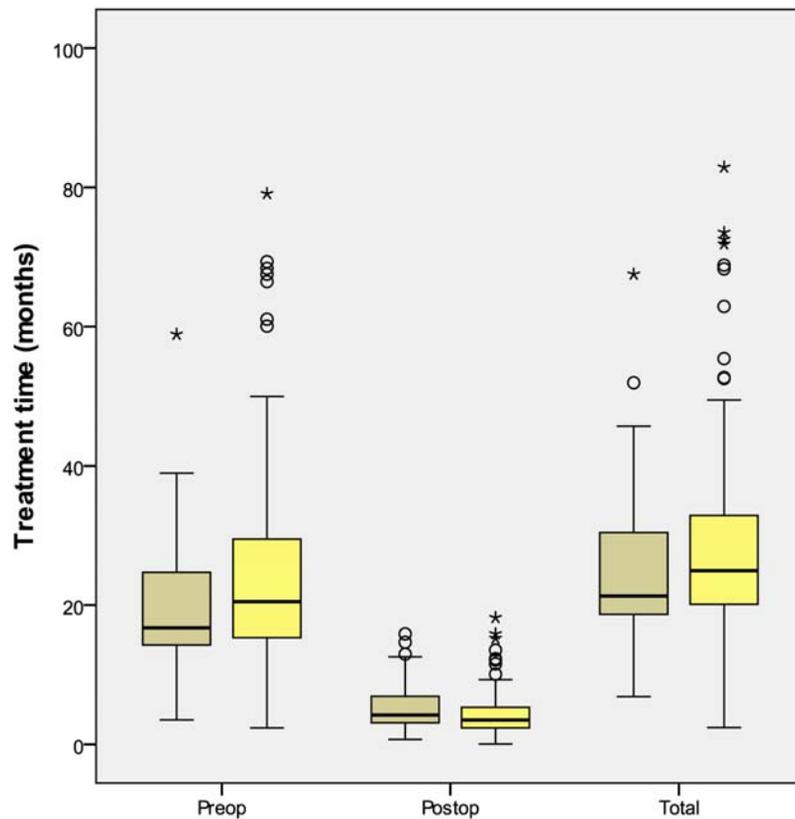
© **Table 2.** Distribution of malocclusions at the University hospital orthodontic clinic (1) and at the 6 orthodontic clinics, data pooled (2)

Clinic	Angle II (%)	Angle III (%)	Anterior open bite (%)	Others (%)
1	38	43	19	0
2	39	51	9	1

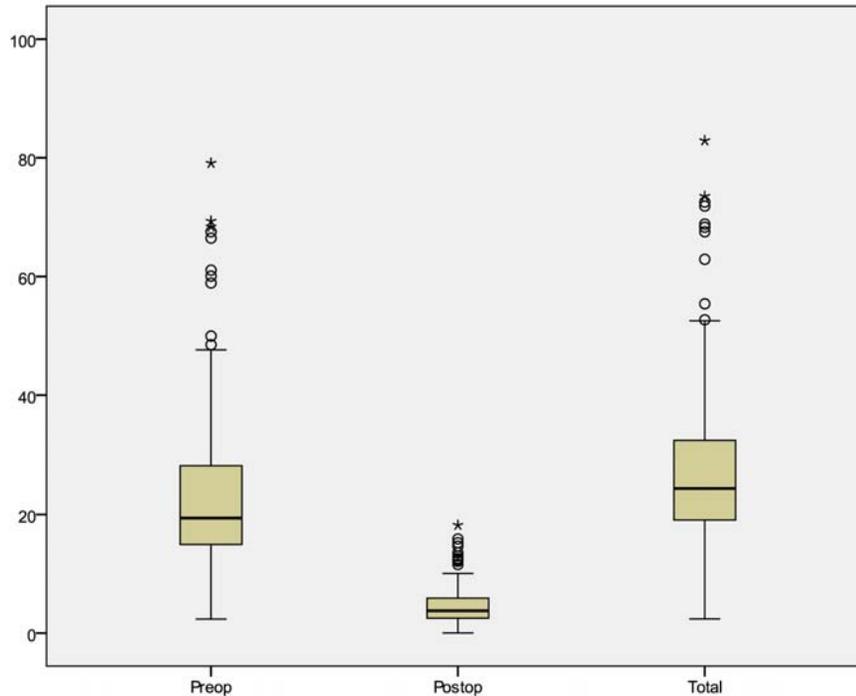
The duration of orthodontic treatment differed significantly between the University hospital orthodontic clinic and the regional clinics ($p = 0.039$). As shown in Figure 1, at the University hospital orthodontic clinic the duration of pre-operative treatment ($p = 0.031$) and total orthodontic treatment time ($p = 0.043$) were significantly shorter, while the duration of postoperative orthodontic treatment was significantly longer ($p = 0.022$). There was no

statistically significant relationship between treatment duration and sex, diagnosis, the number of scheduled appointments or emergency attendance. The University hospital orthodontic clinic had significantly fewer scheduled visits [median 19, mean 20.8 (range 9 - 38)] than the external clinics [median 24, mean 25.6 (range 10 - 90)], but the difference for emergency attendance was not significant (Table 3).

© Figure 1. Duration of orthodontic treatment at the University hospital orthodontic clinic (green) and at 6 regional orthodontic clinics (yellow), data pooled



© Figure 2. Duration of orthodontic treatment for all subjects



© Table 3. Number of scheduled appointments and acute attendance (mean value, range and standard deviation) at the University hospital orthodontic clinic (1) and at the 6 regional orthodontic clinics, data pooled (2)

Number of visits (mean)	Clinic 1		Clinic 2	
Scheduled appointments	20.8 (9-38)	SD = 6.4	25.6 (10-90)	SD = 10.4
Emergency attendance	1.5 (0-7)	SD = 1.7	1.7 (0-20)	SD = 2.6

Discussion

In cases of severe skeletal deviations, combined orthodontic-orthognathic surgical treatment is necessary in order to normalize the occlusion and facial appearance. Some patients perceive the orthodontic part of the treatment to be more unpleasant than the surgery. The decision to undergo such treatment is not taken lightly and adequate patient information, particularly with respect to duration of treatment, is essential. For Swedish patients, the relevant information should be based on analysis of data collected from Swedish orthodontic services, rather than extrapolation of data from international studies. Appropriate information should foster realistic patient expectations, leading to better outcomes and greater patient satisfaction with treatment delivery.

The present study evaluated the duration of orthodontic treatment in conjunction with orthognathic

surgery and examined some possible determining factors. In previous studies it has been shown that the only factors affecting treatment time were the treatment setting and the orthodontist's experience (3, 9). Treatment time was significantly shorter at a clinic where the orthodontists were more experienced and had daily contact with the maxillofacial surgeons. In this context, four possible explanatory variables were selected for analysis in the present study: sex, diagnosis, number of scheduled appointments/ emergency attendance and treatment setting (clinic attached to a university teaching hospital, or a regional clinic). The results showed that only the treatment setting influenced the duration of orthodontic treatment *i.e.* the results are in good agreement with those of the above mentioned studies (3, 9). For patients treated at the University hospital

orthodontic clinic, preoperative and total orthodontic treatment times were significantly shorter and required significantly fewer scheduled appointments. An important contributing factor might be that for orthodontists in the Department of Dentofacial Orthopaedics at Linköping University Hospital, patients having orthognathic surgery comprise a relatively large proportion of the caseload: they are more experienced in management of orthodontic-orthognathic surgery cases and are in daily contact with the maxillofacial surgeons. The duration of postoperative treatment was significantly longer at the University hospital orthodontic clinic. This finding may reflect the fact that some patients underwent part of their postoperative orthodontic treatment at the University hospital orthodontic clinic, but attended their regional orthodontic clinic for the entire preoperative - and most of the postoperative - treatment. With respect to emergency attendance, there were no significant differences between the University hospital orthodontic clinic and the regional orthodontic clinics.

It is important to note that there is close collaboration between the Linköping University hospital orthodontic clinic and the regional orthodontic clinics in this study. Orthodontists from the University Hospital Department of Dentofacial Orthopaedics visit the regional clinics regularly as consultants, for treatment planning and discussion. If necessary, there is further contact by telephone and study models can be sent from the regional orthodontic clinics to the University hospital orthodontic clinic for advice on further treatment.

The total treatment time was calculated from the start of preoperative treatment to the time of completion of the orthodontic treatment, i.e. it included the time when patients were waiting for surgery, the surgery itself, and the postoperative interval, from surgery to the start of postoperative orthodontic treatment. The reason for this is that from the patients' perspective, treatment time comprises the entire period during which they are wearing braces. The median value for the total duration of treatment was 27.8 (range 5.9 - 79.1) months. This is quite similar to conventional orthodontic treatment time (5, 6, 10,11).

In 5.8% of the subjects, (10 out of 207) the total orthodontic treatment time was increased because of the prolonged duration of pre-operative treatment. There were several contributing factors:

1. initial attempts to treat major skeletal discrepancies by orthodontics only, either because it was the patients' wish or the severity of the case had been underestimated,
2. treatment of an acute problem, such as retained maxillary canines that were difficult to align in the dental arch: these cases were subsequently treated by a combination of surgery and orthodontics,
3. slow tooth movement, complicated by poor patient compliance, such as the use of Class II / III-elastics,
4. waiting time for surgery,
5. cancelled and missed appointments.

Conclusion

1. The median duration of orthodontic treatment in conjunction with orthognathic surgery is 27.8 months. This is similar to the duration of conventional orthodontic treatment.
2. At the University Hospital Department of Dental Orthopaedics, the duration of preoperative and total orthodontic treatment was less and postoperative treatment was longer than in the external clinics.
3. The duration of orthodontic treatment was not influenced by sex, diagnosis, or number of scheduled appointments / emergency attendance.
4. There were significantly fewer scheduled appointments at the University hospital orthodontic clinic, but emergency attendance did not differ significantly between the University hospital orthodontic clinic and the regional orthodontic clinics.

Acknowledgements

This project was supported by The Public Dental Service of Östergötland (Östergötland County Council). The authors wish to thank colleagues from the regional orthodontic clinics in the counties of Östergötland, Kalmar, Kronoberg, Sörmland and Blekinge. Thanks also to Annica Gustavsson, orthodontic assistant at the University hospital orthodontic clinic, for supplying the orthodontic records, to Birgit Ljungkvist for statistical analyses, Joan Bevenius Carrick for English language revision and to colleagues at the Linköping University hospital orthodontic clinic and the orthodontic clinics in Östergötland County for their kind and helpful advice.

References

1. Cheng LHH, Roles D, Telfer MR. Orthognathic surgery: the patients' perspective. *Br J Oral Maxillofac Surg* 1998;36:261-3
2. Cunningham SJ, Hunt NP, Feinmann C. Perceptions of outcome following Orthognathic surgery. *Br J Oral Maxillofac Surg* 1996;34:210-13
3. Dowling PA, Espeland E, Krogstad O, Stenvik A, Kelly A. Duration of orthodontic treatment involving orthognathic surgery. *Int J Adult Orthod Orthognath Surg*. 1999;14(2):146-52
4. Edler RJ. Problems in the orthodontic management of orthognathic cases. *Eur J Orthod* 1990;12:420-37.
5. Fink DF, Smith RJ. The duration of orthodontic treatment. *Am J Orthod Dentofacial Orthop* 1992;102:45-51
6. Fisher MA, Wenger RM, Hans MG. Pretreatment characteristics associated with orthodontic treatment duration. *Am J Orthod Dentofacial Orthop* 2010;137(2):178-86
7. Luther F, Morris DO, Hart C. Orthodontic preparation for orthognathic surgery; How long does it take and why? A retrospective study. *Br J Oral Maxillofac Surg*. 2003 Dec;41(6):401-6
8. Nurminen L, Pietilä T, Vinkka-Puhakka H. Motivation for and satisfaction with orthodontic-surgical treatment, a retrospective study of 28 patients. *Eur J Orthod* 1999;21:79-87
9. Proffit WR, Miguel JA. The duration and sequencing of surgical-orthodontic treatment. *Int J Adult Orthognath Surg*. 1995;10(1):35-42
10. Taylor PJS, Kerr WJS. Factors associated with standard and duration of orthodontic treatment. *Br J Orthod* 1996;23:335-341
11. Vig PS, Weintraub JA, Brown C, Kowalski CJ. The duration of orthodontic treatment with or without extractions: A pilot study of five selected practices. *Am J Orthod Dentofac Orthop* 1990;97(1):45-51
12. Williams AC, Shah H, Sandy JR, Travess HC. Patients' motivation for treatment and their experiences of orthodontic treatment. *J Orthod* 2005;32:191-202

Address:

Dr Snjezana Slavnic
 The Centre for Orthodontics and Paediatric Dentistry
 SE 601 82 Norrköping, Sweden
 E-mail: snjezana.slavnic@lio.se

Management structures and beliefs in a professional organisation. An example from Swedish Public Dental Health Services

SVEN ORDELL^{1,2}, BJÖRN SÖDERFELDT¹

© Abstract

Work as a dentist is stressful and demanding. In the Public Dental Health Service (PDHS) the heads of clinics' have a great influence on the work environment. In turn the heads have to adapt to the overarching policies on management in each County, which create the environment for the clinics.

The aims of this paper were to describe the management structure of the PDHS as described by their Chief Dental Officers (CDOs), and to test hypotheses that the management systems had "a logical administrative structure".

A postal questionnaire was mailed to all 21 CDOs, who all responded. Context analysis and bivariate correlations were used.

The PDHS employed on average 60% of all dentists in a county. The numbers of clinics for general dentistry in Sweden was 698, and for specialist care 144. The heads of clinics were dentists in 92%.

Four hypotheses were tested.

- 1/ A separate political board did not lead to closer governance of the PDHS.
- 2/ There was more emphasis on measurable than on qualitative objectives and follow-up.
- 3/ There was only partial correlation between a larger county and a more formalized management.
- 4/ There was no correlation between size of county and beliefs on advantages of scale.

There was a widespread belief in advantages with larger clinics both from administrative, and rather surprisingly, from clinical aspects.

Two of the four hypotheses could not be corroborated which indicates that the management structures were more formed by county specific principles.

The four hypotheses on administrative behaviour were only partially corroborated. The implications for delivery of care to sparsely populated areas need to be monitored in view of the beliefs in larger clinics. The limits for decisions by management and for professional discretion must be monitored closely considering their effects on work environment and on the quality of care the professionals are able to deliver.

Key words

Dentistry, management, professional organisations; public dental health service

¹Department of Oral Public Health, Malmö University, Malmö, Sweden

²Dental Commissioning Unit, Östergötland County Council, Linköping, Sweden

Ledningsstrukturer och uppfattningar i en professionell organisation. Ett exempel från svensk folktandvård

SVEN ORDELL, BJÖRN SÖDERFELDT

Sammanfattning

☉ Arbete som tandläkare är stressfullt och påfrestande. Inom Folktandvården (FTV) har klinikcheferna stort inflytande på hur arbetsmiljön upplevs. Klinikcheferna i sin tur måste anpassa sig till de yttre ramarna och policier som finns inom varje landsting.

Syftet med detta arbete var att beskriva hur styrningen av FTV var uppbyggd sett ur Folktandvårdschefernas (CDO) synvinkel, och att testa fyra hypoteser som utgick från att de administrativa systemen inom FTV var "logiskt uppbyggda".

Metoden var en postenkät till alla 21 CDO, som alla svarade. Analyserna gjordes med innehållsanalyser av texterna och som bivariata analyser.

FTV hade 698 kliniker för allmäntandvård med 620 klinikchefer vilka var tandläkare i 92%. Det fanns 144 kliniker för specialisttandvård. I genomsnitt var 60% av tandläkarna inom ett landstingsområde anställda inom FTV.

Fyra hypoteser testades med följande resultat:

- 1/ En egen politisk nämnd gav inte mera detaljerad styrning av FTV.
- 2/ Det lades mera vikt vid uppföljning av mätbara mål som ekonomi och kvantitet än på kvalitativa mål.
- 3/ Det var endast delvis en korrelation så att större landstingsområden hade mer formaliserad styrning.
- 4/ Det fanns ingen samvariation mellan storlek på landstinget och tilltron till stordriftsfördelar.

Det fanns en stark tilltro till stordriftsfördelar inom administrationen men även inom vården. Två av de fyra hypoteserna kunde inte beläggas vilket tyder på att management-filosofierna mera formas av landstingsspecifika principer.

De fyra hypoteserna kunde bara delvis beläggas. Tilltron till stordriftsfördelar kan få implikationer för möjligheterna till tandvård i glesbygd och bör följas noga. Avgränsningen mellan administrativ styrning och de professionellas beslutsfattande måste följas noga med hänsyn till dess inverkan på arbetsmiljön och på den vårdkvalitet de professionella tillåts upprätthålla.

Introduction

Dental care in Sweden is politically governed on two levels, nationally by the law as decided by Parliament and regionally by the County Councils, who are responsible for planning the availability of dental care for their inhabitants (16). The delivery of dental care in Sweden is divided between employed dentists in the Public Dental Health Service (PDHS) and private practitioners. These sectors are about equal in sizes (18). The 21 geographically defined County Councils govern the PDHS within the nationally decided framework. Financing is by taxes for care to children and adolescents, up to and including the age of 19. Care is also financed by the County Councils for defined frail elderly and for groups of patients where dental care is essential and integrated in medical care (16).

The PDHS was started to provide dental care for children at the end of the 1930s and has since grown into the present organisations. The PDHS now mostly consider themselves to be on a competitive market with the private practitioners, as both sectors have the same refunds for their adult patients from the National Dental Insurance. The care for children and adolescents is now operating on market like conditions with a consumer choice of care provider. The fees for patients are set individually by the private practitioners and for the PDHS by the political assembly in each County. The PDHS operates both general dentistry and specialist care dentistry in eight officially recognized specialities in Sweden. The PDHS is led by a chief dental officer (CDO) in each county.

Work as a dentist is stressful and demanding. This has been shown in several reports internationally (10) and nationally (2,3) and recently by *Hjalmer*s (13). The local management, the heads of clinics; have a great influence on the acceptability of the work environment (13). However, the local managers have to accept and adapt to the overarching policies on management and control systems in each County Council. These systems create the environment for the care organisations that the County Council governs. As the County Councils vary greatly, their respective PDHS organisations are different and may provide an opportunity to compare varying adaptations and solutions to a common environment, legally and marketwise.

We will here describe and analyse this local environment for the PDHS clinics from the perspective of the Chief Dental Officer of each county, but first some theories on organisation and management.

In this part we will outline the basic theories underlying the aspects on organisations that we study. The theories are only outlined to give a background to the study and the references are mostly basic textbooks.

Dentistry is a Human Service Organisation (12) where work is performed on and interacting with patients. The quality and efficiency of that work is dependent on the professionals in the organisation. The organisation is dependent on their individual capacity, in a wide meaning, to define each patient's problems, suggest solutions and perform them. The problems of management in a professional organisation has been acknowledged for a long time (1) and pertains to both methods of defining problems and processes to solve them. The moral aspects on these processes in a Swedish PDHS have been explored by *Hjalmer*s (13) who found that there were considerable gaps between what dentists wanted to do and the reality they perceived.

The purpose of an organisation is usually stated as focussing on spreading information, communication and decision-making (6). The PDHS organisations were not designed from a clean sheet of paper but the ways of organising and of decision-making usually have roots in earlier organisations (5). One such base was the hospitals and the health care organisations, and that can still be seen in the ways the County Councils measure and follow up the performance of their organisations.

One important aspect on organisation and its capacity to fulfil its purposes is the span of control, how many individuals are reporting to the same manager in different layers. The size of the span of control has been a subject for administrative research for long time (9) and generally, the more complex the environment the smaller the span.

Another important issue for an organisation is the ability to transfer resources to undersupplied units. A larger organisation would have a more formal approach to this sort of transfer of resources in order to utilise its advantage of size.

Advantages of scale may occur in production, in administrative handling or in resource management such as the acquiring of capital (1, 5). These advantages in production typically occur when unit costs for an organisation follows a stepwise curve, i.e. up to a certain size of organisation one employee can handle the work load in question. Above this size two employees are needed to handle the work up to a third step when three persons are needed etc. This is well described in the management literature (5).

The basis for increase in production by scale usually calls for a division of labour. This division of labour is usually described as difficult to arrange in a managerially efficient way in professional organisations as various professions compete for their own monopoly of expertise (1).

Aims

The aims of this paper were twofold

1. to describe some aspects relevant to aim 2 and not available in comprehensive form in other documents on the present management structure of the respective PDHS in each county from the perspective of their CDOs, and

2. to test the hypothesis that the management and control systems have “a logical administrative structure”. The idea of a logical administrative structure leads to four hypotheses derived from theories on business administration as outlined above

Hypothesis 1.

Counties with a political board that directly governs only the PDHS have closer governance with fewer degrees of freedoms for the heads of clinics.

Hypothesis 2.

There is a greater emphasis on quantitative than on qualitative objectives and follow-up. Thus there is more emphasis on economics and quantity of care than on quality of care, as the former are easier to measure for the administration.

Hypothesis 3.

There is a relation between the size of the county and its managerial style in that a larger county has more formalized systems and less dialogue between levels and more formal delegation to heads of clinics.

Hypothesis 4.

There is a relation between the size of the county and the beliefs in advantages of scale. A larger organisation will have a more positive view of these advantages.

Methods

The respondents were the Chief Dental Officers (CDO) of each county in that position at the time of the questionnaire. The term CDO is through out used to denominate the non-political civil servant head of the PDHS in the counties. They are all members of the Swedish Association of PDHS. The aims of the study were presented for them at a meeting

in January 2007, and they volunteered to participate and to be contacted by e-mail.

The questionnaire was sent out in May 2007 and for CDO:s who had moved to other positions, we sent the questionnaire to their successors. The first answers arrived in May and the last in October after several reminders both by e-mail and by ordinary mail. Answers finally arrived from all 21 counties.

The proportion of dentists in the counties employed by the County Council was collected from the official statistics (18).

County size was based on the official number of inhabitants in each county in the year 2006 (19). For some analyses the three largest counties were grouped together (1 177 thousand - 1 904 thousand inhabitants), and the four smallest into one group (57 thousand – 179 thousand). The remainder, 14 counties, constituted a middle group (234 thousand – 417 thousand). The bivariate analyses used actual sizes of counties by number of inhabitants. We used the size of county as a proxy for size of PDHS in each county as the overarching responsibilities for the PDHS are regulated by law (16)

The questionnaire contained questions with both set alternatives and open-ended questions. There was space for comments at each question. The open-ended questions were analysed using quantitative context analyses (20).

The total number of respondents was small, so the internal non-responses on each question were important. The internal response rates (n) are given in brackets where applicable. No analysis of the nonresponse was undertaken as the questions were open ended.

A number of indices were computed for the analyses

1. An index for *economic objectives* by combining the answers on the two relevant questions (With what degrees of detail are objectives for the clinics set, incomes and costs). This index had the range 2-6 with the higher value indicating more overarching and less detailed setting of objectives.

2. An index for *qualitative objectives for care* by adding the scores on four questions on qualitative aspects on the setting of objectives for different groups of patients (With what degrees of detail are qualitative objectives for the clinics set, for children and adolescents /for emergency patients /for adults /for new patients). Values could vary between 4 and 12 with a higher number indicating more overarching and less detailed setting of objectives.

3. An index for *quantitative objectives* for care by adding the scores on four questions on quantitative aspects on the setting of objectives for different groups of patients (with what degrees of detail are quantitative objectives for the clinics set, for children and adolescents /for emergency patients /for adults /for new patients). Values could vary between 4 and 12 with a higher number indicating more overarching and less detailed setting of objectives.

4. An index for the degree of *management by objectives* by adding the relevant scores. This index combines indices 1-3 and includes the same variables. Values vary between 10 and 30, a higher number indicating more overarching and less detailed setting of objective.

5. An index indicating the *degree of centralization* of management by adding the scores on the questions on the decision-making by heads of clinics (10 questions on what decisions heads of clinics can make). Values varied between 10 and 20, with the higher number indicating more centralized decision-making and more management control from the CDOs.

6. An index indicating the *degree of dialogue* in management by adding the relevant scores on three questions (a/how are resources transferred between clinics when there is a shortage; by dialogue, yes/no, b/how is follow up carried out from CDO to heads of clinics; by direct dialogue; three alternatives, c/ how is follow up carried out from CDO to individual teams; by direct dialogue; three alternatives). Values varied between 3–8, with a higher number indicating less dialogue.

7. An index for *administrative advantages* of scale was computed from the number of factors in the open-ended questions given by each respondent by adding the number of positive factors and subtracting the number of negative factors for each respondent. The values of this index were between -3 and + 4. A negative value indicated that the number of disadvantages were greater than the number of advantages.

8. An index for *clinical advantages* of scale was computed from the number of factors in the open-ended questions given by each respondent by adding the number of positive factors and subtracting the number of negative factors for each respondent. The values of this index were between -5 and + 5. A negative

value indicated that the number of disadvantages were greater than the number of advantages.

In the indices 7 and 8 the opinions of each respondent were summarized to one value indicating whether the advantages or the disadvantages were dominating for each respondent. Each respondent might have understood the questions differently and the individual answers were not adjusted in relation to how many aspects were listed nor in which order. We used open ended questions as the items likely to be listed was not known with certainty. We wanted the respondents to answer without being guided into set alternatives. The use of open-ended questions naturally gave less validity than more structured questions would have given. We wanted to capture the most salient points for each respondent and these would be considered first.

Statistical analyses were performed as bivariate analyses in SPSS version 15.0. For bivariate correlations Spearman's rho was used. Measures of statistical significance were not used as the population was studied in extensio.

Results

Description of some aspects on the present structure of the PDHS in Sweden.

The average proportion of dentists in each county employed by the PDHS was 60%. The smallest proportions were found in Stockholm (41%) and Skåne (54%) counties, and the largest in the two most northern counties with 81% and 72%.

The PDHS of two counties were Public Limited Companies fully owned by their respective County Council. A separate political board for the PDHS was found in four organisations.

The total number of clinics for general dentistry was given as 698, and the number of specialist clinics was 144. The total number heads of clinics was 620 in the 698 clinics in general dentistry. The heads of these clinics were dentists in 92%, 4,4% were dental hygienists and 3,4% had another background.

The degree of decentralisation of decision-making to the heads of clinics varied, but showed an inverse correlation to size of county ($\rho = -0,46$) meaning that larger counties had more formal decentralisation.

Testing the hypotheses

Hypothesis 1.

A separate political board for the PDHS was found

in four organisations. Two of these were of the intermediate size and one was reported from the large and one from the small counties.

Theoretically the political board would have more time to attend to the dental sector in contrast to other political boards that also governs for example health care.

There was no difference in the scores for the indices for degree of *management by objectives*, for *centralization* or for *dialogue* between these four counties and the others. The two indices for *objectives for care* showed no correlation to having a separate political board. The indices for *advantages of scale*, administrative and clinical, showed that the counties with a separate political board had a more positive view on these advantages (mean for administrative advantages 2 versus 0 and for care 3 versus 1).

Hypothesis 1 could thus not be corroborated.

Hypothesis 2.

The *index for economic objectives* (index 1) showed a median score of 4 (range 2-6, n=21). The *index for quantitative objectives for care* (index 3) showed a median score of 9 (range 4-12, n=20), and the *index for qualitative objectives for care* (index 2) showed a median score of 10 (range 6-12, n=21). These scores with higher numbers showing less formalised processes where objectives were set more overarching, showed that qualitative objectives for care were set less formally than economic or quantitative ones.

The bivariate association between the indices for economic objectives and for quantitative objectives for care showed a strong association ($\rho=0.46$). Bivariate analyses showed that the CDOs responded similarly on the two indices for objectives of care ($\rho=0.53$, n=21).

The objectives for the clinics as regards economical variables were very detailed for costs in almost half (47%) of the answers. The larger counties all responded "very detailed", the middle group reported "very detailed" in 36% and the smallest in 50%. Objectives for income were reported as "very detailed" by all the larger counties but more divided between "very detailed" and "mostly as an overall budget" by the others.

Care for children and adolescents was ranked high on the list of prioritised groups within the PDHS. Objectives for that care were set as very detailed by ten counties out of 21 and only five answered that objectives were set as overall plans.

Objectives for emergency patients were usually set as overall objectives. This was stated for quantitative objectives (83%) as well as for qualitative ones (76%). For adult patients, the least prioritised group, objectives were usually very overarching. Only three responses (n=21) stated "very detailed" on qualitative objectives and four gave that alternative on quantitative objectives for these patients.

The follow up from CDO and staff on the activities of the clinics was addressed by some of the open-ended questions in the questionnaire. A typical answer from the CDO of one of the large counties: "economic objectives are followed each month" and objectives for care "yearly, but more often for such as access to care".

An answer from one of the small counties where the CDO stated: "economic and care objectives and follow-ups are reported in the yearly reports and in person-to-person dialogue".

In sum, the indices revealed a similar pattern where quantitative objectives and follow up were reported as more frequent and more detailed than qualitative measures.

Hypothesis 2 was regarded as corroborated.

Hypothesis 3.

The largest counties' CDOs stated that they had structures for information that were more formal, while those in the smallest ones stated structures with more face-to-face meetings.

The reports on the follow up can be made in several different ways. The largest counties stated written reports more often, in two cases of three, other counties stated written reports in one fourth of the answers.

The reporting and follow-up from the CDO to the individual dental teams in the clinics showed no differences according to size of county. Regular information from the CDO to the heads of clinics was usually in a written format (n=19) or by electronic mail (n=17). Regular person-to-person meetings were reported to be used less frequently. The communication from the central level to the individual dental teams was stated to be solely by the heads of clinics in 11 out of 21 cases.

The objectives for the clinics, as regards economical variables, were very detailed for costs in almost half (47%) of the answers. Larger counties responded "very detailed" more often.

Objectives for care for children and adolescents were set as very detailed by ten counties out of 21 and

only five in the middle group answered that objectives were set as overall plans. The larger counties all reported, “very detailed”. For adult patients objectives were usually very overarching. There were no correlations to size of county.

The various constructed indices showed no bivariate associations with absolute size of county, neither the *index for economic objectives* (index 1), the *index for qualitative objectives of care* (index 2), nor the indices for *management by objectives* (index 4) or the *degree of dialogue* (index 6). The computed *index for quantitative objectives* for care (index 3) showed an inverse correlation to size of county ($\rho = -0.47$), suggesting that the larger counties had more detailed setting of these objectives. The *index for centralization* (index 5) showed an inverse association with size of county ($\rho = -0.46$), meaning that the larger counties had a more decentralised decision-making. The right to alter a budget ($\rho = -0.23$), as well as to use a surplus ($\rho = -0.30$) showed only weak inverse correlations to size of county.

Transfer of resources between clinics could be answered by several alternatives. The most common answer was “by dialogue” in 18 cases ($n=21$) or “by a central person” in eight answers ($n=11$). There were no differences according to size of PDHS. Similarly, eight counties out of 15 had a central staff person that could support the clinics in this kind of conflict.

The results suggest that the CDOs in larger counties more often had organisations where objectives were set in a more detailed manner and that a larger organisation had more formally decentralised decision-making.

Hypothesis 3 was regarded as partially corroborated.

Hypothesis 4.

The results here were based on answers to four open ended questions where the content of the answers was coded into categories. The tables present categories where three or more of the CDOs answers were found. Several other answers were given only by one or two of the respondents.

The mean score for the sum of administrative advantages and disadvantages stated by each respondent was zero indicating that the positive and negative sides were regarded as equal. The same index for care showed a median of 2 indicating that the positive effects were in majority.

An open question on optimal size of a clinic gave

a range of answers where units smaller than 12-15 employees were seen as unwanted unless geographic accessibility for patients was an issue. Two CDOs in larger counties preferred larger units up to about 30 employees. The computed indices for the total sums of items given for advantages and disadvantages of scale showed that neither the *index for administrative advantages of scale* nor the *index for clinical advantages of scale* did correlate to size of county ($\rho = 0.08$ and $\rho = 0.11$ respectively). The two indices, however, showed a strong bivariate correlation ($\rho = 0.50$), which showed that the respondents held similar beliefs on advantages of scale for the two dimensions.

Hypothesis 4 could thus not be corroborated.

© **Table 1.** CDOs views on advantages and disadvantages of scale in administration. Answers from several questions were added. More than one item could be given. Number of answers to the underlying question = n.

Variable	Number of answers for each variable	
Less resources used	14	(n=20)
Less total administration	8	(n=14)
Difficulties with information spread	9	(n=17)
Impersonal for personnel	5	(n=17)
Demanding leadership	5	(n=17)
More personnel at each clinic	4	(n=14)
Better leadership with well trained manager	4	(n= 14)
More efficient usage of personnel	4	(n= 14)
Better leadership	4	(n=20)
Administration takes time from care	3	(n=17)
Much time for meetings	3	(n=17)
Spread of information more difficult	3	(n=14)

© **Table 2.** CDOs views on advantages and disadvantages of scale for care. Answers from several questions were added. More than one item could be given. Number of answers to the underlying question = n.

Variable	Number of answers for each variable	
Better spread of competence	10	(n=20)
Less vulnerable from vacancies	9	(n=20)
Quality aspects, mentorship	8	(n=20)
Issues of quality of care	8	(n= 14)
Impersonal for patients	5	(n=17)
Many caregivers to the same patient, low quality	4	(n=17)
Lack of cooperation in clinic	3	(n=11)

Discussion

There was a widespread belief in advantages of scale with larger clinics both administratively, but also rather surprisingly, from clinical aspects. A trend to have one head for several clinics could be noted in some counties. Two out of the four hypotheses could not be corroborated which indicates that management of the PDHS was, at least in part, more formed by underlying principles of administration in each county than by conventional managerial theories adapted to dental care. This was in accordance with theories on decision-making where previous solutions to problems are taken as points of departure to solve later problems an organisation may encounter (7, 14). The results also showed that the discussions about other categories than dentists as heads of clinics was not substantiated in actual facts, as nearly all heads were dentists.

Other methods for data collection could have been used, such as interviews by telephone or similar. Interviews could have given a better in-depth understanding of the management from the CDOs' perspective but would have been very difficult to arrange with this group of respondents. Interviews can be used with advantage to follow up some interesting statements from the questionnaires. Before the meeting with all CDOs the method had been drafted and we learned there that we needed to keep the format as short as possible to achieve reliable responses from these respondents who often were pressed for time. One disadvantage with the chosen method of data collection might be that other officials than the CDOs themselves actually answered the questionnaire. We consider this a possibility but if the CDO gave the task to someone else, that someone must have good knowledge on these questions.

The questionnaire was sent out by e-mail as all the respondents had volunteered to participate and preferred such communication. It was sent out in May and the last answers arrived five months later. The relative long time-span was considered to be of little concern as the questions were general and not especially time specific.

The present management structure of the respective PDHS in each county was described from the perspectives of their CDOs. This means that the findings in the study was based on subjective data from CDOs, data they wanted us to see. Data they did not want us to access could be suppressed. This is a common and well-known problem in studies based on questionnaires. However the answers presented on some questions and the varied responses on others

make it less likely that all CDOs had a common interest in manipulating the results.

The overarching hypothesis that the management and control systems have "a logical administrative structure" was broken down in four hypotheses. The first hypothesis was based on the assumption that the workload of a board with many different activities would be greater than the load for a board with fewer or a single activity. The necessary time would not be there to allow in-depth discussions and detailed political decision making. In the garbage can model terms of *Cohen et. al.* (4) the decision makers in the larger board would not have the same time opportunities for decisions on dental care as those boards with a single purpose. The results showed that no closer governance could be demonstrated in the four counties with a separate political board. We cannot distinguish whether this illustrates that the governance of the PDHS had not been adapted to the role of a separate board or if the results show that the role for the board was mainly a strategic one with little short-term consequences for the governed body. Perhaps questions like the ones raised in this questionnaire were not on the agenda for political discussions. The underlying theories (9) suggest that management tends to measure what is more easily measured and not what is critical to measure. This becomes more evident when the outcomes of the core activities of the organisation are difficult to evaluate in economic terms.

It could be argued that the outcome measures of the PDHS should be in accordance with the Dental Act (16) (good oral health for the whole population) and therefore relevant measures should be used in the management of the PDHS.

In studying the limits of the CDOs' management, it would be fruitful to examine what the CDOs can manage and what must be the domain of the professionals themselves to define, set objectives for and follow up. In a professional organisation, the professional work constitutes the core activity of the organisation (17) and dental care in Sweden is such an organisation (15). The CDOs might assume that the professionals in the organisations do indeed fulfil their obligations as professionals and provide good oral health for the population. The PDHS must be seen as a Human Service Organisation with a close cooperation and interaction between the service provider and the patient (12), which would ascertain that the population received care that would lead to the stated objectives. However, the focus on qualifications for employment in the PDHS has shifted from

professional requirements towards more economic ones (8). The results here showed that the economic variables for setting of objectives and for follow-up were indeed followed much more frequently than the variables for care. Within the prioritised groups of patients specified objectives of care and more detailed planning were reported than for other groups of patients. The traditional views on public budgets and budgeting processes can be traced in that controls of costs are followed more closely than control of incomes, which is in accordance with theories on development of organisations (5). These findings were in accord with the theories outlined above and hypothesis two was regarded as corroborated.

The two following hypotheses dealt with size of organisation and we used number of inhabitants in each county as a proxy for the size of the administration needed to govern the respective PDHS. The proportion of publicly employed dentists was different in four out of the 21 counties but similar in all the others. Two counties with a smaller number of publicly employed dentists were among the larger group of counties and the two with a greater proportion of PDHS dentists were the two most northern counties. The purpose of an organisation is usually stated as focussing on spreading information, communication and decision-making (6). In administrative terms, the span of control (here the number of heads of clinics that report to the same CDO) would be too great in a bigger organisation for allowing an efficient dialogue type of management.

The results showed that the larger counties had more formal administrative processes and also that information was spread in a more formal way from CDOs to heads of clinics and not directly to the dental teams, which was in accordance with the theoretical framework. Larger counties more often reported very detailed setting of economic objectives for the clinics. However, the mandate to alter a budget to redistribute given resources showed only a weak correlation to size of county.

Another important issue for an organisation is the ability to transfer resources to undersupplied units, and a larger organisation would in theory have a more formal approach to this sort of transfer. However, this formal capability for transfer of resources between clinics showed no correlation to size of organisation in our study. One explanation could be that such transfers use all sorts of different strategies simultaneously, which might not be covered by our alternatives of answers to this question. The results demonstrated that the index for degree

of centralisation and the index for qualitative objectives of care, showed that a larger organisation had a significantly higher degree of decentralisation which is in line with the theoretical thinking on size and organisation (6).

We consider that hypothesis three was corroborated, a larger organisation was more formalised in reporting and more decentralised as regards heads of clinics' decision-making.

Advantages of scale may occur in production, in administrative handling or in resource management such as the acquiring of capital (5). These advantages in production typically occur when unit costs for an organisation follows a stepwise curve, as outlined above (5). The basis for increase in production by scale usually calls for a division of labour. This division of labour is usually described as difficult to arrange in a managerially efficient way in professional organisations as various professions compete for their own monopoly of expertise (1).

The CDOs generally had a positive view on larger units, quoting better efficiency and better quality of care. The larger organisation would be thought to more clearly see the possible advantages of scale. The indices constructed for advantages of scale did not corroborate that larger organisations had a more positive view on these advantages. Other reports indicate that there is little evidence for advantages of scale in dental settings (11). A study on primary health care organisations that related their performances with sizes found that the larger ones performed no better than the smaller (21). Discussing mergers to create larger units, these authors also suggest that:

"Mergers are seen as a way to increase management capacity and may reflect the desire of managers to manage large organisations" (21,p11).

Our results showed that size matters, as most CDOs considered a clinic size of some four or five dentists to be the smallest size to be effective. The CDOs had a more positive view on advantages of scale in the clinical field than in administration, which we regard as noteworthy in the context outlined from other fields. We found that hypothesis four could not be corroborated.

Conclusions

The administrative logics of the studied large professional organisations could only in part be described with data from theoretical frameworks and the

PDHS organisations in the different counties only partially followed the logics in these theories. However, a larger organisation was more formalised and more decentralised as regards heads of clinics' decision-making. Different governance as measured in this study could not be identified in the organisations that had a separate political board. Whether the widespread general belief in advantages of scale will lead to a concentration of public dental care to major cities should be monitored, as should the impact thereof on access to care for vulnerable parts of the population.

In studying the limits of the CDOs' management, it would be fruitful to examine what the CDOs can manage and what should be the domain of the professionals themselves to define, set objectives for and follow up. In a professional organisation, the professionals constitute the core activity of the organisation and the manner professional standards are maintained would be interesting to follow.

Further studies are also needed to understand the logics that form the environment for a large politically governed professional organisation.

Acknowledgement

The authors are indebted to the CDOs who took the time to answer our questions and also to two anonymous referees for very helpful and clarifying comments and suggestions.

References

- Abbott A. *The System of Professions. An Essay on the Division of Expert Labor.* The University of Chicago Press. Chicago. 1988.
- Aronsson G, Bejerot E, Härenstam A. Healthy work – ideal and reality among public and private employed academics in Sweden. *Public Pers Manage* 1999;28:197-215.
- Bejerot E. *Dentistry in Sweden- Healthy work or ruthless efficiency?* Thesis. Arbetslivsinstitutet 1998:14. Solna. 1998.
- Cohen M, March J, Olsen J. A Garbage Can Model of Organizational Choice. *Adm Sci Q.* 1972;17:1-25.
- Danielsson A. *Företagsekonomi. En översikt.* [Business administration. An overview]. Studentlitteratur. Lund. 1983.
- Dessler G. *Organization Theory: Integrating Structure and Behavior.* Prentice-Hall. Inglewood Cliffs, N.J. 1980.
- Enderud H. *Beslutningar i organisationer.* [Decisions in organisations] Fremad. Århus. 1989.
- Franzen C, Söderfeldt B. Changes in employers' image of ideal dentists and managers in Swedish public dental sector. *Acta Odont Scand* 2002;60:290-96.
- Gortner H, Mahler J, Nicholson J. *Organization Theory. A Public Perspective.* The Dorsey Press. Chicago. 1987.
- Gorter RC, te Burke JH, Eijkman MA, Hoogstraten J. Job resources in Dutch dental practice. *Int Dent J* 2006;56:22-8.
- Grytten J, Skau I. Honorarer og stordriftsfordeler i privat tannlegepraksis. [Prices and advantages of scale in private dental practice] *Den Norske Tannlegeforenings Tidene.* 1999. 109:172-8.
- Hasenfeldt Y. *Organizational Forms as Moral Practices: The case of Welfare Departments.* *Soc Serv Rev.* 2000;Sept:329-51.
- Hjalms K. *Good work for dentists - ideal and reality for female unpromoted general practice dentists in a region of Sweden.* Thesis. Malmö University. 2006.
- March J, Olsen J. *Ambiguity and choice in organisations.* Universitetsförlaget. Oslo. 1982.
- Ordell S, Söderfeldt B. *An analysis of present dental professions in Sweden.* *Swed Dent J.* 2006;30:155-64.
- SFS 1985:125. *Tandvårdslagen. [Dental Act].* Stockholm. 2008.
- Shortell S, Kalunzny A. *Health Care Management.* John Wiley and sons. New York. 1988.
- Socialstyrelsen [National Board of Health and Welfare] NPS 2007. *Tillgång på barnmorskor, sjuksköterskor, läkare, tandhygienister och tandläkare 2005.* [Availability of midwives, nurses, physicians, dental hygienists and dentists 2005]. 2007-125-5. Stockholm. 2007.
- Statistics Sweden. Web access: www.ssd.scb.se
- Weber RP. *Basic contents analysis.* Sage. London. 1990.
- Wilkin D, Bojke C, Coleman A, Gravelle H. The relationship between size and performance of primary care organisations in England. *J Health Serv Res Policy* 2003;8 jan:11-7.

Adress:
Dr Sven Ordell
Bispmotala 13
SE-591 31 Motala, Sweden
E-mail: sven.ordell@lio.se

190. Self-perceived oral health, dental care utilization and satisfaction with dental care, a longitudinal study 1992 - 1997 of a Swedish age cohort born in 194
Katri Ståhlacke (2007) 400 SEK
191. Orthodontic anchorage - Studies on methodology and evidence-based evaluation of anchorage capacity and patients perceptions
Ingalill Feldmann (2007) 400 SEK
192. Studies on the prevalence of reduced salivary flow rate in relation to general health and dental caries, and effect of iron supplementation
Håkan Flink (2007) 400 SEK
193. Endodontic treatment in young permanent teeth. Prevalence, quality and risk factors.
Karin Ridell (2008) 400 SEK
194. Radiographic follow-up analysis of Brånemark® dental implants
Solweig Sundén Pikner (2008) 400 SEK
195. On dental caries and caries-related factors in children and teenagers
Anita Alm (2008) 400 SEK
196. Immediate loading of implants in the edentulous maxilla
Göran Bergkvist (2008) 400 SEK
197. On the role of number of fixture, surgical technique and timing of loading
Alf Eliasson (2008) 400 SEK
198. Quality management and work environment in Swedish Oral And Maxillofacial Surgery Göran Pilgård (2009) 400 SEK
199. Premature birth. Studies on orthodontic treatment need, craniofacial morphology and function
Liselotte Paulsson (2009) 400 SEK
200. Dental gold and contact allergy
Camilla Ahlgren (2009) 400 SEK
201. On cobalt-chrome frameworks in implant dentistry
Lars Hjalmarsson (2009) 400 SEK
202. Dental behaviour management problems among children and adolescents – a matter of understanding?
Annika Gustafsson (2010) 400 SEK
203. On oral health in children and adults with myotonic dystrophy
Monica Engvall (2010) 400 SEK
204. Methodological studies of orofacial aesthetics, orofacial function and oral health related quality of life
Pernilla Larsson (2010) 400 SEK
205. Oligodontia and ectodermal dysplasia
Birgitta Bergendal (2010) 400 SEK
206. Resilient appliance therapy of temporomandibular disorders. Subdiagnoses, sense of coherence and treatment outcome
Håkan Nilsson (2010) 400 SEK
207. Immigrant background and orthodontic treatment need - quantitative and qualitative studies in Swedish adolescents
Eva Josefsson (2010) 400 SEK



The supplements can be ordered from Swedish Dental Journal, Box 1217, SE-111 82 Stockholm, Sweden.

Subscription of the supplements can be arranged.

Posttidning **B**



Swedish Dental Journal
Swedish Dental Journal is the scientific journal of
The Swedish Dental Association and of The Swedish Dental Society

