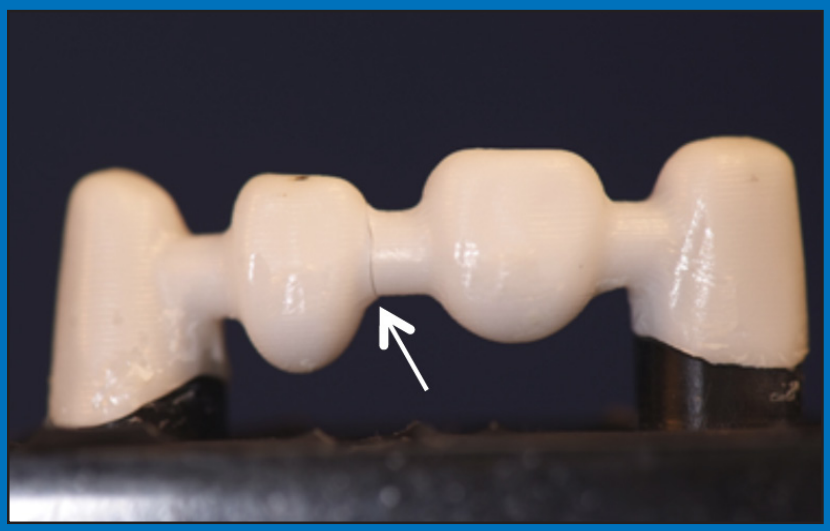
Swedish Dental Journal

Scientific Journal of The Swedish Dental Association

No. 4/13
Vol.37 Pages 161-216



Fracture strength of all-ceramic (Y-TZP) three- and four-unit fixed dental prostheses with different connector design and production history page 179

CONTENTS

Adolescents with high periodontal risk in Public Dental Service
Jansson, Adler, Jonés 161

Water cleaning systems improves the water quality in dental unit water lines (DUWL). A report from the Public Dental Health of Västra Götaland region, Sweden
Dahlén, Hjort, Spencer 171

Fracture strength of all-ceramic (Y-TZP) three- and four-unit fixed dental prostheses with different connector design and production history
Mahmood, Linderoth, Vult von Steyern, Wennerberg 179

Abstracts of free communications and posters presented at the 49th Annual Congress of the Swedish Dental Society, Stockholm, November 14–16, 2013 189

Contents of Swedish Dental Journal Volume 37, 2013 coverpage 3

Swedish Dental Journal

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

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.tlt@tandlakarforbundet.se
Bank: Skandinaviska Enskilda Banken
Bankgiro: 404-4699 Postgiro: 45 86 34-3

Subscriptions
Sweden: SEK 950 Others: SEK 1 260
(Supplements are not included.)
For subscriptions delivered to adresses 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 coulor figures. Each Table should be written on a separate sheet. They should be numbered with Arabic numerals and each should have a heading.

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.

Reprints are not generally available. The Swedisch Dental Journal is available in PDF format at www.tandlakarforbundet.se - Log in - In English.

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

Adolescents with high periodontal risk in Public Dental Service

LEIF JANSSON[1,2], LOTTIE ADLER[1], CATARINA JONÉS[3]

Abstract

◎ The purpose of the present study was to investigate the prevalence of adolescents with high periodontal risk and to identify factors with influence on the decision to refer a patient to a specialist clinic of Periodontology, on compliance rate and on treatment outcome.

The investigation was conducted as a retrospective study on adolescents at age 13-17. In total, clinical examinations and risk evaluations according to caries- and periodontal risk were performed on 50347 adolescents in general dentistry at ages 13, 15 and 17 in 2007. Individuals with a high periodontal risk were included in the present investigation. A high periodontal risk was defined as presence of sites with periodontal pocket depths >6mm and loss of periodontal tissue support. Multiple logistic regression analyses were adopted to calculate the influence of the potential predictors on the investigated dependent variables.

In total, 0.5% of the adolescents were found to have high periodontal risk. The diagnosis local periodontitis and the number of periodontal pockets with probing depths >6 mm were positively and significantly correlated to referral to a periodontist. Eighteen percent dropped out before the treatment was completed. Smokers had a significantly lower compliance than non-smokers. The success rate was significantly lower for individuals with many periodontal pockets and for those with the diagnosis local periodontitis.
The prevalence of adolescents classified as having high periodontal risk was low. A large frequency of subjects dropped out before the periodontal treatment was completed, especially at the specialist clinics.

Key words

Adolescents, periodontal risk, periodontitis

[1] Departments of Periodontology, Public Dental Service at Kista and Skanstull, Stockholm County Council, Sweden
[2] Division of Periodontology, Department of Dental Medicine, Karolinska Institutet, Huddinge, Sweden.
[3] Department of Periodontology, Public Dental Service at Kaniken, Uppsala County Council, Sweden

Ungdomar med förhöjd parodontal risk i folktandvården

LEIF JANSSON, LOTTIE ADLER, CATARINA JONÉS

Sammanfattning

◉ Syftet med studien var att undersöka prevalensen ungdomar med förhöjd parodontal risk och att identifiera faktorer som har ett signifikant samband med benägenheten att remittera till parodontolog, med patientens samarbetsgrad och behandlingsutfall.

Detta är en retrospektiv studie som omfattar ungdomar i åldrarna 13-17 år. Kliniska undersökningar och riskbedömningar utfördes år 2007 på 50347 ungdomar i allmäntandvården i åldrarna 13, 15 och 17 år. Individer som bedömdes ha förhöjd parodontal risk inkluderades i studien. Förhöjd parodontal risk bedömdes föreligga vid förekomst av tandköttsfickor med ett sonderingsdjup av minst 6 mm samt förlust av parodontal stödjevävnad. Multipel regressionsanalys tillämpades för att analysera potentiella prediktorers effekt på studerade beroendevariabler.

Hos 0.5% av ungdomarna bedömdes förhöjd parodontal risk föreligga. Diagnosen lokal parodontit och antalet tandköttsfickor med ett sonderingsdjup av minst 6 mm var positivt korrelerade till benägenheten att remittera till parodontolog. Arton procent av ungdomarna avbröt pågående behandling. Rökare hade en signifikant lägre samarbetsgrad i jämförelse med icke rökare. Andelen lyckade behandlingsresultat var signifikant lägre hos individer med många fördjupade tandköttsfickor och vid diagnosen lokal parodontit.

Sammanfattningsvis visade studien att prevalensen för hög parodontal risk var låg hos ungdomarna. En hög andel av individerna avbröt den parodontala behandlingen innan den var avslutad och detta var speciellt uttalat på specialistklinikerna.

Introduction

Periodontal diseases are infections caused by microorganisms colonizing the tooth surface at or below the gingival margin (28). These oral microorganisms belong to the endogenous microbiota of most people. Some microorganisms in the subgingival flora are more important than others as etiological agents of periodontitis but chronic as well as aggressive forms of periodontitis are not mono-infections (8). The clinical manifestations of the disease depend upon the nature of the inflammatory response in the periodontal tissues, which is modified by genetic factors such as the individual susceptibility (13) and risk factors, like smoking and diabetes mellitus (6).

The frequency of plaque-associated gingivitis is high in children as well as in adults (1, 12) but only a minority of individuals develops aggressive and severe forms of periodontitis (19, 23). The most common form of periodontitis is chronic periodontitis and can be characterized as localized or generalized depending on number of sites affected. Chronic periodontitis is most prevalent in adults but can occur in children and adolescents (5). The prevalence varies between continents and race-ethnic groups. Chronic periodontitis in young people is believed to be similar to chronic periodontitis in adults (4).

Aggressive periodontitis is a much more uncommon disease (5). Findings from epidemiological studies report a prevalence of 0.5-5% depending on continent. Aggressive periodontitis is characterized by a high rate of disease progression in otherwise clinically healthy persons (5). The familial aggregation is one of the main characteristics associated with aggressive periodontitis (5). The majority of individuals affected are less than 30 years old. It can be classified as local or general. The local form has a distinctive radiographic bone loss usually occurring at the first molars and one or more incisors. The general form affects three or more teeth other than incisors and first molars. The association between oral hygiene level and occurrence of aggressive periodontitis is weaker compared to the effect of plaque on chronic periodontitis (29).

In Public Dental Service of the County of Stockholm, all patients visiting general clinics are classified according to periodontal- and caries risk. The identification of individuals with an increased risk makes prevention and treatment of caries and periodontal disease more effective. In addition, the risk evaluations enable to study differences between clinics according to prevalence of individuals at high risk and tendencies over time.

The purpose of the present study was to investigate the prevalence of adolescents with high periodontal risk in Public Dental Service in the County of Stockholm and to identify factors with influence on the decision to refer a patient to a specialist clinic of Periodontology, on compliance rate and on treatment outcome. In addition, the prevalence of high caries risk was studied for this group of adolescents.

Material and methods

The investigation was conducted as a retrospective study on adolescents at age 13, 15 and 17 in 2007 at the Public Dental Service, Stockholm County Council, Sweden. In total, clinical examinations and risk evaluations according to caries- and periodontal risk were performed on 50347 adolescents in general dentistry at ages 13, 15 and 17 in 2007. In 35 out of 63 clinics at least one individual was registered as having a high periodontal risk (mean 6.5, range 1-35). Individuals with high periodontal risk according to the evaluations in general dentistry were included in the present investigation. A high periodontal risk was defined as presence of one or more sites with periodontal pocket depths ≥6mm and radiographic marginal bone loss. A high caries risk was registered if the following criteria were fulfilled: ≥1 caries lesions in the dentine and/or presence of a proximal restoration or ≥2 new and/or progressing proximal enamel caries lesions. The final sample included 228 patients with high periodontal risk. The following anamnestic, clinical and radiographic variables were collected by a periodontist from the records in the databases for individuals with a high periodontal risk according to the evaluations in general dentistry:

- Age.
- Gender.
- Medical history in the health questionnaire.
- Smoking habits.
- Referral to a specialist clinic of Periodontology (two clinics at Public Dental Health).
- Number of visits to a dentist
- Number or treatments by a dental hygienist
- Defaults from at least two appointments.
- Drop-out from treatment (did not fulfil the treatment plan).
- Periodontal treatment (non-surgical, flap surgery, regenerative surgery).
- Number of sites with periodontal pockets with probing depths 4-5 mm at baseline.
- Number of sites with periodontal pockets with probing depths ≥6 mm at baseline.

Table 1. Distribution (%) according to caries risk and periodontal risk for adolescents at ages 13, 15 and 17

A. Age 13, N=16439

Risk	Low caries risk	High caries risk	Total
Low periodontal risk	80.8	18.9	99.7
High periodontal risk	0.2	0.1	0.3
Total	81.0	19.0	100

B. Age 15, N=17224

Risk	Low caries risk	High caries risk	Total
Low periodontal risk	77.3	22.3	99.6
High periodontal risk	0.2	0.2	0.4
Total	77.5	22.5	100

C. Age 17, N=16684

Risk	Low caries risk	High caries risk	Total
Low periodontal risk	72.8	26.4	99.2
High periodontal risk	0.4	0.4	0.8
Total	73.2	26.8	100

- Number of sites with periodontal pockets with probing depths 4-5 mm at re-evaluation.
- Number of sites with periodontal pockets with probing depths ≥6 mm at re-evaluation.
- Diagnosis (dichotomized variable):
  - Periodontitis (aggressive/chronic, score 1): The proximal linear distance between the cementoenamel junction and the most coronal part of the marginal bone was measured with a cursor on the digital radiographs. If the distance was >2 mm on at least two permanent teeth, the diagnosis was local periodontitis. If marginal bone loss was present on more than two permanent teeth other than first molars and incisors, the diagnosis was generalized periodontitis.
  - Gingivitis: clinical signs of gingival inflammation (score 0).
- Presence of bleeding periodontal pockets with probing depths >4 mm at re-evaluation.
- Presence of caries lesions in the dentine
- Presence of proximal restorations
- Presence of new and/or progressing proximal enamel caries lesions.

Statistical analysis

The descriptive statistics and statistical analyses were performed using the statistical package SPSS Statistics 18.0. In all analyses, the statistical computational unit was at subject level. Chisquare tests were performed in order to study differences of frequency distributions between groups according to investigated variables. The dichotomous variable compliance was defined as score 1 if the subject had less than two defaults from appointments and fulfilled the treatment plan. The dichotomous variable treatment success was scored 1 if no bleeding periodontal pockets ≥4 mm remained at the re-evaluation of the periodontal therapy. Multiple logistic regression analyses were adopted to calculate the influence of the potential predictors on the investigated dependent variables. Results were considered statistically significant at $p<0.05$.

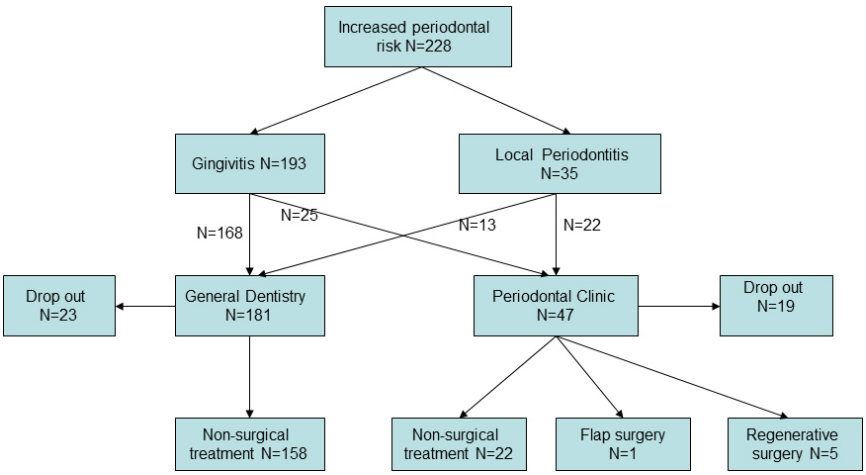
Results

The distributions according to caries- and periodontal risk for adolescents at ages 13, 15 and 17 are presented in Table 1. The percentage of subjects with high periodontal risk was increased from 0.3% at age 13 to 0.8% at age 17. The corresponding relative frequencies for high caries risk were 19% and 27%, respectively. For 50% of the adolescents at age 17 with high periodontal risk, the caries risk was evaluated to be high. However, for subjects with low periodontal risk at age 17, the caries risk was high for 27% of

Table 2. Frequency distributions according to age, gender, and clinic

Age	Gender	Treatment in general dentistry	Treatment in periodontal clinic
13	Male	12	2
	Female	16	5
15	Male	32	5
	Female	16	11
17	Male	57	12
	Female	48	12
Total		181	47

Figure 1. Flow chart of adolescents with increased periodontal risk



the cases. In total, 120 males and 108 females were found to have high periodontal risk (Table 2) and most subjects (57%) belonged to the age group 17 yrs.

Five percent of the adolescents (12 subjects) declared that they were smokers. A majority of the adolescents were healthy. Four individuals had a heart disease, one had diabetes and one reported epilepsy. Autistic syndrome disorders were diagnosed in two cases. Presence of allergy was registered for 11% of the adolescents.

A flow chart describing the subjects with high periodontal risk is illustrated in Figure 1. The diagnosis local periodontitis was valid for 15% of the subjects. None of the subjects had a generalized periodontitis. Fifty-one individuals with increased periodontal risk had one permanent tooth with marginal bone loss >2 mm. Six percent of the adolescents at age 13 yrs with high periodontal risk had the diagnosis local periodontitis, while the corresponding frequencies for subjects at ages 15 and 17 yrs were 14% and 18%, respectively. Among the individuals with increased periodontal risk and increased caries risk, the criteria for increased caries risk were fulfilled in 95% of the cases, while the criteria for increased periodontal risk were fulfilled in 38% of the cases. Twenty-one percent of the individuals at high periodontal risk were referred to a specialist clinic of Periodontology; 16% of the males and 26% of the females. However, this difference according to gender was not statistically significant (p=0.06). The results of the multiple logistic regression analyses, using referral to a periodontal clinic as the dependent variable, showed that the diagnosis local periodontitis and the number of periodontal pockets with probing depths ≥6 mm were positively and significantly correlated to referral to a periodontist (Table 3).

The periodontal pocket depths before periodontal treatment were found to be <4 mm for a majority of the subjects who were treated in general dentistry (Figure 2), while 89 % of the individuals referred to a periodontal clinic had one or more sites with periodontal pocket depths 4-5 mm (Figure 3). In general dentistry, 13% of the subjects had sites with periodontal pocket depths ≥6 mm (Figure 2), while the corresponding frequency at the periodontal clinics was 60% (Figure 3). The most frequent tooth group affected by deepened periodontal pockets ≥6 mm was the first maxillary molars (11%, Table 4) and mandibular first molars (5.5%, Table 4).

Among the adolescents who received periodontal treatment in general dentistry, 13% dropped out before the treatment was completed. The corresponding frequency for individuals at the periodontal clinics was 40% and this difference was statistically significant (p<0.01). At the periodontal clinics, six

Table 3. Results of logistic regession analysis with referral as dependent variabel. N=228

Independent variable	Odds ratio	95% Confidence interval	P
Local Periodontitis	6.24	(2.47; 15.7)	<0.01
Number of periodontal pockets with depth ≥6 mm	1.20	(1.02; 1.42)	0.03

Figure 2. Frequency distribution of periodontal pocket depths before treatment for adolescents treated in general dentistry (N=181).

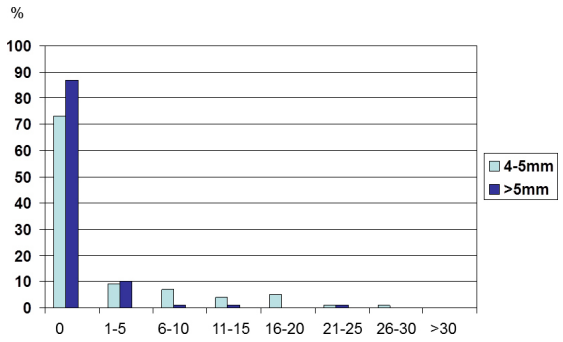
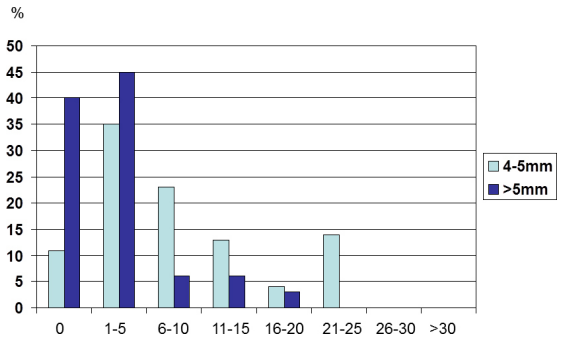


Figure 3. Frequency distribution of periodontal pocket depths before treatment for adolescents treated in a periodontal clinic (N=47).



individuals dropped out before the start of periodontal treatment, one subject dropped out after regenerative surgery and 12 dropped out after start of non-surgical treatment. The frequencies of default from at least two treatments were 26% in general dentistry and was significantly higher (43%) at the periodontal clinics ($p=0.03$). The frequencies according to default from treatments or drop outs did not differ significantly between sexes or age groups. Smokers had a significantly lower compliance rate than non-smokers ($p<0.01$, Table 5). In addition, the degree of compliance in subjects with several periodontal pockets ≥6 mm was significantly lower compared to adolescents with fewer periodontal pockets ≥6 mm ($p<0.01$, Table 5).

In general dentistry, the mean number of visits to a dentist and a dental hygienist between the baseline examination and the re-evaluation of the treatment were 3.6 (range 1-20) and 2.3 (range 0-10), respectively. The corresponding mean values at the periodontal clinics were 2.1 (range 1-8) visits to a dentist and 3.6 (range 0-17) to a dental hygienist. All the adolescents in general dentistry were treated with non-surgical periodontal therapy (Figure 1). For 53% of the individuals who did not drop out from periodontal treatment, no sites with bleeding periodontal pockets deeper than 3 mm were present at the next pocket depth registration. At the re-evaluation of the treatment in periodontal clinics, the corresponding frequency was 82% after non-surgical periodontal therapy. Flap surgery was performed in one case with several deepened pockets ≥6 mm but without marginal bone loss (Figure 1). Several deepened pockets remained after treatment and this individual did not cooperate due to several defaults from visits to the dental hygienist. Five subjects were treated with regenerative surgery with enamel matrix proteins. Three of those cases were treated successfully with bone fill of angular bone defects at the re-evaluation after about one year, while pocket depth reduction without bone fill was obtained in one case. In the last case, the individual did not cooperate due to not showing up during the maintenance phase after surgical treatment and neither pocket depth reduction nor bone fill occurred.

The success rate after periodontal treatment was significantly lower in cases when the subjects fulfil-

Table 4. Distribution (%) according to tooth type with periodontal probing pocket depths >6mm

Tooth type	General Dentistry	Periodontal clinic
First maxillary molars	11	31
Second maxillary molars	2.0	7.4
Maxillary premolars	0.7	0
Maxillary incisors	1.8	3.2
Maxillary canines	0	0
First mandibular molars	5.5	14
Second mandibular molars	1.8	0
Mandibular premolars	0	0
Mandibular incisors	2.4	1.8
Mandibular canines	0	0

Table 5. Results of logistic regression analysis with compliance as dependent variable. N=228

Independent variable	Odds ratio	95% Confidence Interval	P
Smoker	0.081	(0.020; 0.398)	<0.01
Number of periodontal pockets with depth ≥6 mm	0.873	(0.829; 0.918)	<0.01

Table 6. Results of logistic regression analysis with treatment success as dependent variable. N=186

Independent variable	Odds ratio	95% Confidence Interval	P
Defaults from treatment	0.10	0.04; 0.27	<0.05
Number of periodontal pockets 4-5 mm	0.81	0.47; 0.86	<0.05
Number of periodontal pockets ≥6 mm	0.50	0.36; 0.71	<0.05
Local Periodontitis	0.12	0.04; 0.32	<0.05

led the treatment but had at least two defaults from visits to the dentist or dental hygienist ($p<0.05$, Table 6). In addition, the success rate was significantly lower for individuals with many periodontal pockets with probing depths 4-5 mm ($p<0.05$) and ≥6 mm ($p<0.05$) as well as for those with the diagnosis local periodontitis ($p<0.05$).

Discussion

The risk assessments were performed by general dentists in Public Dental Health and the criteria for risk evaluations should be well-known among the dentists. The risk evaluations of caries seem to have been adequately performed with 95% of the subjects classified in accordance with the risk criteria. However, since presence of loss of periodontal tissue support is a requirement to belong to the group with increased periodontal risk, the risk has been overestimated in a majority of the cases. It is obvious that the clinicians have followed a comprehensive picture of the patient at the decision, probably including lifestyle factors such as oral hygiene level and smoking habits, since it is more likely that a more frequent maintenance programme will be implemented for those individuals with increased risk for caries and periodontitis.

A positive and significant association was found between increased periodontal- and caries risk. Earlier studies have found strong and inverse associations between proximal caries and periodontitis in adolescents (11, 25). In a case-control study on 23 adolescents with the diagnosis juvenile periodontitis and 23 matched controls, the subjects with juvenile periodontitis had significantly less caries on proximal surfaces compared to the control group (25). In contrast, other studies did not demonstrate any significant associations between these variables (2, 15). An investigation on 686 adolescents in suburban Stockholm found no significant relationship between alveolar bone loss and presence of proximal caries (2). However, the same study showed a positive relationship between proximal restorations and alveolar bone loss in adolescents in accordance with studies demonstrating an increasing incidence of periodontitis when proximal restorations with overhanging margins are present (2, 3). This association may be a consequence of local accumulation of plaque on restoration margins leading to gingival inflammation and periodontitis initiation. In the present study the validity of the caries risk evaluations was found to be high, while the validity of the periodontitis risk assessments was low since a majority of the individuals classified as high periodontal risk had gingivitis. Thus, the significant and positive association between periodontal and caries risk evaluations might be the consequence of a higher prevalence of gingivitis in subject with an increase in the number of proximal fillings due to physical retention of plaque. Another explanation can be a tendency to classify individuals as having an increased risk for caries as well as for periodontitis in presence of high plaque levels.

The prevalence rates of chronic and aggressive periodontitis in adolescents in West Europe are 1.0-3.0% and 0.1-0.5%, respectively (5). In the present study, 0.5 % of the subjects were classified by the general dentists as having an increased periodontal risk and 0.1 % of the individuals were classified as having periodontitis according to the evaluations of a periodontist. The number of individuals with marginal bone loss >2mm on at least two permanent teeth who were classified as low periodontal risk is unknown. Since the periodontal risk was overestimated for a majority of the individuals classified as having high periodontal risk, the frequency of underestimated cases might be low. In a study from north Sweden (17), 3.5% of children in public dental clinics at age 16 years in 1975 and 1988 had bone loss >2 mm on studied bitewing radiographs. Another study from northern Sweden (16) on subjects aged 16-18 years reported a prevalence of bone loss >2mm of 1%. The corresponding prevalence in the present study was 0.3% for adolescents at age 17 if those with > one permanent tooth with bone loss >2 mm were included. However, comparisons according to prevalence rates are not relevant since the degree of bone loss in the group with low periodontal risk was unknown.

In the literature, the features of chronic and aggressive periodontitis have been compared. The clinical signs of inflammation are often more prominent in chronic periodontitis (7). The progression rate is more rapid and the biofilm is described as thinner in adolescents with aggressive periodontitis (7). However, there is no clear distinction between chronic and aggressive periodontitis (7). Studies with histological examinations describe similar patterns for aggressive and chronic periodontitis according to distributions of inflammatory cells in the lesions (27). In the present study, the diagnosis periodontitis has been used and no distinction between chronic and aggressive periodontitis was made.

Smoking is an established risk factor for chronic periodontitis (6) while the association between smoking habits and aggressive periodontitis is more unclear (10). Five percent of the adolescents declared that they were smokers. The smokers had a significantly lower compliance rate compared to non-smokers. In addition, subjects with more severe periodontitis did significantly more often not fulfill the treatment plan or dropped out from treatments. These results are in accordance with an earlier study on adults at the same specialist clinic (14) demonstrating that smokers interrupted periodontal treatment more often than non-smokers. In addition, the smokers who had interrupted the treatment after the first re-evaluation had significantly deeper periodontal pockets compared to the other patients. Another study on patients in a specialist private practice confirms the negative correlation between smoking and compliance during the maintenance phase (20). Significant explanatory factors related to low compliance in young people in Norway at age group 12-18 were negative beliefs of dentists and high caries experience (26). Thus, the risk for non-compliance during dental treatments seems to increase for adolescents with a more severe degree of the oral diseases caries and periodontitis. In the present study, non-compliance was significantly more frequent at the specialist clinic, which is located more distant from the subjects compared to the general clinic.

Reports concerning treatment outcomes in adolescents in long-term follow-up studies are limited. Longitudinal studies with a follow-up period of at least 5 years reported improved periodontal conditions with clinical attachment gain in adolescents (18, 30). A retrospective study on subjects considerably older (15-29 years) reported significant reduction of periodontal pocket depths and improved bone loss scores after 6-12 years after non-surgical and surgical periodontal therapy followed by supportive therapy, (24). The frequency of recurrences of the disease has been evaluated in 11 children at age 7-13 years after periodontal therapy but without supportive care during a follow-up period of 14-19 years and recurrence of periodontitis was found only for two subjects (21). This result is in contrast to two other follow-up studies on adolescents with aggressive periodontitis without initial treatment and maintenance therapy (9, 22). These studies demonstrated increased number of sites with clinical attachment loss and progressive bone loss. In a majority of the cases in the present study, non-surgical therapy was used in accordance with recommended treatment for adolescents with gingivitis (10). Corrective surgical therapy may be added to the non-surgical treatment in cases with bone loss (10). However, the long-term results of the periodontal therapy seem to depend on application of adequate maintenance care routines after the active treatment.

In conclusion, the prevalence of adolescents classified as having high periodontal risk was low. A large frequency of subjects dropped out before the periodontal treatment was completed, especially at the specialist clinics. A deepened cooperation and communication between the general clinic and the periodontal clinic concerning the treatment plan might improve the compliance rate. It is plausible that the frequency of patients fulfilling the treatment plans would rise if more adolescents were treated in their neighborhood in close collaboration with a periodontist.

References

1. Albandar J, Brown LJ, Brunelle JA, Löe H. Gingival state and dental calculus in early-onset periodontitis. J Periodontol 1996;67:953-9
2. Albandar J, Brown LJ, Löe H. Dental caries and tooth loss in adolescents with early-onset periodontitis. J Periodontol 1996;67:960-7.
3. Albandar J, Buischi YAP, Axelsson P. Caries lesions and dental restorations as predisposing factors in the progression of periodontal diseases in adolescents. A 3-year longitudinal study. J Periodontol 1995;66:249-54.
4. Albandar J, Rams T. Risk factors for periodontitis in children and young persons. Periodontol 2000 2002;29:207-22.
5. Albandar J, Tinoco E. Global epidemiology of periodontal diseases in children and young persons. Periodontol 2000 2002;29:153-76.
6. Albandar J. Global risk factors and risk indicators for periodontal diseases. Periodontol 2000 2002;29:177-206.
7. Armitage G, Cullinan M. Comparision of the clinical features of chronic and aggressive periodontitis. Periodontol 2000 2010;53:12-27.

8. Armitage GC. Comparison of the microbiological features of chronic and aggressive periodontitis. Periodontol 2000. 2010;53:70-88
9. Brown L J, Albandar JM, Brunelle JA, Loe H. Early-onset periodontitis: progression of attachment loss during 6 years. J Periodontol 1996;67:968–75.
10. Clerehugh V, Tugnait A. Diagnosis and management of periodontal diseases in children and adolescents. Periodontol 2000 2001;26:146-68.
11. Fine D, Goldberg D, Karol R. Caries levels in patients with juvenile periodontitis. J Periodontol 1984;55:242-6.
12. Gjermo P, Rösing CK, Susin C, Opperman R. Periodontal diseases in South and Central America. Periodontol 2000 2002;29:70-8
13. Heitz-Mayfield LJA. Disease progression: identification of high-risk groups and individuals for periodontitis. J Clin Periodontol 2005;32:196-209
14. Jansson L, Hagström K. Relationship between compliance and periodontal treatment outcome in smokers. J Periodontol 2002;73:602-7.
15. Julihn A, Barr Argholme M, Modéer T. Risk factors and risk indicators in relation to incipient alveolar bone loss in Swedish 19-years-olds. Acta Odont Scand 2008;66:139-47.
16. Källestål C, Matsson L, Holm AK. Periodontal conditions in a group of Swedish adolescents. (I). A descriptive epidemiologic study. J Clin Periodontol 1990;17:601-8.
17. Källestål C, Matsson L. Marginal bone loss in 16-year old Sedish adolescents in 1975 and 1988. J Clin Periodontol 1991;18:740-3.
18. Lindhe J, Liljenberg B. Treatment of localized juvenile periodontitis. Results after 5 years. J Clin Periodontol 1984;11:399–410.
19. Löe H, Anerud A, Boysen H, Morrison E. Natural history of periodontal disease in man. Rapid, moderate and no loss of attachment in Sri Lankan laborers 14-46 years of age. J Clin Periodontol 1986;13:431-45
20. Mendoza AR, Newcomb GM, Nixon KC. Compliance with supportive periodontal therapy. J Periodontol 1991;62:731-6.
21. Mros ST, Beglundh T. Aggressive periodontitis in children: a 14-19-year follow-up. J Clin Periodontol 2010;37:283-7.
22. Oliveira Costa F, Cota LO, Costa JE, Pordeus IA. Periodontal disease progression among young subjects with no preventive dental care: a 52-month follow-up study. J Periodontol 2007;78:198–203.
23. Oliver RC, Brown LJ, Löe H. Periodontal diseases in the United States population. J Periodontol 1998;69: 269-78
24. Saxén L, Asikainen S, Sandholm L, Kari K. Treatment of juvenile periodontitis without antibiotics. A follow-up study. J Clin Periodontol 1986;13:714–9.
25. Sioson P, Furgang D, Steinberg L, Fine D. Proximal caries in juvenile periodontitis patients. J Periodontol 2000;71:710-6.
26. Skaret E, Raadal M, Kvale G, Berg E. Factors related to missed and cancelled dental appointments among adolescents in Norway. Oral Sci 2000;108:175-83.
27. Smith M, Seymour G, Cullinan M. Histopathological features of chronic and aggressive periodontitis. Periodontol 2000 2010;53:45-54.
28. Socransky S, Haffajee AD. The bacterial etiology of destructive periodontal disease: current concepts. J Periodontol 1992;63:322-31.
29. Stabholz A, Soskolne A, Shapira L. Genetic and environtmental risk factors for chronic periodontitis and aggressive periodontitis. Periodontol 2000. 2010;53:138-53
30. Wennström A, Wennström, Lindhe J. Healing following surgical and non-surgical treatment of juvenile periodontitis. A 5-year longitudinal study. J Clin Periodontol 1986;13:869–82.

Corresponding author:
Dr. Leif Jansson
Folktandvården Skanstull
Götgatan 100
SE-118 62 Stockholm, Sweden
e-mail: leif.jansson@ftv.sll.se

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) 400 SEK

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 Ståhlnacke (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

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

Water cleaning systems improves the water quality in dental unit water lines (DUWL). A report from the Public Dental Health of Västra Götaland region, Sweden

GUNNAR DAHLÉN[1,2], GUNILLA HJORT[1], INGER SPENCER[2]

Abstract

◎ Biofilms are formed in the dental unit waterlines, which leads to unacceptable high levels of bacteria in the water used for dental treatment. Public Dental Health in Västra Götaland, Sweden, decided in 2010 to install water cleaning systems in all dental units. This report shows the effect of this water-cleaning program comprising 841 dental units.

The 841 dental units in 111 clinics in the Public Dental Health Service of Västra Götaland region participated in the study. 50 ml water was sampled from the air-water syringe after 2-3 hrs of use and were analyzed for the number of fast-growing (2 days incubation) and slow-growing (7 days incubation) bacteria calculated as colony forming units (CFU) per ml. Approved water quality was set to <100 CFU/ml according to the recommendations from the Board of Health and Wellfare (Socialstyrelsen).

Altogether 77.3% of the dental units reached approved levels, which was considerable higher than the 25.2% that were approved in a similar study at FTV in the city of Göteborg 4 years earlier when no water cleaning systems were installed. Further, 474 dental units using the Alpron/Bilpron weekend system 83.4% were approved, 136 units using Unit Clean system 87.5 % were approved and 15 using the Sterilox system all reached below 100 CFU/ml. The 199 dental units with inbuilt cleanings systems by the manufacturers based on hydrogen peroxide only 56.3 % were approved. A number of 45 (22.6%) showed very high levels (> 10 000 CFU/ml) indicating serious problems with the practical procedures or installation of the systems that needs further attention.

The study showed generally improved conditions of the water in the dental units after the introduction of water cleaning systems in the clinics of Public Dental Health Service of Västra Götaland Region, Sweden although the problem still remains in many units.

Key words

Dental unit water lines, biofilm, water cleaning systems.

[1] Department of Oral Microbiology and Immunology, Institute of Odontology, Sahlgrenska Academy at Gothenburg University, Gothenburg, Sweden

[2] Public Dental Health (Folktandvården) in Västra Götaland Region, Skövde, Sweden

Vattenreningsystem förbättrar vattenkvaliteten i tandläkarutrustningarna. Rapport från Folktandvården i Västra Götaland, Sverige

GUNNAR DAHLÉN, GUNILLA HJORT, INGER SPENCER

Sammanfattning

◎ I dentala unitars (tandläkarutrustningar) slangsystem bildas biofilmer som kan ge höga bakteriehalter i det vatten som används vid tandbehandling. Problemet är utbrett och Folktandvården i Västra Götaland beslöt att under 2010 förse samtliga unitar med någon form av vattenreningssystem. Föreliggande studie genomfördes för att se effekten på vattenkvaliteten i de dentala unitar som var försedda med vattenreningssystem under 2010.

841 dentala unitar från 111 tandvårdskliniker (både allmäntandvårds och specialist kliniker) inom Folktandvården i Västra Götaland deltog i studien. Utvärderingen inbegrep både "snabbväxande" (2 dagars inkubering) och "långsamväxande" (7 dagars inkubering) bakterier i 50 ml vatten avtappat från unitens trevägsspruta efter minst 2-3 timmars användning. Antalet bakterier beräknades som antalet kolonibildande enheter (CFU) per ml. Godkänd vattenkvalitet sattes enligt Socialstyrelsens rekommendation om dricksvattenkvalitet till 100 CFU/ml.

77,3 % av de undersökta unitarna fick godkända värden, vilket är avsevärt högre än de 25,2 % som blev godkända vid en motsvarande undersökning inom FTV i Göteborg 4 år tidigare i de unitar där ingen vattenrening förekom. Av de 474 unitar som var försedda med Alpron/Bilpron-systemet godkändes 83,4%, 136 med Unit Clean godkändes 87,5% samt 15 med Sterilox där alla hade godkänt vatten. Däremot kom endast 56,3 % av de dentala unitar med inbyggt reningssystem från fabrikanten baserat på väteperoxid att godkännas. 45 (22,6 %) av dessa uppvisade mycket höga värden (> 10 000 CFU/ml) av snabbväxande mikroorganismer vilket tyder på allvarlig brist i hanteringen av eller installationsproblem med dessa inbyggda vattenreningssystem. Studien visar dock på en klar förbättring av förhållandet i klinikernas vatten i dentala unitar.

Introduction

Biofilms are formed within dental unit water lines (DUWLs) and leads to a poor and unacceptable quality of the water during dental treatment (4). Bacteria are present in small droplets (aerosols) formed by the use of high-speed, ultrasoncation and air/water spray and both patients and staff may inhale them. The vast majority of the microorganisms is autotrophic and non-pathogenic and rather innocent for healthy individuals, but may be hazardous for immune-compromised or old patients (12, 17). Sometimes the microbial level within the DUWLs could be of such a magnitude that it must be regarded as unacceptable to use it also in regular dental treatment. The water can in extreme cases be bad smelling/tasting and discolored. Many countries have therefore introduced recommendations or guidelines for the water quality in DUWLs to be at a level of drinking water (4, 13, 16). In addition, the water in DUWLs may contain pathogenic microorganisms such as *Pseudomonas* spp, coliforms and *Legionella pneumophila* (2, 3). Especially the latter has been frequently recognized in the tap water in many countries otherwise regarded as having a good standard of the tap water and for using the tap water as drinking water (5).

The Swedish Board of Health and Welfare recommended in 2006 (15) that the water of DUWLs should not exceed 100 CFU/ml and that the level should be controlled annually. This led the Pubic Dental Health Service of Gothenburg city to perform a survey for all dental units within the organization (5) to evaluate the conditions of the dental units of its clinics. Among 405 units in 34 clinics only 102 (25.2%) showed levels below the approved treshold of 100 CFU/ml and none of the 34 clinics had acceptable conditions in all their units. Furthermore, L. penumophila was detected in 61 (15.1%) units of 13 (38.2%) clinics. The direction of the Public Dental Health decided in 2010 to install water-cleaning systems in all clinics of the Region of Västra Götaland, Sweden. This report is the first to show the effect of such a program on the water quality in DUWLs.

Materials and Methods

Clinics and Dental Units.

The Swedish Board of Health and Welfare (15) recommended that all dental units should be controlled yearly and necessary steps should be taken if the water of DUWLs did not reach drinking water quality (<100 CFU/ml). The Public Dental Health Service (Folktandvården, FTV) of Västra Götaland (including the city of Gothenburg), Sweden was reorganized in 2006 and includes today over 100 general and specialist clinics and ca 1200 dental units. The directory for the FTV decided that all units should be equipped with some form of water cleaning system at the end of year 2010. Based on a comparison (6) the following systems were recommended Alpron (Alpron/Bilpron, Svensk Dentalservice, Göteborg, Sweden), Unit Clean (DAB, Upplands Väsby, Sweden) or Sterilox, (DAB, Upplands Väsby, Sweden). Newly installed units with inbuilt cleaning systems from the manufacturer (KaVo, Upplands Väsby, Sweden, Planmeca/Plandent, Forsbergs Dental AB, Stockholm, Sweden and XO Care A/S, Hörsholm, Denmark) were also included. Thus 841 dental units was equipped with a cleaning system and participated in the survey of the water quality of DUWLs. The remaining dental units in the clinics of the region were not sampled and controlled due to the fact that cleaning systems were not installed in 2010.

To fully evaluate the effect of the cleaning system installation, the dental units in clinics of Gothenburg City that were included and reevaluated in 2010 were specifically compared with the data four years earlier. Of the 405 dental units evaluated in 2006, 300 were reevaluated in 2010. The remaining dental units were not controlled, 49 due to renovation, 29 due to installation of a cleaning system was not accomplished and 27 due to negligence.

Samples and analysis.

A time-schedule was set for all clinics by the clinic coordinator to get samples from the same clinic concomitantly and also to arrange transportation to the laboratory within 24 hrs. All samples were taken in the morning after 2-3 hrs of work. Dental units that were not in use that particular day were flushed 3 mins before sampling. Mondays were avoided due to a suspected accumulation of bacteria during the weekend prior to sampling. The aim was to obtain the lowest value ("best value") of the units.

A volume of 50 ml water was collected the air-water-syringe into a sample tube from each of all the dental units at the clinic. The samples were sent to the laboratory without special cooling procedures. The analysis was performed at the laboratory for Oral Microbiology, Institute of Odontology, Sahlgrenska Academy at University of Gothenburg according to the protocol given by the Swedish Institute for Communicable Disease Control (Smittskyddsinstitutet)(14) and have been used in previous studies (5). The samples were diluted 1/100 and 0.5

ml from concentrated and from the 1/100 dilution was inoculated on agar plates with Difco Nutrient agar (Becton, Dickinson and Company, Sparks, Maryland, USA). The plates were allowed to absorb the liquid for one hour on the bench. The plates were then incubated at 22 °C and air for enumeration of heterotrophic aerobically grown bacteria as colony forming units (CFU)/ml. Nutrient agar plates were analyzed by counting all colonies under the microscope (x16) after 2 days (fast growing). Swedish National Food Agency, Uppsala, Sweden (8) also recommended that slow growing bacteria should not exceed the level of 5000 CFU/ml for tap water used as drinking water and thus the plates were read also after 7 days (slow growing) incubation. The number of slow growing bacteria was calculated as the total number of colony forming units (CFU) after 7 days minus the number of CFU after 2 days. Both values were given as CFU/ml.

Results

A number of 650 (77.3%) dental units showed less than 100 CFU/ml (Table 1) and were thus approved using the guidelines of the Swedish Board of Health and Wellfare. If the EU and US recommendations (1, 17), for DUWLs of <200 CFU/ml were used 679 (80.1%) dental units would have been approved and using the drinking water standard of CDC (Centre of disease control, Atlanta, Georgia, US) of 500 CFU/ml as a cut off point 713 (84.8%) dental units would have been acceptable.

A number of 474 units were equipped with the Alpron/Bilpron system and 397 (83.4%) showed <100 CFU/ml, 410 (86.5%) <200 CFU/ml and 422 (90.1%) had <500 CFU/ml (Table 2). Of the 136 dental units using Unit Clean 119 (87.5 %) showed <100 CFU/ml and the 15 dental units using the Sterilox system all (100%) showed less than 100 CFU/ml in the DUWLs samples. A number of 199 dental units had inbuilt systems from the manufacturers based on hydrogen-peroxide with silver ions (e.g. Oxygenal, Planosil/Sanosil, XO WCS), only 112 (56.3 %) showed less than 100 CFU/ml. It was also noticed

Table 1. Number of approved dental units after control of the water quality of the water lines of 841 dental units in FTV of Västra Götaland, Sweden and with some form of water cleaning system installed during year 2010

Limit for fast growing bacteria (CFU/ml)	Limit for slow growing bacteria (CFU/ml)	Number of approved dental units (%)
<100	-	650 (77.3)
<100	<5000	633 (75.3)
<200	-	679 (80.1)
<200	<5000	660 (78.5)
<500	-	713 (84.8)
<500	<5000	689 (81.9)

Table 2. Number of approved dental units after control of the water quality of the water lines in 474 dental units in FTV of Västra Götaland, Sweden installed with Alpron/Bilpron weekend system for cleaning DUWLs during 2010

Limit for fast growing bacteria (CFU/ml)	Limits for slow growing bacteria (CFU/ml)	Number of approved units (%)
<100	-	397* (83.4)
<100	<5000	388 (81.9)
<200	-	410 (86.5)
<200	<5000	402 (84.8)
<500	-	422 (90.1)
<500	<5000	422 (90.1)

*14 units showed >10 000 and 3 units >100 000 CFU/ml.

Table 3. Number of approved dental units after control of the water quality of the water lines in dental units in FTV of Västra Götaland, Sweden, 136 with Unit Clean (monthly), 15 with Sterilox (continuous) and 199 with inbuilt water cleaning system (KaVo Oxygenal, Plandent/Plameca Planosil or XO-4 WCS), all installed during year 2010

Type of cleaning system	Limit for fast growing bacteria (CFU/ml)	Number of approved units (%)
Unit Clean (n=136)	<100	119 (87.5)
Sterilox (n=15)	<100	15 (100)
Inbuilt system (n=199)	<100	112 (56.3)

Table 4. Number of units with inbuilt water cleanings systems and indicated levels of bacteria (CFU/ml)

Type of unit	Type of cleanings system	Number of DUWL´s			
		Total	>100 CFU/ml (%)	>10 000 CFU/ml (%)	>100 000 CFU/ml (%)
Planmeca/Plandent	Planosil	162	73 (45.0)	35 (21.6)	17 (10.4)
XO 4	WCS	19	14 (73.6)	6 (31.5)	3 (15.7)
KaVo	Oxygenal	18	2 (11.1)	1 (5.5)	0 (0)
Total inbuilt systems	Hydrogen-peroxide	199	89 (44.7)	45 (22.6)	20 (10.1)

Table 5. Comparison of the number of approved dental units in the Public Dental Service clinics in the City of Gothenburg tested in 2006 prior installation and in 2010 after installation

Type of cleaning system installed between 2006 and 2010	Total number of dental units	Number of approved dental units (CFU <100/ml) in 2006 (%)	Number of approved dental units (CFU <100/ml) in 2010 (%)
Alpro/Bilpron	250	25 (10.0%)	206 (82.4%)
Unit Clean	6	0	6 (100%)
Plandent/Plameca, XO-4 WCS	59	7 (11.9%)	22 (47.5%)
Total	315	32 (10.2%)	234 (74.3%)

that 45 (22.6 %) had more than 10 000 CFU/ml and 20 (10.1%) had more than 100 000 CFU/ml.

The 300 dental units in the City of Gothenburg that were evaluated 2006 before installation of cleaning systems, were reevaluated in this study 2010. Of these, 250 were equipped with the Alpron/Bilpron system and the number of approved dental units increased from 25 (10.0%) in 2006 to 206 (82.4%) in 2010. Similarly, for 59 dental units were installed with new dental units with inbuilt cleaning systems (48 Planmeca/Plandent units and 11 XO4 units), only 22 (47.5%) reached the recommended level below 100 CFU/ml in this evaluation 2010. Unit Clean was installed in 6 dental units that were not approved in 2006 but all 6 were approved in 2010. Sterilox was not installed in any of the studied dental units in the clinics in the City of Gothenburg.

Discussion

This report showed that 77.3 % of the 841 dental units in FTV clinics of Västra Götaland Region, Sweden that were controlled during 2010 after installation of some form of cleaning system had an acceptable standard (below 100 CFU/ml) according to the Swedish guidelines from the Board of Health and Welfare. This is remarkably higher than the values found in the survey performed in the Public Dental Health in the City of Gothenburg four years earlier when practically no units were equipped with cleaning systems and when only 25.2 % of the DUWLs were approved. This strongly indicates the right decision to invest in water cleaning systems to improve the water quality. Still 22.7% of the dental units did not reach the goal. If other limits were used the number of acceptable units was reduced to below 20%. Sweden has chosen a limit of 100 CFU/ml, while other EU countries use 200 CFU/ml (for review see 4). However, the effect on the number of units that would have been approved by the EU standards is only marginal and additional 29 units would have been approved. Similarly, if 500 CFU/ml, which is a drinking water standard by the CDC in the US and also current CDC guidelines for infection control in dental healthcare settings (7) have been used an additional 34 units have been approved. In view of the variation obtained between different dental units and the probable time related fluctuations between sampling occasions, even 500 CFU/ml could have been regarded as temporary and acceptable without doing any further steps to improve the system. In case of a bacterial density of >100 CFU/ml but <500 CFU/ml the system should be checked more frequently.

The international recommendations are dealing with heterotrophic aerobic bacteria and thus correspond to the "fast growing" (2 days) in the present study. In addition, we included growing bacteria after 7 days, which illustrates that there are commonly more bacteria present in the DUWLs than those that are detected in a rapid 2 days test. The bacteria that are colonizing the DUWLs are autotrophic slow-growing biofilm bacteria that may even be growth inhibited but not killed by the antiseptics used in cleanings-systems. They may be innocent for the health of patients and staff, however indicate poor conditions of the unit and the DUWLs and it is likely that the risk increases for presence of more rapidly growing bacteria including pathogens such as *L. pneumophila* to occur in such units.

The most remarkable outcome of this observational study was the comparatively low number of approved newly installed units equipped with cleaning systems from the manufacturer. These systems sometimes give the impression that they work automatically but this is not true. All systems need maintenance and the instructions must be followed strictly and the outcome needs to be controlled regularly. On the other hand, we do not know how these systems work longitudinally over several years and how efficiently they can prevent biofilms to be formed and whether the biofilms could be removed once they have become established. Notably, several of the most contaminated units and with the highest number of bacteria in the water (>10 000 and

>100 000 CFU/ml) were obtained from units with this "inbuilt" cleaning systems based on hydrogen peroxide and silver ions. This must be further analyzed whether this depends on poor instructions and maintenance or on shortcomings of using hydrogen peroxide in this type of systems. It could well be so that the test samples were collected too close to the installation and the cleaning have not reached its complete effect. Lin et al. (8) evaluated hydrogen peroxide on dental unit biofilms and found that there was no eradication even when 7% hydrogen peroxide was used for 24 hrs. To remove well-established biofilms, it may take more than 2 months when initial and multiple periodic cleanings are performed using hydrogen peroxide. The notably difference between the KaVo/Oxygenal on one hand and the Planmeca/Planosil system on the other indicate that some explanation is to be found in the unit brand rather than hydrogen peroxide. The findings for inbuilt systems needs further attention.

The other three systems (Alpron/Bilpron, Unit Clean, and Sterilox) used to equip dental units that have no inbuilt cleanings systems seem to work sufficiently. The majority of the clinics used the Alpron/Bilpron weekend system and 16.6 % of these did not reach the limit of 100 CFU/ml. The system is fairly easy to handle and is a non-continuous system, where the disinfection process is performed over the weekend. However, this weekend cleaning can intermittently be forgotten and may lead to an increased contamination and biofilm formation. There is also little information how efficient this system is on established biofilms and heavily contaminated units.

The Unit Clean system has been evaluated previously (11). It is a cleaning system used monthly and has the purpose to eradicate the biofilm using two separate solutions that work overnight. It has the advantage that cleaning procedures may be evaluated by 4 microbiological tests included in the manufacturing of this system in order to check the water-quality after installation. If the bacterial level is not sufficiently reduced, a third solution (Unit Clean P based on sodium hypochlorite) can be used as a shock treatment to remove internal biofilms in the DUWLs. In heavily contaminated units this procedure it may be necessary to repeat this shock treatment several times illustrating the difficulties to remove the biofilms once they have become established. Using antiseptics in the cleaning procedures are thus no guarantee that the biofilm is eradicated and the outcome needs to be tested.

Sterilox is a continuous system that produces a super-oxidised (Sterilox/Optident) water. It has been tested previously (10). It showed in the present study the best results (100%), although a lot fewer units were tested compared to those tested with Alpron/Bilpron and Unit Clean.

This study showed dramatic improvements of the water quality in the water lines of dental units in clinics of Public Dental Health Service (Folktandvården) of Västra Götaland Region after installation of cleaning-systems but still a certain number of clinics/units has unacceptable levels of bacteria in the water. The study also indicates the inbuilt "automatic" systems using hydrogen-peroxide had the least favorable effect but it is not known if that depends on a non-adequate handling of the system or a short-coming of the systems itself. The water quality in the DUWLs needs to be regularly controlled and necessary steps should be taken if the bacterial level is unacceptably high.

Acknowledgement

Special thanks go to all involved clinics and clinic coordinators of Folktandvården in Västra Götaland Region for a valuable cooperation in the study.

References

1. American Dental Association. ADA statement on dental unit waterlines. J Am Dent Assoc 1996;127:185-6.
2. Atlas RM, Willims JF, Huntington MK. Legionella contamination of dental unit waters. Appl Environ Microbiol 1995;61:1208-13.
3. Challacombe SJ, Fernandes LL. Detecting Legionella pneumophila in water systems: comparison of various dental units. J Am Dent Assoc 1995;126:603-8.
4. Coleman DC, O´Donnell MJ, Shore AC, Russell RJ. Biofilm problems in dental unit water systems and its practical control. J Appl Microbiol 2009;106:1424-37.
5. Dahlén G, Alenäs-Jarl E, Hjort G. Water quality in water lines of dental units in the Public Dental Health Service in Göteborg, Sweden. Swe Dent J 2009;33:161-72.
6. Dahlén G, Alenäs-Jarl E, Rexon B, Hjort G. Så kan dåligt unitvatten förbättras. Tandläkartidningen 2010;102:58-63.
7. Kohn WG, Harte JA, Malvitz DM, Collins AS, Cleveland JL. Centers for disease control and prevention. Guidelines for infection control in dental health care settings -2003. J Am Dent Assoc 2004; 135: 33-47.
8. Lin S-M, Svoboda KKH, Giletto A, Seibert J, Puttaiah R. Effects of hydrogen-peroxide on dental unit biofilms and treatment water contamination. Eur J Dent 2011, 5:47-59.
9. Livsmedelsverket 2009. http://www.slv.se.
10. Martin MV, Gallagher MA. An investigation of the efficacy of super-oxidised (Optident/Sterilox) water for disinfection of dental unit water lines. Br Dent J 2005;198:353-4.
11. Möller Å, Dahlén G. Regelbunden rengöring av unitar.

Tandläkartidningen 2007;99:52-6.
12. Pankhurst CL, Coulter WA. Do contaminated dental unit waterlines pose a risk of infection? J Dent 2007;35:712-20.
13. Schel AJ, Marsh PD, Bradshaw DJ, Finney M, Fulford MR, Frandsen E, Ostergaard E, Ten Cate JM, Moorer WR, Mavridou A, Kamma JJ, Mandilara G, Stosser L, Kneist S, Araujo R, Contreras N, Goroney-Bermes P, O´Mullane D, Burke F, O´Reilly P, Hourigan G, O´Sullivan M, Holman R, Walker JT. Comparison of the efficacies of disinfectants to control microbial contamination in dental unit water systems in general practices across the European Union. Appl Environ Microbiol 1006; 72: 1380-7.
14. Smittskyddsinstitutet (SMI) 2008. http://www.smittskyddsinstitutet.se
15. Socialstyrelsen (SOS). Att förebygga vårdrelaterade infektioner. Artikel nummer 2006;123:12.
16. Walker JT, Bradshaw DJ, Fulford MR, Marsh PD. Microbiological evaluation of a range of disinfection products to control mixed-species biofilm contamination in a laboratory model of a dental unit water system. Appl Environment Microbiol 2003; 69:3327-32.
17. Walker JT, Bradshaw DJ, Finney M, Fulford MR, Frandsen E, Ostergaard E, Ten Cate JM, Moorer WR, Schel AJ, Mavridou A, Kamma JJ, Mandilara G, Stosser L, Kneist S, Araujo R, Contreras N, Goroney-Bermes P, O´Mullane D, Burke F, Forde A, O´Sullivan M, Marsh PD. Microbiological evaluation of dental unit water systems in general practice in Europe. Eur J Oral Sci 2004;112:412-8.

Corresponding author:
Dr. Gunnar Dahlén
Department of Oral Microbiology and Immunology
Institute of Odontology
Sahlgrenska Academy
University of Gothenburg
Box 450
SE-40530 Gothenburg, Sweden
E-mail dahlen@odontologi.gu.se

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

208. The preterm child in dentistry. Behavioural aspects and oral health
Susanne Brogårdh-Roth (2010) 400 SEK

209. Cone Beam computed Tomography - radation dose and image quality assessments
Sara Lofthag Hansen (2010) 400 SEK

210. Organisation and management of Public Dentistry in Sweden. Past, present and future
Sven Ordell (2011) 400 SEK

211. Intra-oral soft tissue expansion and volume stability of onlay bone grafts
Peter Abrahamsson (2011) 400 SEK

212. Correction of posterior crossbite in the mixed dentition - studies of treatment effects, stability and cost-effectiveness.
Sofia Petren (2011) 400 SEK

213. Zirconium dioxide based dental restorations - studies on clinical survival and fracture behaviour
Christel Larsson (2011) 400 SEK

214. On tooth movements and associated tissue alterations related to edentulous areas and bone defects
Birgitta Lindskog Stokeland (2011) 400 SEK

215. On minor salivary gland secretion in children, adolescents and adults
Mikael Sonesson(2011) 400 SEK

216. Molar Incisor Hypomineralization. Morphological and chemical aspects, onset and possible etiological factors
Tobias Fagrell (2011) 400 SEK

217. Bonding of porcelain to titanium- clinical and technical possibilities
Per Haag (2011) 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.

Fracture strength of all-ceramic (Y-TZP) three- and four-unit fixed dental prostheses with different connector design and production history

DEYAR JALLAL HADI MAHMOOD, EWA H LINDEROTH, PER VULT VON STEYERN, ANN WENNERBERG

Abstract

◎ Aims: To investigate how different default settings for connector design of two different CAD/CAM systems, i.e. to compare how different radii of curvature in the embrasure area of the connector affect the fracture strength and the fracture mode of 3-unit and 4-unit all-ceramic FDPs made from Y-TZP and to investigate how the number of pontics affect the fracture strength of Y-TZP.

Material and methods: 32 all-ceramic three (3Z) and four (4Z) -unit, Y-TZP, FDP cores were made and divided in 4 groups, with 8 FDP in each group. The groups 3Z:1 and 4Z:1 were generated with a mechanical scanner, Procera® Forte and the FDPs in group 3Z:2 and 4Z:2 were generated with an optical scanner, NobelProcera® Scanner. The connector dimensions were set to 3 mm x 3 mm and core was set to 0.7 mm. The design of radius of the gingival and occlusal embrasures in the connector areas was set according to default settings and the manufacturer's recommendations. All the FDP cores were subjected to heat treatment, thermocycled for 5,000 cycles, preloaded for 10,000 cycles to simulate ageing and finally loaded to fracture.

Results: Regarding connector design a significant difference was found between group 3Z:1 and 3Z:2 ($P<0.05$), and group 4Z:1 (50% of the FDPs fractured during preloading 30-300N) and 4Z:2 ($P<0.05$). An extra pontic decreased the fracture strength up to 45%. Conclusions: The default settings of the two different CAD/CAM systems had a great impact on the fracture strength. It is important that a CAD/CAM system is equipped with possibilities to design a connector that fulfils the clinical demands of mechanical function and longevity. The most crucial factor for the load-bearing capacity is the design of the radius of the gingival embrasures. Increasing the number of pontics from three to four decreases the load-bearing capacity nearly twice.

Key words

All-ceramic FDPs, connector-design, CAD/CAM, radii, 3-4 unit FDPs

Department of Prosthetic Dentistry, Faculty of Odontology, Malmö University, Malmö, Sweden

Brotthållfasthet hos helkeramiska (Y-TZP) tre- och fyra-leds broskelett: betydelsen av connectordesign och produktionshistorik

DEYAR JALLAL HADI MAHMOOD, EWA H LINDEROTH, PER VULT VON STEYERN, ANN WENNERBERG

Sammanfattning

◎ Yttriumoxidstabiliserad zirkoniumdioxid (Y-TZP) används frekvent inom tandvården. Helkeramiska broar måste dimensioneras och designas med hänsyn till bromaterialets specifika materialegenskaper. Särskilt kritisk är utformningen av connectorområdet. Rekommendationerna avseende connectordimensionerna för anteriora 3- och 4-ledsbroar av Y-TZP varierar mellan 2 till 4 mm i vertikal riktning och mellan 2 till 4 mm i horisontell riktning. Utöver dimensioneringen måste hänsyn tas till connectorns utformning då connectorns gingivala radie har en stor betydelse för konstruktionens totala brotthållfasthet. Vid belastning utsätts broar med liten gingival radie för högre spänningskoncentrationer i connectorområdet jämfört med broar med större gingival radie. Den gingivala utformningen av connectorer kan ha en ännu större betydelse för brotthållfastheten om antalet hängande led utökas från ett till två.

Syftet med föreliggande studie var att undersöka hur förinställningarna avseende design av connectorer i två olika CAD/CAM-system påverkar brotthållfastheten, hur den gingivala radiens storlek påverkar brotthållfasthet och frakturmönster samt undersöka hur brospannets längd, dvs antalet hängande led påverkar brotthållfastheten hos 3- och 4-ledsbroar av Y-TZP.

Två olika CAD/CAM-system användes för att framställa totalt 32 broskelett av Y-TZP, varav 16 st 3-ledsbroar med ett hängande led och 16 st 4-ledsbroar med två hängande led. Broskeletten delades in i 4 grupper baserat på antal led och utformning av connectorernas gingivala radie. För att framställa grupperna 3Z:1, 4Z:1 användes en mekanisk scanner, Procera®Forte och för grupperna 3Z:2, 4Z:2 användes en optisk scanner, NobelProcera® Scanner.

Samtliga broar utsattes för värmebehandling (simulerad porslinspåbränning), termocykling (5°C – 55°C / 5000 cykler), cyklisk förbelastning (30 – 300N / 10 000 cykler) och belastades slutligen till brott. Samtliga broar fakturerade i connectorområdet och efter okulär besiktning kunde man konstatera att samtliga frakturer startat i connectorns gingivala del. Medelvärdena för last vid brott var i grupp 3Z:1 734 N, grupp 4Z:1 405 N, grupp 3Z:2 910 N samt i grupp 4Z:2 520 N.

Med reservation för de begränsningar som en *in-vitro* studie innebär dras följande slutsatser: Förinställningarna i de olika CAD/CAM systemen hade avgörande betydelse för brotthållfastheten. Eftersom connectorområdet utgör den svagaste punkten i en helkeramisk brokonstruktion är det avgörande att CAD/CAM systemens standardinställningar tillåter en konstruktionsdesign som uppfyller de mekaniska och kliniska kraven.

Storleken på den gingivala connectorradien har avgörande betydelse både för brotthållfastheten och för frakturmönster. Genom att öka antalet hängande led från ett till två hängande led minskar brokonstruktionens brotthållfasthet med ca 50 %.

Introduction

Yttria-stabilised tetragonal zirconia polycrystals (Y-TZP) was introduced in dentistry in the nineteen-nineties. Pure zirconium-dioxide (zirconia) exists in three crystalline phases at different temperatures. The material is unsuitable for structural or mechanical applications in those stages. By adding one of several oxides, yttria, ceria, calcia or magnesia (so called stabilizers), which dissolve within the crystal structure of zirconia, it is possible to densify the material in the tetragonal phase range to yield a fine-grained microstructure consisting almost completely of tetragonal grains, metastable at room temperature (Y-TZP) (8,16,29).

If a crack is formed in the material, each tetragonal grain has the potential to transform into a monoclinic one with a volume expansion of 4-5% near the crack tip and in this way inhibit further propagation of the crack. This mechanism is described as transformation toughening or phase transformation (16), giving the material great potential for stress-bearing and wear-resistant applications even if the transformation is a one way progression. However, when the transformation takes place, the crack hindering effect cannot prevent further crack growth (29).

To ensure optimal clinical performance, the dimensions of a fixed dental prostheses (FDPs) in general and of the connectors in particular, must be adequate since stress concentrations of the framework are developed at the intersections of the pontics. Important factors are the connector diameter, the diameter and the number of the pontics and the radius of curvature at their intersection (17,27).

Recommendations for connector dimensions for Y-TZP vary from 2 to 4 mm in occluso-gingival height and 2 to 4 mm in bucco-lingual width (6,14,17,28,30,31). Furthermore, it has been shown that, in order to reduce the fracture probability when designing all-ceramic FDPs, the shape of the connector is an important factor to consider (9,20,21). In particular, the radius of curvature at the gingival embrasure plays a significant role in the load-bearing capacity. FDPs with small gingival embrasure radii are subjected to high stress concentrations in the connector area during loading, compared to FDPs with large embrasure radii. Previous studies show that a larger radius of the gingival embrasure results in significantly higher fracture resistance compared to FDPs with smaller embrasure radii. In conclusion, it has been shown that not only the material properties, but also the design of an all-ceramic FDP, play an important role for the strength of the reconstruction. Hence, it is important for both dental technicians and dentists to have control of the design parameters as well as the material used (1,20).

Computer-aided design and computer-aided manufacturing (CAD/CAM) systems are used for producing Y-TZP FDPs. There are several CAD/CAM-systems on the market but in each system the design is basically dependent on the design limitations of the CAD-software and the milling properties of the CAM-system (1,9,20,21). Many of the design parameters can be adjusted to fit each case to be milled individually, while other are not and instead fixed as default settings determined by the manufacturers. The limitations in the CAD/CAM systems have sometimes led to FDPs with a particular type of connector design. It differs from the other designs, having small radii approximally, connected with a straight beam, this have been shown to reduce the strength of all-ceramic FDPs (1,30,31). Thus, it could be possible that the design limitations of different CAD/CAM system could have an influence on the fracture strength, and consequently the clinical outcome of all ceramic FDPs. The aims of this study were:

- to investigate how different default settings of two different CAD/CAM systems, i.e compare how different radii of curvature in the embrasure area of the connector affect the fracture strength and the fracture mode of 3-unit and 4-unit all-ceramic FDPs made from Y-TZP.
- to investigate how the length of the FDPs (i.e. the number of pontics) affect the fracture strength of Y-TZP.

Material and methods

A total of 32, all-ceramic, Y-TZP, 16 three- and 16 four-unit FDP cores with differing design were made. There were one or two intermediate pontics, supported by end abutments. The FDPs were then divided according to design in four groups (3Z:1, 3Z:2, 4Z:1 and 4Z:2), including 8 FDPs in each group.

Preparation

For the fabrication of the master model for the three-unit FDPs, a plastic model of an upper jaw (KaVo YZ, OK VZ 623 0401 180, KaVo Dental, GmbH, Germany) was used. Two abutment preparations were made on the left central incisor and the left canine, the left lateral incisor was removed. Two abutment preparations were made for the four-unit FDPs on the right central incisor and the left canine, the left

central incisor and the left lateral incisor were removed. The aim was to design a preparation with a 120° chamfer and an angle of convergence of 15°. Subsequently a full arch A-silicone (Flexitime Mono Phase, Heraeus Kulzer, GmbH, Germany) impression was made and poured with die stone (Everest® Rock, Type 4 die stone, KaVo Dental, GmbH, Germany) to produce two master cast.

Scanning

Two different scanners were used to perform the FDPs. Data for groups 3Z:1 and 4Z:1 was generated with a mechanical scanner, Procera® Forte (Nobel Biocare, Zurich, Switzerland). The master casts were scanned and the data was transferred to a computer equipped with CAD software (Procera CAD Design C3D, version 2.60) where the intended design of the FDPs was established. The connector dimensions were set to 3 mm x 3 mm and the minimum thickness of the core was set to 0.7 mm. The design of radius of the gingival and occlusal embrasures in the connector areas was set according to the default settings in the CAD program, and according to the manufacturer's recommendations. Data for the FDPs in group 3Z:2 and 4Z:2 were generated with an optical scanner, NobelProcera® Scanner (Nobel Biocare, Zurich, Switzerland). The master casts were scanned and the data of the NobelProcera® optical scanner was transferred to a computer equipped with CAD software (NobelProcera 3D prosthetic design, version 4.1.10.4.) where the intended design of the FDPs was established according the protocol for the first two groups. The CAD data for the FDPs was subsequently sent to a production center (Procera® Production center, Stockholm, Sweden) where it was used for the production of the 32 FDPs in Procera® Zirconia bridge material, following the regular production line. Finally the FDPs were sent back to the Faculty of Odontology, Malmö University, where they were to be tested.

Heat treatment

All FDP cores were subjected to heat treatment in a calibrated porcelain furnace (Ivoclar P 500, Ivoclar Vivadent AG Schaan/Liechtenstein) to simulate the firing cycles of the veneering porcelain (Nobel Rondo™ Zirconia, Nobel Biocare, Gothenburg, Sweden) recommended for the core material used. Four firing programs were used: Liner, Dentin 1, Dentin 2 and finally Glaze as shown in Table 1 (Table 1.), all according to the manufacturer's instructions.

Ageing procedures

Two stages of ageing were performed for all FDPs. In the first stage, all FDP cores underwent thermocycling (LTC Multifunctional Thermocycler, LAM Technologies electronic equipment, Italy) using a small basket controlled by a device driver. All FDP cores underwent 5,000 thermocycles in two water baths at temperatures of 5 °C and 55 °C. The cores were placed in a basket for transfer between the two baths. Each cycle lasted 60 seconds, 20 seconds in each bath and 10 seconds to complete the transfer between the baths. After thermocycling, the cores were dried.

Supporting tooth analogues

Tooth analogues for the testing procedure were made simultaneously with the production of the FDPs, as inspection blocks from the same CAD-file as the one used to produce the FDP cores at the production center (Procera® Production center, Stockholm, Sweden). According to previous studies 32 inspection blocks of a polymer material were made to enable precision check and to support the FDPs during testing (20).

Cementation

Prior to cementation, the tooth analogues were steam cleaned and subsequently treated with ED primer II A and B (Kuraray Medical INC, Tokyo, Japan) which was applied to the cementation surfaces according to the manufacturer's instructions.

The FDPs of all four groups were luted onto the tooth analogues with Panavia F 2.0 luting cement (Kuraray Medical INC, Tokyo, Japan) using both light and Oxyguard II (Kuraray Medical INC, Tokyo, Japan), according to the manufacturer's recommen-

Table 1. General Firing Program. NobelRondo™ Zirconia Ceramics

Firing Program	Pre-heating temp.	Pre-heating drying time (min)	Heating Rate Y-TZP	Firing temp.	Holding time (min)	Vacuum (hPa)
Liner firing	575 °C	8	45/55 °C	930 °C	1	50
Dentin firing 1	575 °C	9	45/55 °C	910 °C	1	50
Dentin firing 2	575 °C	8	45/55 °C	900 °C	1	50
Glaze firing	575 °C	5	45/55 °C	880 °C	1	-

dations. During setting of the cement, all FDPs were loaded in the direction of insertion with a force of 15 N for a period of 60 seconds. After cementation the FDP cores were placed in a plastic container, with water covering the bottom surface and a sealing lid, to create a moist environment to prevent desiccation of the luting cement.

Second stage of ageing of FDP cores

In the second stage of ageing, all FDP cores underwent cyclic preloading at loads between 30 and 300 N, comprising 10,000 cycles and a load profile in the form of a sine wave at 1 Hz. In all groups the force was applied with a stainless steel intender, 2.5mm in diameter, placed centrally on the incisal edge of the pontic at the three-unit FDPs, and centrally on the lateral incisor pontic at the four-unit FDPs, to avoid sliding during loading. During preloading all FDPs were stored in distilled water and mounted at a 10° inclination relative to the vertical plane.

Load to fracture

In the final stage of testing, the FDPs were mounted in a testing jig at a 10° inclination and subjected to a load applied by a universal testing machine (Instron 4465, Instron Co. Ltd, Norwood, MA, USA). The crosshead speed was 0.255mm/min and the load was applied with a stainless steel intender placed centrally on the incisal edge of the pontic at the three-unit FDPs, and centrally on the lateral incisor pontic at the four-unit FDPs. In the final step of the procedure, the FDPs were loaded until a fracture occurred, whereupon the loads at fracture were registered. Fracture was defined as a visible fracture through the entire construction.

Table 2. Fracture load (N), mean fracture load and standard deviation

Group	3Z:1 3-unit	3Z:2 3-unit	4Z:1 4-unit	4Z:2 4-unit
Significance	P<0.05		P<0.05	
FDP No				
1	753	805	300*	575
2	749	953	300*	512
3	849	697	499	455
4	735	1070	300*	564
5	767	843	508	430
6	830	997	530	574
7	610	921	300*	503
8	575	999	499	547
Mean(N)	734	910	405	520
SD	96	122	112	55

*FDPs fractured at 30-300 N preload

Throughout the test period, whenever the FDP cores were not being actively tested, they were stored in distilled water.

Statistical analyses

Any differences between groups were tested by means of the student's t-test and were performed to detect any significant differences ($p < 0.05$) between the groups.

Results

The fracture data are listed in Table 2. During the cyclic mechanical preload (30-300N) four of the FDPs in group 4Z:1 fractured.

All the 32 FDPs in the present study were examined to establish the fracture modes which were distributed as follows:

- In group 3Z:1 six of the FDPs fractured at the distal connector area on the left central incisor and through the pontic. Two FDPs fractured at the mesial connector area of the left canine and through the pontic. All FDPs fractured at the sharp mesial corner of the connector.
- In group 4Z:1 seven of the FDPs fractured at the mesial area of the connector on the left lateral incisor and through the pontic. One FDP fractured at the mesial connector area of the left canine and through the pontic. All FDPs fractured at the sharp mesial corner of the connector.
- In group 3Z:2 four of the FDPs fractured at the distal connector area on the left central incisor and through the pontic. Four FDPs fractured at the mesial connector area on the left canine and through the pontic. All fractures were located in the center of the connector area, where the connector is thinnest.
- All the FDPs in group 4Z:2 fractured at the mesial connector area on the left lateral incisor and through the pontic. All fractures were located in the center of the connector area, where the connector is thinnest.

Discussion

To simulate clinical conditions the FDPs underwent different ageing treatments. According to some studies, the temperatures that the core is subjected to during porcelain firing may decrease the mechanical properties of the ceramic material. In the case of Y-TZP a possible explanation is that machine grinding initiates the tetragonal to monoclinic transformation, creating a compressive layer, and that these

residual stresses are relaxed during porcelain firing reversing the transformation. Transformation from the monoclinic to the tetragonal meta-stable phase may occur as soon as a given temperature is reached, regardless of the holding time (10,13,30,31).

Heat-treating Y-TZP to simulate porcelain firing, a preheating process with or without actual veneering, can be carried out, both to exclude the risk that the porcelain itself affects the results but also because the veneer material is more complicated to build up in a standardised way, as generally veneering requires a high level of skilled workmanship. It was therefore decided to exclude this production step in the present study.

The FDPs can be thermo-cycled in order to simulate ageing and to expose the materials to fatigue. The change in temperature creates stresses corresponding to mechanical stresses in the mouth. The wet environment may also affect the materials by enhancing micro-crack growth due to stress corrosion. The strength degradation rate is a slow process affecting the all-ceramic material differently depending on several micro-structural parameters, such as – in the case with Y-TZP - yttrium distribution and concentration, the distribution of flaw populations and grain size (2,5,38).

Cyclic preloading in an aqueous environment can be performed to simulate ageing of the material in the oral cavity during function. It has been reported that ceramic materials show an abrupt strength degradation and transition in damage mode after multi-cyclic loads compared to static loading tests. Hence, it is essential to consider fatigue and environmental influence, as water in the saliva enhances crack-growth in a ceramic reconstruction when subjected to small alternating forces during mastication in the clinical situation (14,35).

According to several previous studies a test method and tooth analogues, with a low elastic modulus, was used, since the test method must reflect the range and distribution of strength, with consideration being paid to the brittle nature of the material (18,29,37).

In the present study the connector design and core thickness of the FDPs in all groups was made according to the default settings of the CAD software in order to find out how the settings for the connector design, i.e. their consequences upon the design, would affect the over-all load-bearing capacity of the FDPs. Default settings are standard in many CAD/CAM systems, as an help for the operating dental technician but they might also be an adaption to the limitations of the size and form of the milling pins or the numbers of axis in the CAM system. The default setting is often designed by software programmers without specialist knowledge of designing FDPs, the tools of the software is locked and can´t be adjusted by the operating dental technician. Those limitations of the default settings might result in FDPs with inadequate design. The intention with using two different CAD/CAM systems and compare the results (Table 2.) was to establish two different connector designs (Figure 1. and 2.), presuming that the default settings would be different from each other since the first system is older than the second one. In the group 3Z:1 and 4Z:1 the default settings of the CAD system resulted in FDPs with a straight beam shaped connector with a small radii at the intersection area, creating a sharp corner or notch, in the transition area. (Figure 1) (14,30,31). A different system was used to scan and design the FDPs in group 3Z:2 and 4Z:2 which resulted in a connector design more according to the recommendations, i.e. with an arch shaped connector with larger gingival embrasure radii and smooth transmissions in the intersection areas (1,3,7,9,10,15,19,20,21,23,25).

All the FDPs in the present study fractured in the connector area which corresponds with previous

Figure 1. Connector design group 3Z:1, 4Z:1

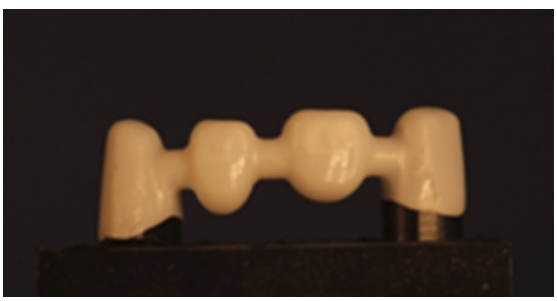
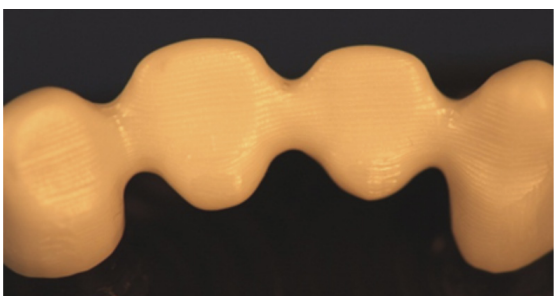


Figure 2. Connector design group 3Z:2 and 4Z:2



studies of all-ceramic FDPs (1,7,9,12,17,18,20,21,22,26,30,31,32,34).

Comparing the different connector design according to fracture strength a significant difference was found between group 3Z:1 and 3Z:2 ($P<0.05$), and group 4Z:1 and 4Z:2 ($P<0.05$). This shows that a design of the FDPs, with an arch shaped connector, larger gingival embrasure radii and smooth transmissions in the intersection areas gives a minimum 20% higher load-bearing capacity, which supports the recommendations in a previous study (1).

When analysing the fracture mode it could be stated that there is a relation between the design of the FDPs and the fracture mode. A 3-point bend test was used to test the FDPs. Such test is known to create compressing loads on the loaded side and tensile stress on the opposite side, causing a crack initiation there (22,23). It is also known that ceramic materials are extremely sensitive to notches or indentations and that such on the tensile stress side probably will be where a crack originates. To prevent a crack in the ceramic material caused by tensile load, increasing the radii in the insertion area and design the connector with a large radii of curvature is important factors to consider in order to increase the all over fracture strength of the construction (1). In group 3Z:1 and 4Z:1 with the straight beam design and a small radius at the insertion area, the total fractures seems to have started at the sharp corner (Figure 3.). In group 3Z:2 and 4Z:2 the total fractures seems to origin in the zenith of the arch shaped connectors, which is logic as the bulk of material is thinnest there (Figure 4.)

The results in this study show that the design affects both fracture strength and the fracture mode. The results emphasises that, to be able to take advantage of the properties of the ceramic materials all FDPs must be properly designed, i.e. without any sharp angels, especially in the transition areas between coping or pontic and connector. The design in the 3Z:1 and 4Z:1 group is a design contraindicated to all recommendations and to previous studies since the radius of curvature at the gingival embrasure plays a significant role in the load-bearing capacity. FDPs with small gingival embrasure radii are subjected to higher stress concentrations in the connector area during loading, compared to FDPs with large embrasure radii. Even if the studied material in the present study is relatively limited the result is according to previous studies that show that a larger radius of the gingival embrasure between each unit results in significantly higher fracture resistance compared to FDPs with smaller embrasure radii (1,3,7,9,10,15,19,20,21,23,25). With an oval shaped connector designed in the CAD-software the radius of the gingival embrasure increases in size. As the more increased radius of connector curvature at the gingival embrasure and between each unit, the higher the total fracture strength of the FDP (1,3,9,10,15,19,20,21,23,24).

According to the manufacture Nobel Biocare, "Procera® zirconia has a flexural strength 1120 MPa and is recommended for single crown up to long span FDPs". The load-to-fracture values are in all groups significantly lower than the values unveiled by the manufacturer, which probably can be explained by the design of the FDPs.

Comparing the mean values in group 3Z:1 and 4Z:1 the shorter FDPs show that the extra pontic in group 4Z:1 decreased the fracture strength with at least 45 %. There would probably be a greater decrease than shown here due to the estimated values of the FDPs that fractured during preloading. In groups 3Z:2 and 4Z:2 the extra pontic in group 4Z:2 decreased the fracture strength with 43%. Due to *Luthy et al* (19) increasing the number of pontics, i.e. from three to four, will decrease the over-all load-bearing capacity approximately two times. The results in the present

Figure 3. Fracture mode group 4Z:1. Crack showed with arrow

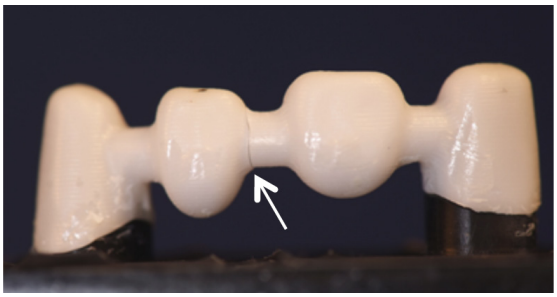
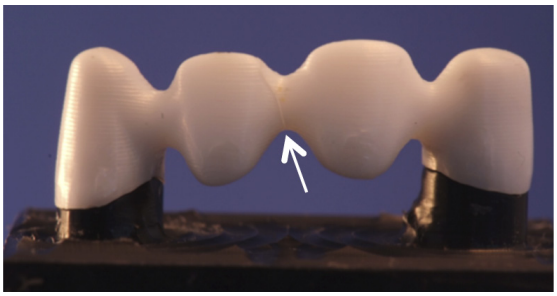


Figure 4. Fracture mode group 4Z:2. Crack showed with arrow



study support their findings, but demand some comments. The only groups that can be compared giving a fair result are 3Z:2 and 4Z:2 since half the FDPs in group 4Z:1 fractured during the preloading process and therefore can´t be compared to group 3Z:1. In group 4Z:1 the connector design is the most probable cause to the premature fractures.

Despite that uncertainty the statistics of this study supports the theory that regardless connector design increasing the length of the FDP span from three units to four units decreases the load bearing capacity approximately twice.

The design of the all-ceramic FDPs can be most crucial for the clinical survival. Therefore it is most important that both dentists and dental technicians are aware of the importance of using the correct settings of the CAD/CAM-system and optimizing the design in order to create a FDP that will fulfil the clinical demands.

Within the limitations of this *in-vitro* study it can be concluded that:

- The default settings of the two different CAD/CAM systems had a great impact on the fracture strength. It is important that a CAD/CAM system is equipped with possibilities to design a connector that fulfils the clinical demands of mechanical function and longevity.
- The design and the size of the radius of the gingival embrasures is crucial for the load-bearing capacity but also affects the fracture mode of the FDPs.
- Increasing the number of pontics from three to four decreases the load-bearing capacity nearly twice. Increasing the number of pontics even more would probably weaken the FDPs even more, but further research must be conducted to be able to predict the results.

Acknowledgment

The Y-TZP FDPs and the supporting test analogues were kindly provided by Nobel Biocare, Zurich, Switzerland.

The Panavia F 2.0 cement were kindly provided by RH Dental ApS, Gentofte, Denmark.

References

1. Bahat Z, Mahmood DJ, Vult von Steyern P. Fracture strength of three-unit fixed partial denture cores (Y-TZP) with different connector dimension and design. Swed Dent J 2009;33(3):149-59.
2. Chevalier J, Loh J, Gremillard L, Meille S, Adolfson E. Low-temperature degradation in zirconia with a porous surface. Acta Biomater 2011 Jul;7(7):2986-93.
3. Dittmer MP, Kohorst P, Borchers L, Stiesch M. Influence of the supporting structure on stress distribution in all-ceramic FPDs. Int J Prosthodont 2010 Jan-Feb;23(1):63-8.
4. Fahmy NZ. Influence of veneering materials on the marginal fit and fracture resistance of an alumina core system. J Prosthodont 2011 Jan;20(1):45-51.
5. F.F. Lange, GL. Dunlop, B.I. Davis. Degradation During Aging of Transformation-Toughened ZrO2-Y2O3 Materials at 250°C. J Am Ceram Soc 1986;69:237–40.
6. Filser F, Kocher P, Weibel F, Luthy H, Scharer P, Gauckler LJ. Reliability and strength of all-ceramic dental restorations fabricated by direct ceramic machining (DCM). Int J Comput Dent. 2001 Apr;4(2):89-106.
7. Fischer H, Weber M, Marx R. Lifetime prediction of all-ceramic bridges by computational methods. J Dent Res 2003 03;82(3):238-42.
8. Guazzato M, Quach L, Albakry M, Swain MV. Influence of surface and heat treatments on the flexural strength of Y-TZP dental ceramic. J Dent 2005 01;33(1):9-18.
9. Kamposiora P, Papavasiliou G, Bayne SC, Felton DA. Stress concentration in all-ceramic posterior fixed partial dentures. Quintessence Int 1996 10;27(10):701-6.
10. Kelly JR. Perspectives on strength. Dent Mater 1995 Mar;11(2):103-10.
11. Kelly JR, Tesk JA, Sorensen JA. Failure of all-ceramic fixed partial dentures in vitro and in vivo: analysis and modeling. J Dent Res 1995 06;74(6):1253-8.
12. Kern M, Fechtig T, Strub JR. Influence of water storage and thermal cycling on the fracture strength of all-porcelain, resin-bonded fixed partial dentures. J Prosthet Dent 1994 03;71(3):251-6.
13. Kheradmandan S, Koutayas SO, Bernhard M, Strub JR. Fracture strength of four different types of anterior 3-unit bridges after thermo-mechanical fatigue in the dual-axis chewing simulator. J Oral Rehabil 2001 Apr;28(4):361-9.
14. Koutayas SO, Kern M, Ferraresso F, Strub JR. Influence of framework design on fracture strength of mandibular anterior all-ceramic resin-bonded fixed partial dentures. Int J Prosthodont 2002 May-Jun;15(3):223-9.
15. Larsson C, Holm L, Lövgren N, Kokubo Y, Vult von Steyern P. Fracture strength of four-unit Y-TZP FPD cores designed with varying connector diameter. An in-vitro study. J Oral Rehabil 2007 09;34(9):702-9.
16. Lin J, Shinya A, Gomi H, Shinya A. Finite element analysis to compare stress distribution of connector of lithia disilicate-reinforced glass-ceramic and zirconia-based fixed partial denture. Odontology. 2012 Jan;100(1):96-9.
17. Luthardt RG, Holzhuter MS, Rudolph H, Herold V, Walter MH. CAD/CAM-machining effects on Y-TZP zirconia. Dent Mater 2004;20:655-662.
18. Luthardt RG, Holzhuter M, Sandkuhl O, Herold V, Schnapp JD, Kuhlisch E. Reliability and properties of ground Y-TZP-zirconia ceramics. J Dent Res 2002 Jul;81(7):487-91.
19. Luthy H, Filser F, Loeffel O, Schumacher M, Gauckler LJ, Hammerle CH. Strength and reliability of four-unit all-ceramic posterior bridges. Dent Mater 2005 Oct;21(10):930-7.
20. Mahmood DJ, Linderoth EH, Vult Von Steyern P. The influence of support properties and complexity on fracture strength and fracture mode of all-ceramic

fixed dental prostheses. Acta Odontol Scand. 2011 Jul;69(4):229-37.
21. Mollers K, Patzold W, Parkot D, Kirsten A, Guth JF, Edelhoff D. Influence of connector design and material composition and veneering on the stress distribution of all-ceramic fixed dental prostheses: a finite element study. Dent Mater 2011 Aug;27(8):e171-5.
22. Oh WS, Anusavice KJ. Effect of connector design on the fracture resistance of all-ceramic fixed partial dentures. J Prosthet Dent 2002 May;87(5):536-42.
23. Oh W, Gotzen N, Anusavice KJ. Influence of connector design on fracture probability of ceramic fixed-partial dentures. J Dent Res 2002 09;81(9):623-7.
24. Onodera K, Sato T, Nomoto S, Miho O, Yotsuya M. Effect of connector design on fracture resistance of zirconia all-ceramic fixed partial dentures. Bull Tokyo Dent Coll 2011;52(2):61-7.
25. Piconi C, Maccauro G. Zirconia as a ceramic biomaterial. Biomaterials 1999 Jan;20(1):1-25.
26. Plengsombut K, Brewer JD, Monaco EA,Jr, Davis EL. Effect of two connector designs on the fracture resistance of all-ceramic core materials for fixed dental prostheses. J Prosthet Dent 2009 Mar;101(3):166-73.
27. Pospiech P, Rammelsberg P, Goldhofer G, Gernet W. All-ceramic resin-bonded bridges. A 3-dimensional finite-element analysis study. Eur J Oral Sci 1996;104(4):390-5.
28. Pospiech P, Rammelsberg P, Unsold F. A new design for all-ceramic resin-bonded fixed partial dentures. Quintessence Int 1996 11;27(11):753-8.
29. Quinn GD, Studart AR, Hebert C, VerHoef JR, Arola D. Fatigue of zirconia and dental bridge geometry: Design implications. Dent Mater 2010 Dec;26(12):1133-6.
30. Raigrodski AJ, Chiche GJ. The safety and efficacy of anterior ceramic fixed partial dentures: A review of the literature. J Prosthet Dent 2001 Nov;86(5):520-5.
31. Richard H. J. Hannink, Patrick M. Kelly, Barry C. Muddle. Transformation Toughening in Zirconia-Containing Ceramics. Journal of the American Ceramic Society March 2000;83:461-87.
32. Richerson DW. Design approaches in modern ceramic engineering. Boco Raton, FL: Taylor & Francis Group, LLC; 2006.
33. Sundh A, Molin M, Sjogren G. Fracture resistance of yttrium oxide partially-stabilized zirconia all-ceramic bridges after veneering and mechanical fatigue testing. Dent Mater 2005: 21(5):476-82.
34. Vult von Steyern P. All-ceramic fixed partial dentures. Studies on aluminum oxide- and zirconium dioxide-based ceramic systems. Swed Dent J Suppl 2005;(173):1-69.
35. Vult von Steyern P, al-Ansari A, White K, Nilner K, Derand T. Fracture strength of In-Ceram all-ceramic bridges in relation to cervical shape and try-in procedure. An in-vitro study. Eur J Prosthodont Restor Dent 2000 Dec;8(4):153-8.
36. Vult von Steyern P, Carlson P, Nilner K. All-ceramic fixed partial dentures designed according to the DC-Zirkon technique. A 2-year clinical study. J Oral Rehabil 2005 03;32(3):180-7.
37. Vult von Steyern P, Jönsson O, Nilner K. Five-year evaluation of posterior all-ceramic three-unit (In-Ceram) FPDs. Int J Prosthodont 2001;14(4):379-84.
38. Vult von Steyern P, Kokubo Y, Nilner K. Use of abutment-teeth vs. dental implants to support all-ceramic fixed partial dentures: an in-vitro study on fracture strength. Swed Dent J 2005;29(2):53-60.
39. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. Dent Mater 2011 Jan;27(1):83-96.
40. Zhang Y, Kim JW. Graded structures for damage resistant and aesthetic all-ceramic restorations. Dent Mater 2009 Jun;25(6):781-90.
41. Yoshimura M, Noma T, Kawabata K, Somiya S. Role of H20 on the degradation process of Y-TZP. Journal of Materials Science Letters 1987;6:465-7.

Corresponding author:
PhD Student Deyar Mahmood
Department of Prosthodontics
Faculty of Odontology
Malmö University
SE-205 06 Malmö, Sweden
E-mail: deyar.mahmood@mah.se

218. Factors Shaping Demand for Prosthetic Dentistry Treatment with Special Focus on Implant Dentistry
Birger Narby (2011) 400 SEK

219. Cone Beam Computed Tomography in Evaluations of Some Side Effects of Orthodontic Treatment
Henrik Lund (2011) 400 SEK

220. Chronic intraoral pain — assessment of diagnostic methods and prognosis
Maria Pigg (2011) 400 SEK

221. The functional importance of estrogen in the periodontium
Daniel Nebel (2012) 400 SEK

222. Enamel of primary teeth Morphological and chemical aspects
Nina Sabel (2012) 400 SEK

223. Oral health and oral treatment need of adults in Sweden - as perceived by patients and dentists
Nina Lundegren (2012) 400 SEK

224. Preterm infants - Odontological aspects
Marianne Rythén (2012) 400 SEK

225. Dentofacial morphology in Turner syndrome karyotypes
Sara Rizell (2012) 400 SEK

226. On the repair of the dentine barrier
Helena Fransson (2012) 400 SEK

227. On temporomandibular disorders - time trends, associated factors, treatment need and treatment outcome
Alkisti Anastassaki Köhler (2012) 400 SEK

228. Experimental Tooth Clenching - A Model for Studying Mechanisms of Muscle Pain
Andreas Dawson (2013) 400 SEK

229. Evaluation of surgically assisted rapid maxillary expansion and orthodontic treatment
Anders Magnusson (2013) 400 SEK

230. On implementation of an endodontic program
Margaretha Koch (2013) 400 SEK

231. Masticatory function and temporomandibular disorders in patients with dentofacial deformities
Cecilia Abrahamsson (2013) 400 SEK

232. On dental caries and dental erosion in Swedish young adults
Helén Isaksson (2013) 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.

Abstracts

of free communications and posters presented at the 49th Annual Congress of the Swedish Dental Society, Stockholm, November 14–16, 2013

Subjects	Nos
Community and Hospital Dentistry	1–7
Cariology, Endodontics, Surgery	8–16
Periodontology, Oral Radiology	17–24
Orthodontics, Paediatric Dentistry	25–29
Prosthodontics	30–31
Stomatognathic Physiology, Others	32–41

◎ ◎ ◎ 1

Self-perceived oral health among 19-year-olds in Östergötland, Sweden. A comparative study between the years 2004 and 2011

A Ahlvin, S Ordell

Tandvårdsgruppen, Landstinget i Östergötland

Aim:
According to the Swedish law the 21 county councils have a responsibility for dental care among children and adolescents including the year they are 19. Clinical epidemiological data have been collected for many years. In 2003 it was decided in Östergötland also to include variables on the adolescents' opinions and knowledge on oral health in connection with the regular check up at 19 years of age. A questionnaire was developed in order to analyze self-perceived oral health and self-rated knowledge about oral health.

Material and method:
This study is an analysis of responses based on two cross sectional surveys made on the total population of 19-year-olds visiting a public or private dentist 2004 respectively 2011 in Östergötland, Sweden. The questionnaire is handed out after the regular check up and is filled out anonymously by the respondent. For the year 2004 the response rate was 53 % (n= 2413). The total population of 19-year-olds for year 2004 was 5332 individuals, and there was epidemiological data for 4572 of these.

For the year 2011 the response rate was 67 % (n= 3803). The total population of 19-year-olds for year 2011 was 6481 individuals, and there was epidemiological data for 5718 of these.

Results:
Almost 90 % of the respondents report they are satisfied with their oral health. There is an overall low knowledge about tooth loss, but boys rate their knowledge higher than girls. Shooting pain from the teeth is a common problem in the group of 19-year-olds. This study shows that girls report more concern about the aesthetics and appearance of their teeth than boys do. Girls also more frequently report suffering from headache than boys. There are no major differences between the groups responding in different local communities or when comparing the answers between year 2004 and 2011.

Conclusions:
A majority of the 19-year-olds responding this survey in the years 2004 and 2011 report satisfaction with their oral health. Girls, however, are overrepresented when it comes to aesthetic and social impact of oral health. The 19-year-olds in this material från 2004 and 2011 report high prevalence for shooting pain. Further studies are necessary to investigate the causes of this.

E-mail: Anna.Ahlvin@lio.se

◎ ◎ ◎ 2

The Shortened Dental Arch concept from the perspective of Swedish General Dental Practitioners: A qualitative study

EK Korduner, B Söderfeldt, I Collin Bagewitz, E Wolf
Faculty of Odontology, Malmö University, Malmö, Sweden

Aim:
The aim of this study was to analyze Swedish General Dental Practitioners (GDPs) attitudes toward the Shortened Dental Arch (SDA) concept and to gain a deeper understanding of individual variation in these attitudes using a qualitative research strategy.

Materials and Methods:
Eleven Swedish GDPs were purposively selected for an in-depth interview regarding treatment considerations in two patient cases and concerning preformulated statements about the SDA concept. All selected GDPs agreed to participate. The interviews were digitally recorded and verbatim transcribed. The qualitative content analysis was used to analyze collected data.

Results:
The emerging theme was "the SDA concept is irrelevant in the complex everyday clinic" to the GDPs, with participants disregarding treatments providing dentitions with loss of posterior teeth. The GDPs stressed the importance of preserving teeth as well as a patient-focused attitude respecting patient needs, in addition to considerations of age and finances. There was little application of the SDA concept by the GDPs when discussing the pre-formulated SDA statements, with which they generally disagreed.

Conclusion:
A uniform pattern in attitudes towards the SDA concept was found among Swedish GDPs. The knowledge of the SDA concept was limited and considered to be irrelevant in the clinical practice. The participants did not appear to use the SDA concept as a treatment model.

E-mail: evakarin.korduner@skane.se

◎◎◎ 3

Health economic analyses of domiciliary dental care compared with dental care at stationary clinic for elderly nursing home residents in Sweden

M Lundqvist[1], S Ordell[2], P Sjögren[3], O Sjöström[3], M Zimmerman[3], T Davidson[1]

[1] Center for Medical Technology Assessment (CMT), Linköping University, Sweden
[2] The Dental Commissioning Unit, County Council of Östergötland, Linköping University, Sweden
[3] Oral Care AB, Sweden.

Aim:
The number and age of the elderly population in Sweden is increasing, and the cost of dental care is expected to increase substantially during the next decades. Improved dental status among elderly, has led to a majority of elderly with most of their own teeth relatively intact, often in combination with dental restorations, or prosthetics (e.g. crowns, bridges, dental implants). Ageing leads to increased morbidity, and hospitalization or dependence on the care of others lead to a risk for severe deterioration of oral health. The county councils subsidize dental care for elderly nursing home residents in Sweden. Elderly nursing home residents are entitled to limited dental care, for the same fixed patient fee as in outpatient health care. The patient is free to choose provider of dental care. Dental care is usually offered at stationary dental clinics, but domiciliary dental care is an alternative. This abstract is based on an extensive report (in Swedish) from CMT, Linköping University.

The aim was to analyze economic consequences of domiciliary dental care, compared to dentistry at a stationary clinic, for elderly nursing home residents in Sweden.

Materials and Methods:
Nursing home staff, officials at county councils, and academic experts in geriatric dentistry were interviewed. Cost analyses and cost-effectiveness analyses were done. The market of dental care was analyzed from a societal perspective, to identify aspects of importance for the choice of stationary clinic or domiciliary dental care for elderly nursing home residents. Risks of asymmetric information between the involved participants (i.e. county council, dental care providers, municipalities, nursing homes, and patients) were analyzed, together with respective incentives to gain benefits.

Results:
For elderly nursing home residents the mean societal cost of domiciliary dental care was lower compared to dental care at stationary dental clinic. Domiciliary dental care was expected to increase the quality of life, and was cost effective compared to dental care at a stationary clinic.

Conclusion:
Domiciliary dental care has lower societal cost, is expected to improve the quality of life, and is cost-effective compared to dental care at stationary clinics, for elderly nursing home residents in Sweden. Since the prerequisites for seeking dental care among the elderly differ, it is important that dental care can be provided at different settings. Increased collaboration between the involved participants is needed in order to improve the efficiency and cost-effectiveness of dental care for elderly nursing home residents.

E-mail: martina.lundqvist@liu.se

◎◎◎ 4

Implementation of laser technology and treatment at county level in the Swedish public dental service

Å Bergholm

Folktandvården Uppsala län, Sweden

Aim:
The aim of this study was to obtain an understanding of the factors that affected the way new technology and methods were used in dentistry after a training program.

Materials and Methods:
A qualitative research method was used to collect data. Nine dentists working in the Public Dental Service (PDS) in Uppsala County in Sweden agreed to be interviewed in the study. They worked in five different clinics, all with laser equipment, and had received training in the use of lasers. The interviews were tape recorded and transcribed, and were analysed using manifest and latent qualitative content analysis.

Results:
The categories in this study were identified as "Prerequisites and obstacles to implementation", "Attitudes to laser technology and treatments" and "Laser technology in the future". The dentists described working with lasers as complicated and problematic. They had concerns about the method relating to the working environment, evidence of efficacy of treatment, costs, and benefits for patients and dentists. The main finding was that the decision to adopt the technology seemed to be based on individual perceptions of the value of lasers compared to other ways of achieving the same goal. They provided uniform proposals regarding how an organization should implement new methods, including an emphasis on the importance of preparation and having opportunities to be able to test and evaluate the technology. Another important factor was support from surrounding staff, colleagues and management.

Conclusion:
Despite all the barriers, respondents were positive about working with laser technology in the future. This was due mainly to their belief that patients would choose laser treatment if they had the option. The dentists also believed that laser technology is a modern technique that would improve with time.

E-mail: asa.bergholm@lul.se

◎ ◎ ◎ **6**

Longstanding effect and outcome differences of palatal plate and oral screen training on stroke-related dysphagia

M Hägg[1, 2], L Tibbling[3]

[1] Speech & Swallowing Centre, Department of Otorhinolaryngology, Hudiksvall Hospital, Hudiksvall, Sweden
[3] Department of Otorhinolaryngology, Linköping University, Linköping, Sweden

Aim:
This study aimed at evaluating (1) if the oral training effect on stroke related dysphagia differs between two different oral appliances, a palatal plate (PP) and an oral screen (OS), and (2) if the training effect remains at a late follow-up.

Materials and Methods:
We included patients with stroke-related dysphagia at two different time periods: the first group of 12 patients studied in 1997– 2 002 had to train with a PP, the other one of 14 patients studied in 2003 – 2008 had to train with an OS. All patients were evaluated by a swallowing capacity test (SCT), and by a self-assessed visual analogue scale (VAS) of water swallowing capacity at entry of the study, after 13 weeks of training, and at a late follow-up.

Results:
At end of treatment the SCT had normalized in 33 % of PP patients and in 71% of OS patients. There was a significant SCT improvement difference between the PP and OS groups in the period from baseline to late follow-up ($p < 0.002$) in favor of the OS group. VAS as tested at baseline and at end of treatment did not differ significantly between the two groups. Training with PP and with OS produced remaining improvement of SCT and of VAS as assessed at a late follow-up.

Conclusion:
The outcome of OS training on SCT in patients with stroke-related dysphagia seems to be superior to PP training. The improvement as assessed with VAS did not differ between the two groups. Training with PP or OS gives a longstanding improvement of SCT and VAS.

E-mail: mary.hagg@lg.se

◎◎◎ 6

The impact of masticatory efficiency and oral muscular coordination ability on caries risk

E Asghari, O Shewakhan, T Alstad

Institute of Odontology, The Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden.

Aim:
The aim of this study was to investigate the association between oral muscular coordination ability and masticatory efficiency on caries risk among healthy young and middle aged adults and further to investigate whether the inclusion of these two factors would help to make a more effective caries risk assessment.

Material and Methods:
A total of 55 subjects in Gothenburg Sweden were included in this study. These subjects were divided into 19-30 year old (n=18), 31-54 year old (n=18), 55-66 year old (n=19). The subjects were examined for: 1) Caries-related status, 2) Saliva, 3) Cariogenic microorganisms, 4) Diet, 5) Oral hygiene, 6) Oral function and 7) Plaque pH. All continuous variables were checked visually if they were skewed. Those which were skewed were transformed into more normal distributions before analyzing their association with other variables. The measure of association used was ANOVA, Spearman's rho when correlation was between only two variables and Pearsons Partial Correlation Coefficients when the test included controlling variables. IBM SPSS statistical package version 20.0 was used and a p-value > 0.05 was considered as statistically significant.

Results:
Masticatory efficiency was associated with sex and number of teeth but had no relationship with caries risk but a tendency towards an association with the number of Mutans streptococci. Oral muscular coordination ability was not statistically significantly related to any other variable but there was a tendency towards associations with sex, masticatory efficiency, saliva secretion and minimum pH level after a sugar challenge.

Conclusion:
Masticatory efficiency and oral muscular coordination ability have only minor if any impact on caries risk as long as persons are healthy and fully dentate. Oral muscular coordination ability and masticatory efficiency might therefore not be helpful to be used as caries predicting factors among healthy fully dentate subjects.

E-mail: ehsan.asghari@vgregion.se

◎◎◎ 7

Decreased concentration of galanin in hippocampus following long term running in SHR rats

J Carleson

Acasia AB, Staffanstorp, Sweden

Aim:
Stress and burnout are not uncommon in dental students and dentist. Stress and burnout are essentially individual-level manifestations resulting from an array of multilevel factors. Stress and burnout-associated factors can be broadly classified as proximal and distal. Proximal factors include personal characteristics (McManus et al. 2004) whereas distal factors may include "environmental" influences such as the specific stressors in the work environment, peer support, financial issues, family and social circumstances, as well as the cultural context. Because these factors operate as an ensemble in complex, often unobservable ways (Link & Phelan 1995), disentangling their individual contributions is challenging. One of the most common findings in burnouts is a reduced memory capacity.

In the present set of experiments I have set out to study the influence of stress (running) in rats with a high autonomic tone (SHR/stress prone) using the neuropeptide galanin (suggested to play a key role in memory functioning in the hippocampus) as a biomarker.

Materials and Methods:
Twenty four rats were divided into 3 Groups with one Control Group (no running), one group running for 6 weeks and one group were running for 12 weeks. Before, during and after running the rats were observed for behavior pattern (aggressive behavior, self-mutilation,, escape from Cage). After 12 weeks all rats were decapitated and tissue samples from the hippocampus, hypothalamus, pituitary ▷

and medial eminence were stored in - 70 C. Analysis of the samples were done with Lowry protein assay and neuropeptides analysis carried out with radio immune assay. Statistical analysis was carried out using SPSS software.

Results:
Galanin-LI decreased (p<0,05) in the hippocampus (mean +/- s.e.) running group (265,7+/- 68,6) vs. controls (678,5+/-189,2) and the running group had a higher degree - novel exploration than controls (p<0,05).

Conclusion:
This study suggest that spontaneous long term running (stress) in SHR rats decrease galanin-LI in the hippocampal formation and reduces their memory capacity when assessing open field behaviour. Possibly galanin-LI could be used as a biomarker of long term stress associated with cognitive impairment. Further studies are needed to test this hypothesis and to assess stressfactors in dental settings.

E-mail: joakimcarleson@hotmail.com

◎ ◎ ◎ **8**

Efficacy of supplemental methods to inferior alveolar nerve block (IANB) for pulpal anesthesia in posterior mandibular teeth with symptomatic pulpitis – A systematic review of clinical trials

A Altersved, E Axelsson, V Dawson, M Pigg

Department of Endodontics, Faculty of Odontology, Malmö University, Malmö, Sweden

Aim:
In the dental practice, emergency treatments are very common, and painful endodontic conditions such as symptomatic pulpitis and symptomatic apical periodontitis are among the most frequent reasons for an emergency visit. When treating mandibular posterior teeth diagnosed with symptomatic pulpitis anesthetic failure is a common problem. Therefore, every dentist is likely to encounter cases of insufficient anesthesia, and thus needs to acquire a strategy to overcome the problem.

The aim of this study was to evaluate the efficacy of various supplemental methods to improve the anesthetic effect of inferior alveolar nerve block (IANB) for endodontic treatment in patients diagnosed with symptomatic pulpitis of a posterior mandibular tooth.

Material and methods:
Systematic literature searches of PubMed, Cochrane Library and Thomson Reuters Web of Science with specific indexing terms and a supplemental handsearch was made. After screening of abstracts, selected articles were retrieved in full text, and examined according to predefined selection criteria. Studies which fulfilled the criteria were included in the review. For each of the included items, study quality was rated as high, moderate, or low quality, based on a structured assessment of the evidence level.

The identified supplemental methods were: (i) buccal and lingual infiltration injection, (ii) intraligamentary injection, (iii) intraosseous injection, and (iv) premedication with analgesic substances (NSAIDs and paracetamol).

Results:
The 3-fold database search yielded 174 records. 23 articles were retrieved in full text. A total of 16 studies were selected, quality assessed, and included in the review. Eight of the studies were rated as high quality and eight as low quality.

Between studies, the supplemental methods to achieve adequate anesthesia were distributed as follows: infiltration anesthesia (4 studies), intraligamentary injection (2 studies), intraosseous injection (2 studies) and premedication with analgesics with or without anti-inflammatory effects (6 studies). One study examined both the effect of buccal infiltration and of intraligamentary injection.

Conclusion:
Anesthesia of mandibular posterior teeth with symptomatic pulpitis can be improved with all the examined supplemental injection methods and with premedication with lornoxicam. The limited available literature suggests that the efficacy of intraosseous injection is superior to that of infiltration and intraligamentary injections, but the evidence is insufficient to provide recommendations for choice of method. Well-designed studies are needed, especially protocols comparing different methods.

E-mail: albin_90_11_16@hotmail.com

9

Sensory function and verbal description of pain in patients with symptomatic apical periodontitis – A pilot study

P Bargiel, E Månsson, T List, M Pigg

Malmö University, Malmö, Sweden

Aim:
Many patients seek dental care because of toothache. In 2010, 40% of all dental emergency visits in Sweden were classified as 'disease of the tooth pulp and the periradicular tissues' according to the Swedish social insurance agency (Försäkringskassan). It is important to set a correct diagnosis in order to provide adequate treatment. Among the possible differential diagnoses to symptomatic apical periodontitis (SAP) we find atypical odontalgia or neuropathic tooth pain, a chronic condition often characterized by changes in sensory function. The aim of this pilot study was to explore the patients' sensory perception, verbal description, and perceived symptoms in symptomatic apical periodontitis, thereby exploring the potential for somatosensory examination and verbal descriptors to be used as diagnostic tools to distinguish symptomatic apical periodontitis from neuropathic pain.

Materials and Methods:
In this clinical study, 10 subjects diagnosed with SAP (mean age 51.8± 14.1 years), and 10 pain free subjects (mean age 51.4 ±13.9 years), participated. All subjects were recruited at the Faculty of Odontology, Malmö University. Qualitative sensory testing (Qual-ST) of the perception of touch, cold and pinprick pain was performed at intraoral gingival and extraoral skin sites, and side-to-side differences were examined in both groups. The short form McGill Pain Questionnaire (SF-MPQ), and the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS), were used to assess verbal pain description in the group of subjects with SAP.

Results:
Side-to-side differences in somatosensory function measured with QualST was found intraorally in 70% of the subjects with SAP and in 50% of the pain-free controls ($P<0.05$). In the SAP group, the most commonly reported verbal pain descriptors according to SF-MPQ were throbbing (73%) and aching (67%). The most frequently reported factors increasing the pain were chewing (70%) and touch, cold or heat (each 40%); and correspondingly, factors reducing the pain were resting and cold (both 20%). According to LANSS, 80% had experienced abnormal sensitivity to touch in the region of the affected tooth.

Conclusion:
Our data indicate that somatosensory changes are common findings in SAP. A considerable variance in verbal descriptions of pain and in factors increasing and decreasing the pain was found, which may indicate that these factors have limited discriminative value in diagnostics. However, due to the small sample collected this

E-mail: bargielpatrik@hotmail.com

10

Tooth survival and apical status – a 5 year follow up of root canal treated teeth

C Benavente-Hansson[1], A Alenius[2], V Semenova[3], E Wolf[1], K Petersson[1]

[1] Department of Endodontics, Faculty of Odontology, Malmö University, Malmö, Sweden, [2] Public Dental Health Service, Brunflo and [3]Private Practice, Hässleholm, Sweden

Aim:
The outcome of endodontic treatments has mainly been evaluated from follow-up of series of cases, not including information on extractions of the root-filled teeth. Combining the survival rate and the frequency of teeth with sound periapical structures at follow-up, might give a more reliable measure of the success-frequency of the root-canal treatments performed and a possibility to identify factors that are correlated to treatment failures. Therefor the aim of this study was to perform a follow-up study of root filled teeth treated during 2006 at the Faculty of Odontology, Malmö University, Sweden, and to combine the data regarding tooth survival and frequency of teeth with sound periapical structures for evaluation of treatment outcome.

Materials and methods:
The study sample consists of all 365 patients with 415 teeth root canal treated during 2006. A random ▷

selection of one tooth per patient was performed. A 5-year clinical and radiographic follow-up examination was started in 2011. To date, data from 147 patients (40 %) has been registered.

Baseline and follow up registrations comprised pulp and periapical status, and marginal bone level assessed from records and radiographs. At follow up clinical data such as tooth extraction, type and quality of coronal restoration as well as clinical symptoms were registered. For assessment of the periapical status, the Periapical Index (PAI) was used by two calibrated observers.

Results:
At follow up 18 of 147 (12%) of the root canal treated teeth were extracted. 93 teeth (63 %) remained and had normal periapical status (PAI 1-2). The 93 teeth with normal periapical status made 72 % of the remaining 129 teeth. 33 (22%) teeth exhibited apical periodontitis (PAI 3-5) and three teeth were not judgeable. A correlation was observed between the presence of an adequate coronal restoration and normal periapical status at follow-up (p=0.002) as well as between marginal bone loss > 1/3 at baseline and frequency of extraction during the observation period (p=0.028).

Conclusion :
An adequate coronal seal of the endodontically treated teeth seemed to be of great importance for normal periapical status at follow-up. Risk-based guidelines would support decision-making regarding treatment of teeth with various periapical and marginal bone conditions, to prevent endodontic treatment of teeth with doubtful prognosis.

E-mail: catherine.benavente-hansson@mah.se

◎ ◎ ◎ **11**

Periapical status in non root-filled teeth in relation to type, material and quality of the coronal restorations. A cross-sectional study of an adult Swedish population

V Dawson, K Petersson, E Wolf, S Åkerman

Departments of Endodontics and Oral Diagnostics, Faculty of Odontology, Malmö University, Malmö, Sweden

Aim:
To compare the periapical status in non root-filled teeth restored with composite, amalgam and laboratory-produced crowns.

Materials and Methods:
From a randomly selected sample of 1 000 adults living in the county of Skåne, Sweden, 440 individuals, 20-89 years old, were examined. For all teeth the following variables were recorded: marginal bone loss, caries and restoration (type, material and quality). Caries and restorations were evaluated by two observers using clinical examination protocol, intraoral clinical photographs and radiographic images (bite-wing and panoramic radiograph). The periapical status was evaluated by three calibrated observers in panoramic radiographs and defined as apical periodontitis (AP) when the periodontal ligament space exceeded its double width or a periapical radiolucency was observed. The association between the periapical status and the type, material and quality of the restorations was analysed using Chi-square test and regression analysis.

Results:
The number of non root-filled teeth was 11 198 of which 4902 had some kind of restoration. AP was observed at 29 (1.6%), 23 (1.3%) and 25 (5.1%) teeth restored with composite, amalgam and a combination of composite and amalgam respectively. In teeth restored with a laboratory-produced crown or a laboratory-produced crown in combination with a filling AP was observed at 32 (6.5%) and 5 (14.7%) teeth respectively. The frequency of AP was significantly higher in teeth restored with laboratory-produced crowns compared to teeth restored with fillings. In the restored teeth AP was observed significantly more often when the quality was judged as inadequate compared to adequate restoration quality (p=0.000). The following restorations were significantly associated with AP: laboratory-produced crown (OR=10.0; p=0.000), laboratory-produced crown in combination with a filling (OR=12.4; p=0.002) and restorations of inadequate quality (OR=20.2; p=0.000). Caries (OR=8.0; p=0.001) and marginal bone loss > 1/3 of the root length (OR=3.4; p=0.000) were also factors associated with AP at the non root-filled teeth.

Conclusion:
The frequency of AP was equally low in teeth restored with composite as in teeth restored with amal-

gam. A higher frequency of AP was observed in teeth restored with a laboratory produced crown and in teeth with non adequate restorations.

E-mail: victoria.dawson@mah.se

◎ ◎ ◎ 12

Complete chemo-mechanical disinfection vs removal of infected tissue in the pulp chamber as emergency treatment in teeth with symptomatic apical periodontitis - a prospective randomized clinical study

Dragicevic M, Stenberg M, Wolf E

Department of Endodontics, Faculty of Odontology, Malmö University, Malmö, Sweden.

Aim:
To compare the pain relieving effect of complete chemo mechanical disinfection of the root canal system with removal of necrotic tissue in the pulp chamber but without instrumentation of the root canals as emergency treatment in teeth with symptomatic apical periodontitis.

Materials and Methods:
The Regional Ethical Review Board, Lund University, Lund, Sweden approved the study. Twentysix patients were selected at the emergency clinic at Malmö University and included patients with symptomatic apical periodontitis. Patients with swelling and/or systemic involvement were excluded. The patients were randomized to either treatment. The preoperative pain level as well as the intake of analgesics was registered. Three to 5 days postoperatively the patients were contacted by phone and asked to grade their current pain level and postoperative intake of analgesics and/or antibiotics.

Results:
The preliminary results show that 92% of the patients treated with complete chemomechanical disinfection of the root canal system obtained satisfying pain relief while the frequency for patients treated with removal of necrotic tissue in the pulp chamber was 80%. The difference was not statistically significant. A minority of the patients in both treatment groups reported analgesic medication post-operatively. No patients in either group reported use of antibiotics postoperatively.

Conclusion:
Both complete chemomechanical disinfection and removal of necrotic tissue implied a significant pain relief as emergency treatment in teeth with symptomatic apical periodontitis. There was no difference between the two treatments concerning the number of patients who obtained sufficient pain relief or in pain relieving effect. The collection of subjects will continue.

E-mail: mille.dragicevic@mah.se

◎ ◎ ◎ 13

Somatosensory Testing in Persistent Dento-Alveolar Pain (PDAP) – Clinical Findings and Reliability

M Pigg, L Baad-Hansen, P Svensson, M Drangsholt, T List

Malmö University, Malmö, Sweden

Aim:
Persistent dento-alveolar pain disorder (PDAP), also known as atypical odontalgia, is a severe and chronic pain suggested to be neuropathic in origin. Neuropathic pain is characterized by sensory abnormalities, revealed by sophisticated quantitative sensory testing (QST) or by a brief qualitative screening with simple instruments (QualST).
The aim of this multicenter study was to (i) describe somatosensory function in patients with PDAP and (ii) explore QualST and QST with regard to reliability of both methods and comparison between methods.

Materials and Methods:
47 patients with PDAP (40 women and 7 men, mean age 55.2±2.0 years, average pain intensity NRS 2.9±0.4, duration 18–240 months) and 69 age- and sex matched controls without pain (53 women and 16 men, mean age 51.8±1.3 years), were recruited from the orofacial pain departments and through advertisements at the University of Washington (USA), Aarhus University (Denmark) and Malmö University (Sweden). Intraoral QST with 13 parameters examining thermal and mechanical perception was performed. 78 of the participants (31 patients, ▷

47 controls) also underwent QualST examining side differences in touch, cold and pinprick pain perception. Testing was performed on the buccal gingiva, adjacent to the painful tooth and at corresponding mirror site (in controls adjacent to the first upper premolars bilaterally). To assess reliability, in 46 participants (25 patients, 21 controls) the examination was performed twice in the same day by two different examiners (inter-examiner reliability) and after 1–2 weeks by one of the examiners (intra-examiner reliability). Mean QST thresholds were calculated, and patient sensory function was expressed as z-scores of loss/gain compared to controls. Intraclass correlation coefficient (ICC; QST) and kappa (QualST) analyzed reliability, and percent agreement compared QST and QualST.

Results:
QST detected somatosensory abnormalities in 87.3% of PDAP patients, most frequently somatosensory gain regarding painful mechanical and cold stimuli, and somatosensory loss regarding cold and mechanical detection. 96.8% of patients and 40.4% of controls displayed QualST side differences in sensory perception. Reliability for QualST ranged from 0.63–0.75. QST reliability ranged between measures from poor–excellent, most measures displaying moderate–good reliability. Agreement between QST and QualST was 55.1–92.1%.

Conclusion:
A large majority of patients with PDAP have pain-site somatosensory abnormalities detectable with intraoral QST, and side differences are frequently found with QualST. The intra- and interexaminer reliability of QST and QualST is sufficient for use in orofacial pain investigations. Agreement between methods is good to excellent, which validates QualST for chair-side screening of somatosensory function.

E-mail: maria.pigg@mah.se

◎ ◎ ◎ **14**

Progression of untreated apical periodontitis at root-filled teeth. A radiological, retrospective cohort study

R Truong, E Lavin, H Fransson

Department of Endodontics, Faculty of Odontology, Malmö University, Malmö, Sweden

Aim:
There is a high frequency of endodontically treated teeth with apical periodontitis in Sweden, but a lack of a well-established practice of how to deal with these. This study aims to investigate radiographic progression of untreated apical periodontitis in previously root-filled teeth left without intervention and to identify factors that affect the progression in order to reach a better foundation for making treatment decisions.

Materials and Methods:
Radiographs of root-filled teeth with apical periodontitis (n = 120) from 90 patients were examined with regards to the change of the apical periodontitis over at least three years during 2002-2011. It is likely that these teeth have been appraised and that a clinical decision has been made stating that no additional treatment for the apical periodontitis was required or that the treatment could be postponed. Data on patients´ age, tooth type, size of the apical lesion, length and sealing quality of the root-filling, type of the coronal restoration and sealing quality of the coronal restoration were recorded. The radiographs were obtained from dental records from a university based clinic.

Results:
Progression of the apical periodontitis was observed in 22.5% of the studied teeth in spite of probable clinical decisions that treatment was not needed for the apical periodontitis or treatment could be postponed. None of the studied variables: the size of the apical periodontitis, the length of the root-filling, the sealing quality of the root-filling, the type of the coronal restoration or the sealing quality of the coronal restoration were found to be correlated to the progression of the apical periodontitis. The apical periodontitis was unchanged in 50% of the teeth and observed more often in the maxilla (p=0.02).

Conclusion:
The results indicate that more than a fifth of the root-filled teeth with apical periodontitis in a group of teeth that most probable had been judged not to require any further endodontic treatment or that the endodontic treatment could be postponed deteriorated during the 3-year study period. Half of the lesions were unchanged. A prospective study is needed to study the natural course of root-filled teeth in order to study the progression of apical periodontitis and to identify factors that affect the progression.

E-mail: Helena.Fransson@mah.se

◎◎◎ 15

Sinus membrane elevation with blood only and simultaneous installation of implants. A twelve years experience

A Thor, C Riben

Institution of Surgical Sciences, Plastic & Oral and Maxillofacial Surgery, Uppsala University, Uppsala, Sweden

Aim:
The aim of all surgical interventions must be to lower morbidity, reduce costs and to speed up the duration of treatment if possible. Rehabilitation with dental implants in the atrophic maxilla has for many years meant a substantial challenge for the restorative team and also meant enduring experiences for the patient such as grafting of autogenous bone. This presentation discusses the use of sinus membrane elevation and experiences made; also for restoration with a fixed prosthesis in cases with severely resorbed edentulous maxillae.

Materials and Methods:
Study subjects were recruited from the Institution of Surgical Sciences, Plastic & Oral and Maxillofacial Surgery, Uppsala University, requiring dental implant treatment and with a bone volume considered insufficient for standard implant protocol. The span of treatment ranged from single restorations to full arch rehabilitations in the maxilla.

The remaining bone levels in the maxillary sinus floor were in some cases 1-2 mm.

Sinus membrane elevation through a lateral entry to the maxillary sinus was performed in all cases. A bony window was cut out with saw or piezo-device and the osteotomized bone was later replaced. One or more implants were placed in an ordinary fashion in the remaining sub-antral bone. The blood clot around the implant was thereafter protected by the replaced bone and mucosal flap.

Healing up to six months was expected and thereafter abutment surgery was performed.

Results:
In a retrospective study of 36 patients, with a follow-up time up to 7 years and 87 placed implants in 52 sinuses, there were four early losses and one late giving a survival rate of implants of 94,25%. Laceration of the sinus membrane occurred in 20 sinuses, 38,5%.

We also experience that severe atrophic cases can be successfully restored with placing the implants in the posterior part of the maxilla using this technique to regenerate new bone around the installed implants.

Conclusion:
Sinus membrane elevation technique for bone regeneration around simultaneously placed implants is a relatively, for the patient, safe and easy way of having new bone formed around implants for retention of a fixed restoration in the maxilla. Treatment periods as well as cost are low. The technique is well accepted and described in the literature and very useful as one of many alternatives in implant surgery.

E-mail: andreas.thor@akademiska.se

◎◎◎ 16

Narrow diameter implants- a solution for limited space in the anterior dental arch? A clinical and radiological long-term study

A Trbakovic, A Thor

Folktandvården Storvreta; Institution of Surgical Sciences, Plastic & Oral and Maxillofacial Surgery, Uppsala University, Uppsala, Sweden

Aim:
It has become more common to replace missing teeth with dental implants but some missing teeth

can be more challenging to replace than others. In the maxillary lateral incisive area and in the mandibular incisor region, difficulties might arise with standard diameter implants because of the small horizontal space and inadequate bone volume. Narrow diameter implants might be a suitable solution in cases like these. The aim of this study was to study how well these implants functioned several years later both from an objective and patient point of view.

Materials and Methods:
We performed a follow-up evaluation of narrow diameter implants that replaced single tooth losses in the anterior upper (laterals) and lower jaw region (anterior and lateral incisors). Patients that received 3.0 mm or 3.3mm diameter single implants between 2002 and 2011 were recruited from three different oral and maxillofacial clinics in Uppsala and Västerås, Sweden. The total of 98 patients were found to match the including criteria and of these 27 participated in the study with total of 30 implants. All patients underwent a clinical and a radiological (CBCT) examination. A radiographic evaluation on the CBCT-scans was executed in regard to the placement of the implants and the resulting distance to the neighbouring teeth.

Results:
The study subjects were between 22 and 83 years of age (mean 56.8 years). The most common implant site was the anterior upper lateral incisive region. The average follow-up period was 63.3 months. Distance between implant and the neighbouring tooth was in average 1.6 mm at the cervical region and 1.8 mm at the middle of the implant.

We found that no implants were lost during this follow-up period and the main complication to the treatment from the patient point of view was discoloration of the buccal gingiva.

Conclusion:
Narrow diameter implants are a relatively simple and time saving treatment solution in anterior narrow spaces compared to, e.g. orthodontic treatment. Although it might be difficult to place the implants in an optimal position because of the compromised space, we can, in this study, not detect pathology of the neighbouring teeth linked to the implant treatment and the fact that the distance between the fixture and the neighbouring root often was less than 1 mm.

E-mail: mella105@hotmail.com

◎ ◎ ◎ **17**

Involvement of monocytes in periodontitis

S Björnfot, E Almer Boström, R Clark, A T Ngyuen Hoang, O Hammarfjord, A Gustafsson, G Johannsen, M Svensson

Center for Infectious Medicine, Department of Medicine, Karolinska Institutet, Huddinge; Division of Periodontology, Department of Dental medicine, Karolinska Institutet, Huddinge, Sweden

Aim:
In Periodontitis (PD), patients suffer from chronic inflammation that causes destruction of tooth supportive tissues. Evidence suggests that the persistent inflammation in PD occurs due to abnormal host innate immune responses to oral micro flora. We hypothesize that defective functional properties of the monocytes, contributes to unrestrained bacteria-induced responses leading to tissue destruction in PD. We aim to study peripheral blood monocytes phenotypically and functionally directly after isolation and after implantation in a unique organotypic human oral tissue model that we established. Studying monocytes from control individuals and PD patients in combination with a model mimicking real tissue has the potential to reveal novel knowledge on pathways dictating monocyte differentiation and function in PD.

Materials and Methods:
Peripheral blood mononuclear cells (PBMCs) and monocytes were isolated from blood of PD and control individuals. PBMCs were analyzed with extracellular and intracellular flow cytometry as well as qPCR. For the organotypic oral tissue model, primary oral fibroblasts were cultured in a collagen-based matrix combined with monocytes and the oral keratinocyte cell line, OKF6-TERT2, seeded on top. Tissue models were stimulated with lipopolysaccharied (LPS) then analyzed with immunofluorescence and H&E staining to reveal tissue structural components and histological alterations. In addition, tissue

models were digested for multicolor flow cytometry analyses.

Results:
PD patients had increased number of leukocytes, mainly due to an increase in monocytes and neutrophils. An alteration in the monocyte subset composition was observed, including a trend towards increased expression of CCR1 and CCR2 in PD. Furthermore, monocytes implanted into the organotypic oral tissue models were extracted from digested models and visualized as CD45 positive cells three and seven days after implantation using flow cytometry. The implanted monocytes (CD45 positive) up-regulated macrophage markers, i.e, CD68, CD80, CD200R, CD163, CD14. Notably, the phenotype of the CD45+ cells changed in an LPS environment with decreased CD200R, CD163, CD16 expression. Furthermore, we found that the model tissue, unstimulated or LPS-stimulated, share the same structural features as real tissue, by studying the expression of cytokeratin-16, E-cadherin, Laminin-V, Claudin, K16, vimentin, fibronectin and Ki-67.

Conclusion:
PD is associated with increased number of monocytes with altered subset composition. We have successfully established an organotypic oral tissue model with monocytes implanted, which can be further used to study the tissue involvement of monocyte differentiation under next to in vivo conditions, and reveal pathways of tissue inflammation and destruction observed in PD.

E-mail: sofia.bjornfot@ki.se

◎ ◎ ◎ 18

Surgical treatment of experimental peri-implantitis: histological and microbiological observations

O Carcuac, I Abrahamsson, T Berglundh

Department of Periodontology, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

Aim:
To evaluate surgical treatment of peri-implantitis at implants with different surface characteristics using anti-infective procedures.

Materials and Methods:
In six, one year old, mongrel dogs the bilateral mandibular premolars were extracted. Three months later 4 implants with different surface characteristics were installed in a randomized order in each side of the mandible. The following implants were used: A: TiOblast surface, B: OsseoSpeed surface, C: experimental surface and D: TiUnite surface. After 3 months experimental peri-implantitis was induced by ligatures and plaque formation. 9 weeks later, the ligatures were removed and plaque control measures were introduced. One month later mucoperiosteal flaps were elevated and the inflamed tissue in the crater formed bone defects was removed. The implants were cleaned with the use of plastic curettes and cotton pellets soaked in either saline (control side) or chlorhexidine (test side). The flaps were repositioned and sutured. Clinical and radiologic examinations were performed and repeated at 2, 3, 4 and 6 months after surgery. Microbiological samples were taken at 3 and 5 months post-operatively. Biopsies were obtained 6 months after surgical therapy and prepared for histological analysis.

Results:
During the course of the experiment after surgical therapy clinical signs of soft tissue inflammation were reduced in all sites except for type D implants in the control (saline) group. In this group of implants swelling and redness persisted in the peri-implant mucosa. The histological examination of the specimens representing endpoint outcomes revealed different results between implant types. Resolution of peri-implantitis was achieved in tissues surrounding implants of type C in both control and test groups. Scattered remaining inflammatory cells were found around implants of type A and B. No signs of resolution were observed in histological sections representing implants of type D. Overall in the control group, the remaining bony defect area and tissue area occupied by inflammatory cells were significantly larger at implants of type D than at the other implants. The microbiological analysis revealed that the total count decreased significantly at 3 and 5 months after surgery for all implants except for implant of type D.

Conclusion:
Resolution of peri-implantitis following surgical treatment without adjunctive use of local and systemic antimicrobial agent is possible. The outcome of therapy is influenced by implant surface characteristics. ▷

The local use of chlorhexidine has minor influence on treatment outcome.

E-mail: oliver.carcuac@odontologi.gu.se

19

Dynamic osteoblast activity around dental implants and bone augmentations visualized using F18 PET/CT-scans over time. A pilot study

A-P Carlsson[1,3], J Sörensen[2,3], A Thor[2,3]

[1] Västerås Hospital, Västerås; [2] Uppsala University Hospital, Uppsala; [3] Uppsala University, Uppsala, Sweden

Aim:
To measure new bone formation rate in the area adjacent to implant surfaces in cases with bone grafting and augmentation and to compare bone formation around different surfaces using PET/CT.

Materials and Methods:
First, a 76-year old female, edentulous in the maxilla, had four implants inserted, on one side two implants with an acid-etched titanium surface and on the other the same surface supplemented with nanometer-scale CaP-particles. CT- and PET-scans were performed immediately after surgery. PET-scans were then executed one, four and eight days postoperatively.

Secondly, a 76-years old male with severe atrophy of the maxilla had autologous platelet-rich plasma (PRP) mixed with particulated iliac crest bone grafted to the buccal side of the maxilla. Sinus membrane elevations, without augmentation material, and installation of two implants in each of the sinus floor were performed. After four months of healing two implants were placed in the anterior bone grafted area. Abutment surgery was performed after additional four months. CT and PET-scan were performed one week after the first operation and thereafter additional PET-scans three weeks, two, four and eight months after surgery.

PET/CT procedures:
The patients received an intravenous injection of 80MBq with F18. Blood samples were taken to calculate the uptake. Standardized uptake values, SUVs were calculated by the formula:

Activity in tissue (Bq/mL) x body weight (g)/total dose (Bq). Average density in the body was set to 1 g/mL. This gave a unit value of the regional activity in proportion to the average activity for the body.

Results:
In the first patient, uptake of F18 in the osteblasts was seen as early as one day after surgery. An increasing uptake could be estimated during the following eight days. Differences between the surfaces could be detected.

In the second case an intense osteoblastic activity could be seen early in the graft and the sinus floor and proceeding throughout the examinations. Osteoblastic activity could also be seen adjacent to the implants.

Conclusion:
Referring to these pilot cases, PET/CT is suggested to be a useful technique to measure and visualize the dynamics of bone healing and bone formation around implants and augmentative procedures of the jaws.

E-mail: anders-petter.carlsson@surgsci.uu.se

20

Novel inhibitors of PGE synthase inhibits PGE2 in vitro and ameliorates experimental periodontitis in rats

A Kats[1], P Georgsson[1], M Norgård[2], G Andersson[2], T Yucel-Lindberg[1]

[1] Department of Dental Medicine, Division of Periodontology, Karolinska Institutet, Stockholm;
[2] Department of Laboratory Medicine, Division of Pathology, Karolinska University Hospital and Karolinska Institutet, Huddinge, Sweden

Aim:
The inflammatory mediator prostaglandin E2 (PGE2) is implicated in the pathogenesis of chronic inflammatory diseases, including periodontitis. PGE2 is also a potent stimulator of bone resorption

due to its capacity to induce osteoclast formation. The inducible enzyme microsomal prostaglandin E synthase-1 (mPGES-1), catalyzing the terminal step of PGE2 biosynthesis, is an attractive target for selective PGE2 inhibition and therapeutic intervention of inflammation. The aminothiazoles were recently identified as novel inhibitors of mPGES-1 abolishing the production of PGE2. In the present study the effect of the aminothiazoles was investigated on experimental periodontitis in rats as well as on osteoclast formation using raw 264.7 cells.

Materials and Methods:
Experimental periodontitis was induced by silk ligatures tied around the second upper molars of Sprague Dawley rats. A total of 80 rats were divided into 4 groups with 20 rats in each group; non-ligated control group, experimental periodontitis group treated with the aminothiazole 4-((4-(2-naphthyl)-1,3-thiazol-2-yl)amino)phenol (TH-848), experimental periodontitis group treated with vehicle, and experimental periodontitis group receiving only ligatures. Blood samples were collected from all rats both at the start and the end of the experimental period for measurements of PGE2 and cytokine levels. After 8 days, the rats were euthanized and the jaws were saved and X-rayed. Alveolar bone levels were assessed on the dental radiographs by two blinded dentists. The raw 264.7 cells were activated to differentiate into osteoclast by addition of RANKL and treated with the aminothiazoles TH-848 and 4-(3-fluoro-4-methoxyphenyl)-N-(4-phenoxyphenyl)-1,3-thiazol-2-amine (TH-644). When the cells had differentiated into multinucleated osteoclasts the cell layers were stained for the osteoclast marker, tartrate resistant acid phosphatase (TRAP). The PGE2 levels were measured by enzyme immunoassay (EIA) in the medium.

Results:
In ligature-induced experimental periodontitis, alveolar bone loss, assessed by X-ray imaging, was reduced by 46% by local treatment with a gel containing the aminothiazole TH-848, compared to the vehicle gel. No systemic effects on cytokine production or PGE2 levels were observed. In addition, the aminothiazoles TH-848 and TH-644 decreased the formation of multinucleated osteoclasts and the expression of TRAP followed by decreased PGE2 production in raw 264.7 cells.

Conclusion:
These results demonstrate that the aminothiazoles represent novel inhibitors for inhibition of PGE2 production, experimental bone resorption and osteoclastogenesis, suggesting these drugs as future candidates for treatment of periodontitis.

E-mail: anna.kats@ki.se

◎ ◎ ◎ **21**

Apical lesions in subjects with and without periodontitis associated with hospital care

E Virtanen[1], B Söder[2], J Meurman[1,3], P-Ö Söder[2]

[1] Institute of Dentistry, University of Helsinki, Finland,
[2] Karolinska Institutet, Stockholm, Sweden,
[3] Department of Oral and Maxillofacial Diseases, Helsinki University Central Hospital, Finland

Aim:
The aim was to study the association between apical lesions and hospital care. The hypothesis was that these dental infections link with systemic health.

Materials and Methods:
The study population is a Stockholm County cohort born 1945-1954 with age range of 30-40 years at baseline; 3273 subjects were randomly selected of these 1676 subjects were clinically examined in 1985. In 2001, 150 patients were ramdomly selected from the original group and 120 of them were clinically and radiologically re-examined. 83 patients were classified having periodontitis (1 or more deep pocket ≥5mm) while 37 had no periodontitis. At clinical examination oral hygiene indexes, probing depths and attachment losses were registered. From x-rays a modified Total Dental Index (TDI), (Mattila et al. 1989) was used to determine the oral infection burden and the Periapical Index (PAI), (Örstavik et al. 1986) to classify the severity of apical lesions. Demographic and hospital data were collected from the National Statistics Center, Örebro, Sweden. T-test and multiple logistic regression analyses were used for statistics (IBM SPSS-20 program).

Results:
There were significant difference in number of apical lesions between patients with and without periodontitis (p=0.006). The severity of the apical lesions, as expressed in PAI, was not significantly different between the groups. In the periodontitis with apical ▷

lesions group, smoking, probing depth, and presence of furcation lesions were statistically significantly different from the periodontitis without apical lesions group (p=0.006, p=0.039 and p=0.007, respectively). Diseases in the circulatory system were the most common systemic diseases in the 120 subjects (13%). Patients with periodontitis and apical lesions showed a higher percentage of diseases in the circulatory system (23%) compared with all the patients. Multiple logistic regression analyses showed that, age, furcation lesions and diseases in the circulatory system were the explanatory variables for the presence of apical lesions, with an odds ratios (with 95% confidence intervals) of 1.36 (1.13-1.64), 3.77 (1.23-11.61) and 4.50 (1.17-17.35), respectively.

Conclusion:
Apical lesions were associated with diseases in the circulatory system. The results thus confirmed our hypothesis.

E-mail: eunice.virtanen@helsinki.fi

◎ ◎ ◎ **22**

A survey on application of image enhancement on digital intraoral radiographs among general dentists

P Tohidast

Karolinska Institutet, Stockholm, Sweden

Objectives:
The objectives of this study were first to present the current status of general dentists on applying image processing facilities for viewing digital intraoral radiographs. Secondly, the dentists' knowledge level on different image processing alternatives was investigated.

Material and Methods:
A questionnaire including 12 questions was sent to 12 dental practices in Stockholm. A total number of 53 dentists participated in the survey for evaluation of knowledge and application of image processing for their daily clinical work. Additionally, 200 radiographs were randomly selected from these clinics. The applied image processing alternatives on each image were tracked. In this way the most commonly applied image processing methods could be objectively presented. Descriptive statistical methods were applied to analyse the use of image processing alternatives for various clinical diagnoses using digital radiographs.

Results:
The education time for the majority of dentists on image processing was between 2-4 hours. Image processing was used frequently during the daily work and was considered to be a helpful approach for improving clinical diagnostics using digital radiographs. The present study showed that the inherent pre-processing algorithm in the software was sufficient in most cases. The most often applied image processing techniques among dentists were adjusting the image brightness and/or contrast.

Conclusions:
Image processing is frequently used during the dentists' daily work and most of the dentists in Stockholm have received short-term education on this subject. However, the authors would suspect that continuous education on the appropriate application of image processing alternatives would further facilitate dentists for various radiographic diagnoses.

E-mail: parisa.tohidast-akrad@stud.ki.se

◎ ◎ ◎ **23**

Radiological evaluation of volume changes in unilateral orbital fractures after reconstruction using a computerized semiautomatic segmentation technique

J Nilsson, A-P Carlsson, J Nysjö, A Thor

Uppsala University, Uppsala, Sweden

Aim:
The purpose of this study is to evaluate reconstruction of unilateral orbital fractures by studying changes in volume, using a system for semiautomatic segmentation of the orbit in CT images before and after surgery.

Materials and Methods:
The 21 subjects in this study was surgically reconstructed due to unilateral orbital fracture. To gain access to the infraorbital rim and orbital floor, subciliar incision were used in all cases, in some of them

with extension. Access to the superolateral orbital rim was performed either by eyebrow or upper eyelid approach. Fixation of the bone fragments was performed with titanium plates with 0.7 mm thickness and corresponding screws. To reconstruct the orbital floor, titanium mesh reinforced with porous polyethylene with a thickness of 0.8 or 1.6 mm were used. Prior to fixation with screws the mesh was trimmed to fit the defect of the orbital floor. The wounds were closed in layers with single sutures of the skin.

Two of the authors (denoted A1 and A2) used a semiautomatic segmentation system to delineate the orbits in the CT images. The system takes user-defined landmarks as input to create a plane that roughly defines the extent of the orbital opening and then automatically fits a deformable model to the enclosed bone cavity. After the initial segmentations had been obtained the anterior border of the orbits was refined by manual editing. From the resulting segmentations we calculated volume changes before and after reconstruction, using the unaffected side as reference.

Results:
21 subjects met the inclusion criteria. There were 5 women and 16 men and their ages ranged from 19-89 (mean age 42 years). The average time between injury and surgery ranged from 1-21 days (mean 6.5 days). Preoperative orbital volume of the unaffected and the affected side was 27.9±2.7 ml and 28.2±3.0 ml, respectively. Before surgery the absolute volume difference between the affected and unaffected side was 1.4±1.2 ml (same for A1 and A2); after surgery the difference was reduced to 0.8±0.6 ml (A1) and 0.9±0.7 ml (A2). The inter-observer difference (A1 - A2) of the volume measurements was 0.5±0.4 ml.

Conclusion:
The preliminary results of this study demonstrate that the reconstruction restores the normal volume of the orbit after injury. It also demonstrates that semiautomatic segmentation is a useful tool for evaluating orbital volume.

E-mail: johanna.lisa.nilsson@gmail.com

◎ ◎ ◎ **24**

Panoramic radiographic findings with reference to acute myocardial infarction: a case-control study

J Holmer[1], N Rathnayake[1], L Rydén[2], K Buhlin[1]

[1] Division of Periodontology and Implant Dentistry, Department of Dental Medicine, Karolinska Institutet, Huddinge; [2] Department of Cardiology, Karolinska hospital Solna, Stockholm, Sweden

Aim:
The objective of this investigation, which is part of the larger PAROKRANK (Periodontal Disease and the Association with Coronary Heart Disease) project, was to determine if radiological findings differed between patients with acute myocardial infarction (AMI) and healthy population-based controls.

Material and Methods:
A total of 204 individuals comprised the study population. 111 patients with their first AMI were recruited 2009-2012 from 11 Swedish hospitals, while 93 healthy subjects were recruited from the population registry as controls. A panoramic radiographic image was obtained from each subject and examined regarding horizontal bone level, number of remaining teeth and apical periodontitis. A blinded investigator performed all radiographic measurements.

Results:
The mean horizontal bone level differed between the two groups: 75% vs. 79% of the total root length in the AMI and control group respectively. The horizontal bone level was significantly associated with AMI. Logistic regression analysis showed a relationship between horizontal bone loss and AMI with an odds ratio (OR) of 3.75 (95% CI 1.86-7.55, $p < 0.001$). No statistical significance in regards to number of remaining teeth or apical periodontitis was detected between the two groups.

Conclusions:
This investigation indicates that horizontal alveolar bone loss is associated with AMI. However, neither apical periodontitis or tooth loss correlates with AMI. This shows the complexity between AMI, oral disease and conclusions regarding the degree of association.

E-mail: jacob.holmer@ki.se

◎ ◎ ◎ 25

Outcome of orthodontic care and residual treatment need in Swedish 19-year-olds

E Göranson, F Lundström, M Bågesund

County Council of Östergötland, Sweden

Aim:
The purpose of this study was to assess the outcome of orthodontic care in the County Council of Östergötland, Sweden by registering the amount of residual need and demand for orthodontic treatment at age 19.

Materials and Methods:
The dental records of 207 (107 M, 100 F) 19-year-olds registered at one public dental health clinic were studied. Individuals both with and without a history of orthodontic treatment were included in the study. A clinical examination was performed where the subjects were graded according to the Index of Complexity, Outcome and Need (ICON). ICON values of 43 or more indicate orthodontic treatment need. The 19-year-olds also filled in a questionnaire regarding residual orthodontic treatment demand.
Possible differences between genders were analysed

Results:
110 individuals (53.1%; 47M, 63F) had partaken in orthodontic consultations.
Orthodontic appliance treatment had been received by 86 individuals (41.6%; 38M, 48F).
A residual orthodontic treatment need was registered in 28 individuals (13.5%; 22 M, 6 F). Eight of these (7M, 1F) had previously received orthodontic treatment by general practitioners, but none of them were treated by orthodontists.

Residual orthodontic treatment demand was expressed by 9 individuals (4.3%; 3 M, 6 F). Only one of these individuals (M) also had residual treatment need. He had previously been treated by a general practitioner with a removable appliance, and thereafter declined the offer of further treatment with fixed appliances.

The proportion of males (35.5%) who had experienced orthodontic treatment was not significantly lower than among the females (48.0%) (p=0.069).
However, a significantly lower percentage of treated males (55.3%, n=21 out of 38) than of treated females (81.3%, n=39 out of 48) had received their treatment by orthodontic specialists (p=0.009).
At 19 years´ age, the percentage of males with residual treatment need (20.1%) was higher than among the females (6.0%) (p=0.002).

Conclusion:
- The present orthodontic care had been successful in the treatment of orthodontic problems. Every patient with both orthodontic treatment need and demand at 19 years of age had previously been offered orthodontic treatment.
- The prevalence of residual orthodontic treatment need at 19 years of age was greater than the demand for orthodontic treatment.
- The proportion of males with residual treatment need was higher than among the females at 19 years of age.

E-mail: emma.goranson@lio.se

◎ ◎ ◎ 26

Treatment efficacy of prefabricated functional appliances and Andresen activators in Class II, division1 cases: a randomized clinical trial

E Čirgić, K Hansen, H Kjellberg

Department of Orthodontics, Institute of Odontology at Sahlgrenska Academy, University of Gothenburg; Department of Orthodontics, University Clinics of Odontology, Public Dental Service, Gothenburg, Sweden

Aim:
The purpose of this study was to compare the clinical effectiveness in reducing large overjet between a prefabricated functional appliance (PFA) and a slightly modified Andresen activator (AA).

Materials and Methods:
A multicenter, prospective and randomized clinical trial was conducted in 12 general dental practices and the study was approved by an ethical committee. The sample consisted of 104 subjects (50 girls, 54 boys) mean age 10.4 years with a Class II, division 1 malocclusion and an overjet ≥ 6 mm. The study was designed as intention to treat and the patients were randomly selected to treatment with either a PFA or

a AA. The PFA and AA group consisted of 61 subjects (32 girls, 29 boys) and 43 subjects (18 girls, 25 boys) respectively. Overjet, trauma, lip seal and treatment discomfort were recorded before and at 3, 6 and 12 months after start of treatment. The endpoint of treatment was set to overjet ≤ 3mm and after this a 6 months retention period followed.

Results:
No significant difference was found in overjet, overbite and sagittal molar correction between the two groups. The treatment of 44 patients with PFA and 25 with AA were considered unsuccessful mainly due to poor compliance or other factors.

Conclusion:
Prefabricated functional appliances are as effective as Andresen activators in correcting overjet, overbite, sagittal relation and lip seal. The advantage with a prefabricated appliance is that no impressions are needed and the cost is about 1/3 of that of the activator. The success rate in treatment with both appliances is however, low.

E-mail: emina.cirgic@vgregion.se

◎ ◎ ◎ 27

Success rate, costs and long-term stability of treatment with activator/headgear combinations carried out by general dental practioners

C Hedlund, I Feldmann

Orthodontic Clinic, Public Dental Service, Gävleborg County Council, Gävle, Sweden

Aim:
The aims of this study were to evaluate treatment outcome with activator-headgear combinations carried out by general dental practitioners, overall costs, long-term stability and patients' satisfaction with treatment and treatment outcome.

Materials and Methods:
All patients who were recommended, by the consulting orthodontists, to start treatment with an activator-headgear combination in the Public Dental Service, Gävleborg County Council, Sweden in 2006 were included in this study (n=97). Inclusion criteria were: Class II Division 1 with at least half a cusp width distal molar relationship, overjet ≥6 mm and presence of dental records to verify treatment outcome. Data were collected from the patient's dental records, before treatment (T0), after active treatment (T1) and 3 years after active treatment for those with favorable outcome (T2). Success rate was defined as successful, partially successful or unsuccessful. Costs were measured as direct and indirect costs. Patients at follow-up answered a questionnaire about satisfaction with treatment outcome, perceived pain and discomfort during treatment, and need for additional treatment.

Results:
Eight patients declined treatment and 4 had missing records thus 85 patients were analyzed, 52 boys and 33 girls (mean age 10.9 years SD 1.37). Thirty-five patients were found to have successful treatment outcome, 15 were partially successful and 35 patients discontinued treatment and/or had a final outcome that was judged as unsuccessful. The main reason for unsuccessful treatment outcome was lack of compliance.
A total cost analysis for all 85 patients amounted to SEK 880 758 and included both direct costs for treatment time and laboratory material and fees. Indirect costs for all patients were estimated to SEK 524 055, with travel expenses excluded.
Thirty-eight patients out of 50 eligible patients participated in the 3-year follow-up. The treatment outcomes were then categorized as successful in 28 patients, partially successful in 9 patients and 1 patient was unsuccessful. Median values for overall satisfaction with treatment and treatment outcome were high 78 (45-100) and 84 (30-100) respectively. Median value for perceived pain and discomfort during treatment was 42 (9-97).

Conclusion:
Fifty out of 85 patients had a successful or partially successful treatment outcome. Overall costs were high (SEK 1 405 000) and treatments were time consuming. However, patients with favorable outcome were stable over time and satisfied with treatment.

E-mail: camilla.hedlund@lg.se

◎ ◎ ◎ 28

Low-lever laser therapy as a method to improve orthodontic treatment – a systematic review

J Subraian, E De Geer, S Petrén, M Sonesson

Department of Orthodontics, Faculty of Odontology, Malmö University, Malmö, Sweden

Aim:
The objective of this systematic review was to determine if low-level laser therapy (LLLT) could serve as an effective method to accelerate tooth movement, prevent orthodontic relapse or diminish acute pain during orthodontic treatment.

Materials and Methods:
The systematic review was performed according to The Swedish Council on Technology Assessment in Health Care. The inclusion criteria were randomized controlled trials or controlled clinical trials, articles written in English or Scandinavian languages, and human studies. The literature search was performed using PubMed, Medline and Cochrane databases up to February 2013. An additional search was carried out in Scitation in October 2013. Two studies were found regarding acceleration of tooth movement when using LLLT and ten studies used LLLT to diminish acute pain. No study on LLLT as a method to prevent orthodontic relapse was found according to given inclusion criteria.

Results:
The studies showed a trend of good results when using low-level laser therapy. Acceleration up to 30 % was shown when using LLLT and subjects reported a lower pain score on numeric rate scale (NRS) or visual analogue scale (VAS) compared to control. The laser regimen was used with a wide range and it is obvious that no consensus has been reached considering different lasers, frequencies and powers.

Conclusion:
This systematic review suggests that low-level laser therapy improve orthodontic treatment in reducing treatment time and pain. However, the quality of the studies was limited and further research is required to achieve a higher level of evidence.

E-mail: emelie_dg@hotmail.com

◎ ◎ ◎ 29

Evaluation of marginal bone level changes during orthodontic treatment, a comparison between banded and bonded first molars

B Lindskog Stokland[1], H Lund[2], K Hansen[1]

Departments of [1]Orthodontics and [2]Oral and Maxillofacial Radiology University Clinics of Odontology, Public Dental Service, Gothenburg, Sweden

Aim:
Aim: The purpose of this study was to evaluate marginal bone level changes around the first molars during orthodontic treatment with fixed appliances and to explore the differences between banded and bonded molars and between banded molars with or without a Goshgarian palatal arch.

Materials and Methods:
Material and methods: Cone beam computed tomography (CBCT) examinations of 151 patients (11-18 years) treated with fixed appliances and extractions of four premolars were analysed. The CBCT images were reformatted in line with the long axis of the tooth/root and the distance from the cemento-enamel junction to the alveolar bone crest was measured on the buccal, mesial, palatal/lingual and distal surfaces

Results:
Results: Three hundred one upper and 302 lower first molars were examined. Two hundred two upper molars were banded and 99 were bonded with buccal tubes. In the lower jaw, 149 molars were banded and 153 were bonded with tubes. Marginal bone loss for the total group, for the upper first molar varied between 0.3 mm for the palatal surface to -0.0 for the distal surface. In the lower jaw the bone loss varied between 0.3 mm for the buccal surface and 0.1 for the distal surface. The bone loss was statistical significant for all surfaces except for the distal surface of the upper molar. The difference between banded and bonded molars was significant only for the distal surface of the lower first molars ($p < 0.05$), with slightly less bone loss on the bonded teeth. Ninety four of the patients with bands had a Goshgarian palatal arch during the major part of treatment and 102 had banded molars only. No statistical differences were noticed in marginal bone loss between the Goshgarian and the non-Goshgarian groups.

Conclusion:
Conclusion: Small but significant bone loss occurs around first molars during orthodontic treatment. The risk for alveolar bone loss is not more pronounced when orthodontic bands and Goshgarian palatal arches are used compared to bonded tubes

E-mail: Birgitta.Lindskog-Stokland@vgregion.se

◎ ◎ ◎ 30

The influence of natural teeth on human cognitive functions

J Bergdahl, P Hansson, K Sunnegårdh-Grönberg, M Bergdahl, L Nyberg, L-G Nilsson

Institute of Clinical Dentistry, UIT The Artic University of Norway, Department of Psychology, Umeå University, Sweden

Aim:
The aim was to clinically investigate the relationship between the number of natural teeth and cognitive functions such as episodic, semantic, and working memory along with visuospatial ability and processing speed. The hypothesis was that hippocampal-dependent cognitive functions, such as episodic memory, are affected in individuals with reduced number of natural teeth.

Materials and Methods:
A population-based sample of 273 participants (145 females/128 males, age range from 55 to 80 years) was investigated. The participants underwent health assessment, completed a battery of cognitive tests, and took part in an extensive clinical oral examination. The cognitive test included assessment of episodic memory, semantic memory, working memory, visuospatial ability and processing speed.

Results:
The number of natural teeth contributed uniquely and significantly to explaining variance (3-4%) in performance on measures of episodic memory and semantic memory over and above individual differences in age, years of education, gender, occupation, living conditions, and medical history. The number of natural teeth did not have an influence on the performance on measures of working memory, visuospatial ability, or processing speed.

Conclusion:
This study shows that number of natural teeth is selectively related to episodic and semantic memory performance. These results, in part, support previous ideas suggesting that tooth loss causes degeneration of neurons in the hippocampal area. Overall, the present study suggests that understanding of cognitive function in relation to oral health is of importance regarding risk factors of cognitive decline.
E-mail: jan.bergdahl@uit.no

◎ ◎ ◎ 31

3D numerical simulation of the fracture process in ceramic FPDs subjected to oblique loading

W Kou[1], JY Qiao[2], L Chen[2], YS Ding[2], G Sjögren[1]

[1] Dental Materials Science, Department of Odontology, Faculty of Medicine, Umeå University, Umeå, Sweden
[2] Institute of Mechanics, Chinese Academy of Sciences, Beijing, China

Aim:
To evaluate how oblique loading affects the fracture of a three-unit (3U) ceramic-based fixed partial denture (c-FPD) framework.

Materials and Methods:
For the 3D simulation, the materials studied were treated heterogeneously and the Weibull distribution law was applied to describe the heterogeneity. The Mohr-Coulomb failure criterion with tensile strength cut-off was used to judge whether the material was in an elastic or failed state. The loading areas were placed either on the buccal cusp or the lingual cusp of the pontic - shaped premolar, with the loading direction at an angle of either 60 degree or 45 degree to the occlusal surface. The stress distribution, fracture initiation and propagation during loading and fracture process were analyzed.

Results:
The main cause of the fracture of the 3U c-FPD framework was tensile stress. The decisive crack, which caused the fracture of the framework, was located at the gingival embrasure of the pontic, regardless of whether the buccal or the lingual cusp was loaded. The loading-displacement curve of the framework showed a linear relation typical of elasto- ▷

brittle material. The framework loaded on the lingual cusp showed lower rigidity but higher failure strength than that loaded on the buccal cusp. Loading at an angle of 60 degree showed higher rigidity than loading at an angle of 45 degree. The simulated fracture surface could be extracted from the fractured framework and the fracture process was clearly revealed.

Conclusion:
The numerical simulation performed allowed the fracture progress of a 3U c-FPD subjected to oblique loading to be followed. In the c-FPD used in the present study, the cause of the fracture was tensile stress failure. The load capacity and rigidity of the framework vary with the loading position and direction: the c-FPD framework loaded on the lingual cusp could withstand higher oblique forces but was more easily deformed than when loaded on the buccal cusp.

E-mail: wen.kou@odont.umu.se

32

Effects of experimental tooth clenching on pain and intramuscular release of 5-HT and glutamate in patients with myofascial TMD

A Dawson, B Ghafouri, B Gerdle, T List, P Svensson, M Ernberg

Department of Orofacial Pain and Jaw Function, Malmö University, Malmö, Sweden

Aim:
This study investigated the effects of experimental tooth clenching on the levels of 5-HT, glutamate, pyruvate, and lactate, as well as on blood flow and pain intensity, in the masseter muscles of M-TMD patients.

Materials and Methods:
Fifteen patients with M-TMD and 15 healthy controls participated. Intramuscular microdialysis was done to collect 5-HT, glutamate, pyruvate, and lactate and to assess blood flow. Two hours after the insertion of a microdialysis catheter, participants performed a 20-min repetitive tooth clenching task (50% of maximal voluntary contraction). Pain intensity was measured throughout.

Results:
A significant effect of group ($P<0.01$), but not of time, was observed on 5-HT levels, and blood flow. No significant effects of time or group occurred on glutamate, pyruvate, or lactate levels. Time and group had significant main effects on pain intensity ($P<0.05$, and $P<0.001$). No significant correlations were identified between: (i) 5-HT, glutamate, and pain intensity or between (ii) pyruvate, lactate, and blood flow.

Conclusion:
This experimental tooth clenching model increased jaw muscle pain levels in M-TMD patients and evoked low levels of jaw muscle pain in healthy controls. M-TMD patients had significantly higher levels of 5-HT than healthy controls and significantly lower blood flow. These two factors may facilitate the release of other algesic substances that may cause pain.

E-mail: andreas.dawson@mah.se

33

Temporomandibular joint osteoarthritis: the role of suPAR

J Lam, S Vekariya, L Ljunggren, P Alstergren, A Dawson

Department of Orofacial Pain and Jaw Function, Malmö University, Malmö, Sweden

Aim:
The aim of this pilot study was to investigate soluble urokinase-type plasminogen activator receptor (suPAR) concentration in saliva in patients with temporomandibular joint osteoarthritis (TMJ OA) and in healthy controls.

Materials and Methods:
Four patients with TMJ OA and 4 healthy individuals were included. The subjects underwent periodontal examination and examination of the masticatory system according to RDC/TMD. In addition, the number of painful mandibular movements was assessed as well as bleeding on probing (BoP) and sampling of saliva was performed. The saliva was analyzed for suPAR and total protein concentrations.

Results:
The mean ± SD concentration of salivary suPAR was 9.8 ± 6.7 ng/mL in the healthy subjects and 17 ± 8.8 ng/mL in the TMJ OA patients. The mean ± SD number of painful mandibular movements in the TMJ OA patients were 3.0 ± 1.2 in right TMJs and 2.2 ± 2.1 in left TMJs whereas the healthy individuals did not have any painful movements. Healthy individuals had a higher mean value of BoP than the TMJ OA patients. No analytical statistics were performed.

Conclusion:
This study suggests to some degree that TMJ OA patients have more TMJ pain on jaw movement at the same time as their saliva concentration of suPAR is higher than in healthy individuals.
E-mail: andreas.dawson@mah.se

34

Fatigue and pain during chewing after whiplash trauma

E Lampa, A Wänman, B Häggman-Henrikson

Department of Odontology/Clinical Oral Physiology, Umeå University, Umeå, Sweden

Aim:
Eating, of which chewing is a part, is a vital function for human life as well as an important element in social life. Chewing includes movements of the lower jaw and head-neck as well as activity of both jaw and neck muscles. Therefore, neck pain and disability following whiplash trauma might affect chewing ability. In patients with chronic pain and dysfunction after neck trauma a disturbed jaw function, including reduced endurance during chewing, has been reported. These observations suggest that jaw pain and dysfunction can develop after neck trauma. It is not known, however, if any limitations in jaw function exist also early after a whiplash trauma. The purpose of this study was to evaluate chewing ability and neck disability in individuals with a recent whiplash trauma compared with healthy controls.

Materials and Methods:
Forty-five individuals (28 women and 17 men, mean age 36 years), who had visited the Emergency department at Umeå University hospital, Sweden, with neck pain following a car accident were examined within three weeks after the trauma and compared with 45 healthy controls (28 women and 17 men, mean age 39 years). All participants performed a 5-minute chewing capacity test and were instructed to report any fatigue or pain during the task. The participants were free to discontinue the chewing test at any time. Neck disability was assessed by a questionnaire, Neck Disability Index (NDI).

Results:
During the chewing capacity test, individuals with a recent whiplash trauma reported more fatigue (49% vs. 22%, P = 0.015) and more pain (27% vs. 7%, P = 0.011) compared to healthy controls. In the trauma group, the cases who reported fatigue and pain during chewing, had a significantly higher neck disability compared with cases without symptoms, (NDI = 26 vs. NDI = 16, P = 0.026).

Conclusion:
The results suggest a reduced chewing capacity early after whiplash trauma. This finding indicates an association between the development of jaw and neck disability following whiplash trauma and emphasizes the close functional linkage between the jaw and neck regions.
E-mail: ewa.lampa@vll.se

35

Modern alloplastic TMJ reconstructions – the treatment of choice?

B Lindell

Department of Surgical Sciences, Oral and Maxillofacial Surgery, Akademiska sjukhuset, Uppsala, Sweden

Aim:
To describe a case report from the operative management and postoperative care after a total joint reconstruction with a Biomet-Lorenz TMJ-prosthesis, present a novel imaging technique with F18 PET-CT and to review the literature as to the safety of this treatment modality.

Materials and Methods:
The presentation is made up by two parts – a case report of a unilateral Biomet-Lorenz custom made prosthesis implanted in a 18-year old girl due to a ▷

posttraumatic ankylosis with a 2-year follow-up with different radiographic modalities, and review of the current literature on total joint reconstruction.

PET-CT has been proved to be a valuable tool for analysing the metabolic bone response in hip arthroplasty and to our knowledge this is the first time a TJR is imaged by a PET-CT, visualising signs of bone metabolism with a fluoride isotope (F18) as a radioactive tracer.

Results:
In the case report the clinical data and the imaging modalities used show biologic integration and function regarding the TJR. The patient's subjective opinion was positive, with no pain and good function, which conclude a satisfactory outcome. The F18 PET-CT showed no signs of pathological conditions on the TJR side.

The current literature of the modern TMJ prosthesis shows that the treatment is a safe and effective option for end-stage TMD, such as ankylosis. Studies on the new Total joint reconstruction (TJR) materials used in orthopaedic surgery show promising results with no soft tissue reactions, and decreased pain and recreation of function. F18 PET-CT has been described as a valuable tool for analysing the bone mineralisation around uncemented orthopaedic hip implants.

Several long-term TMJ-TJR follow-up studies reports improved interincisal opening, significant decreased pain, and improvement of function. The treatment offers an end-stage solution in comparison with the orthopaedic implants of the hip and knee. The currently used materials have been proved biocompatible and long lasting without the disadvantages of earlier materials, including foreign body reactions, giant cell granuloma formations compared to the earlier materials that were used decades ago.

Conclusion:
The case we present has, so far, been successful according to patient satisfaction, clinical and radiographic examinations.

F18 PET-CT has been used as a novel marker for bone mineralisation around the TJR implant. There were no signs of pathology.

Although previously promising results have been published, long-term studies must continue to support the development of safe and functional alloplastic TMJ-prostheses.

E-mail: bjorn.lindell@akademiska.se

◎◎◎ 36

Evaluation of diagnostic information obtained from conventional two-dimensional radiographs of ectopically impacted maxillary canines when compared to cone beam computed tomography; a retrospective study

R Lynds

Department of Image and Functional Odontology, Institute of Oral Medicine, Karolinska Institutet, Huddinge, Sweden

Aim:
The objective of this study is to compare cone-beam computed tomography (CBCT) and conventional two-dimensional radiographic images in order to understand how diagnostics can differ between the two modalities in the case of impacted maxillary canines.

Materials and Methods:
CBCT examinations of impacted canines from between 2008-2011 were preselected from the image data base at the department of image and functional odontology, KI. Among these, 28 impacted canines from 19 patients were used. Each case was independently evaluated by six oral radiologists with respect to localisation of the impacted teeth as well as possible root resorption of adjacent teeth, using provided questionnaires. Collected data representing relevant diagnostic variables were calibrated and statistically analyzed. The registered diagnostic data were then compared to extrapolated values, based on previous CBCT evaluations. These CBCT evaluations were originally documented in each patient's journal, and used as a gold standard.

Results:
CBCT revealed that 50% of the cases presented with root resorption of adjacent incisors, while only 7.1% of the teeth with root resorption were identified based on 2D images. The sensitivity of using 2D images

to diagnose root resorption is 7.1% and specificity is 92.9%. Correct angulation of the impacted canine was determined in 89.3% of the impacted canines, correct cusp location in 53.6%, and the correct stage of root development in 35.7%. The one canine which had visible ankylosis in the CBCT evaluation was not identified using only 2D images, and bone volume could not be determined in any of the cases using 2D images, whereas CBCT could determine bone volume in 93.3% of the impacted canines.

Conclusion:
2D images have very poor diagnostic accuracy on possible existing root resorption of adjacent incisors to the impacted maxillary canine, but are in general quite reliable concerning the localization and the position of the impacted teeth.

E-mail: Randi.Lynds@stud.ki.se

◎ ◎ ◎ 37

Evaluation and treatment of chronic orofacial pain in multidisciplinary and multimodal pain group

E Mc Cormick, M Sjöwall

Malmö Högskola, Malmö, Sweden

Aim:
The purpose of this study was to evaluate two pain groups ("Odontologiska smärtgruppen" at the Faculty of Odontology, Malmö University and "Referensgruppen för långvarig Orofacial Smärta" (ROS), Kalmar) and to investigate patients' experiences regarding communication and treatment effects.

Materials and Methods:
All patients examined by the Odontologiska smärtgruppen the last two years and ROS the last three years were invited to participate in a questionnaire study. Fifteen patients from Odontologiska smärtgruppen and thirteen from ROS responded (67 %). The questionnaire assessed current pain intensity, the impact of pain on everyday life, treatment outcome, jaw function and number of pains.

Results:
Patients from ROS had significantly higher number of other pains before contact with their pain group (p = 0,017). Patients from ROS considered the personal communication with the pain group to be of greater importance for their recovery (p = 0,025) then the patients from the Odontologiska smärtgruppen. Common to all patients was that depression or anxiety (nervousness, uneasiness, little pleasure or interest in doing things) due to orofacial pain the last two weeks had a major negative impact on activities of daily life, treatment result and jaw function limitation.

Conclusion:
This study suggests that patients evaluated at ROS have higher number of other pains before contact with their pain group. The personalized contact with the pain group was of greater importance for the recovery for the patients of ROS. Common to all patients were that depression and anxiety have a major negative impact on activities of daily life, treatment result and limitation of jaw function.
E-mail: olsson.em@hotmail.com

◎ ◎ ◎ 38

Prevalence of whiplash trauma in TMD patients

M Rezvani[1], B Häggman-Henrikson[1,2], T List[1,3]

[1]Department of Orofacial Pain and Jaw Function, Malmö University; [2]Department of Odontology/Clinical Oral Physiology, Umeå University; [3]Department of Rehabilitation Medicine, Skåne University Hospital, Sweden

Aim:
The purpose of this systematic review was to describe the prevalence of whiplash trauma in patients with Temporomandibular Disorders (TMD), and to describe clinical signs and symptoms in co-morbid TMD/whiplash compared to TMD localized to the facial region.

Materials and Methods:
A systematic literature search of the PubMed, Cochrane Library, and Bandolier databases was carried out for articles published from 1 January 1966 to 31 December 2012. The systematic search identified 129 articles. After an initial screening of abstracts, 32 articles were reviewed in full text applying the inclusion and exclusion criteria. Two of the authors evaluated the methodological quality of the included studies. Six studies on the prevalence of neck trauma ▷

in patients with TMD met the inclusion criteria and were included in the review.

Results:
The reported prevalence of whiplash trauma ranged from 8% to 70% (median 35%) in TMD populations, compared to 2% to 13% in the healthy control groups. Compared to patients with TMD localized to the facial region, TMD patients with a history of whiplash trauma reported more TMD symptoms, such as limited jaw opening and more TMD pain, and also more headaches and stress symptoms.

Conclusion:
The prevalence of whiplash trauma is higher in patients with TMD compared with healthy controls. Patients with co-morbid TMD/whiplash present with more jaw pain and more severe jaw dysfunction compared to TMD patients without a history of head-neck trauma. These results suggest that whiplash trauma might be an initiating and/or aggravating factor as well as a co-morbid condition for TMD.

E-mail: birgitta.henrikson@odont.umu.se

39

Correlations between TMJ disorders and systemic diseases. A retrospective mapping study from patients' journals

A Salinas Fredricson, A Rosén

Division of Oral and Maxillofacial Surgery, Department of Dental Medicine, Karolinska Institutet, Karolinska University Hospital Huddinge, Stockholm, Sweden

Aim:
The purpose of this study was to map the correlation between systemic diseases and temporomandibular joint (TMJ) disorders in patients suffering from painful (PC) clicking or chronic closed lock (CCL) of the disc. TMJ disorders (TMJD) is a term encompassing functional problems and give rise to pain both in movement and in rest. The disorders involve muscular problems, which can be stress induced or due to bruxism and disc displacement in the joint. There is an obvious female predominance and preliminary data have shown that TMJ patients have other diseases that may involve the lungs.

Materials and Methods:
The study population consisted of patients that had been diagnosed with chronic closed lock or painful clicking and treated surgically during the years 2007-2011 at the Division of Oral and Maxillofacial Surgery, Karolinska University Hospital, Huddinge. 261 patient journals were thoroughly gone through and their medical history was recorded in accordance to the auto anamnesis that is given to all patients at their first visit to the clinic.

Results:
The study showed a higher percentage of asthmatics in the patient group compared to the general public health. It was also shown that a lot of the patients suffer from headaches, neck and back problems, and general joint diseases. The age median was 44, similar to reports from earlier studies. However, the male/female ratio was shown to be 1:6.5 in patients suffering from CCL and 1:4 in patients suffering from PC, the results differ slightly from earlier studies, as the percentage of female patients suffering from CCL was higher than other studies claim.

Conclusion:
This study showed that the dominance of women was higher for CCL patients than for PC. TMJ disorders were more frequent in the age of 30-50. The most common diseases in patients suffering from TMJ disorders were general muscle and/or joint diseases and allergy and/or asthma. It is essential to expand the case group and also investigate what sort of treatment that has been given to these patients. Future studies should emphasize on the correlation between TMJ disorders and asthma, hypermobility, general joint diseases and neck and/or back problems.

E-mail: adrianfredricson@hotmail.com

◎ ◎ ◎ 40

The effects of experimental stress on the pain sensitivity in the masseter muscle, and cortisol levels in healthy subjects

A Tran, T van Bui, T List, K Bendixen, P Svensson, A Dawson

Malmö University, Malmö, Sweden

Aim:
To investigate the pain sensitivity in the human masseter muscle in response to acute experimental stress in healthy subjects, and to test if (i) experimental stress leads to a mechanical hyperalgesia in the masseter muscle, (ii) the level of salivary cortisol is increased in response to experimental stress, and (iii) experimental stress leads to an increased heart rate and blood pressure.

Materials and Methods:
Fifteen healthy females (mean age 23.7 ± 2.3 years) volunteered in this study. Participants performed randomly two sessions. The Paced Auditory Serial Addition Task (PASAT) was used to induce acute stress in the experimental session, while in the control session participants listened to the PASAT without calculation. Salivary cortisol levels, perceived stress levels, electrical and pressure pain threshold (PT) and pain tolerance levels (PTL) were measured at baseline and after each task. Mixed model analysis of variance was used to test for significant main effects over time and between sessions.

Results:
Significant main effects for time (ANOVA: $P < .001$) and session ($P < .050$) were observed for perceived stress and salivary cortisol levels. The experimental task evoked significantly higher levels of perceived stress and salivary cortisol than the control task. Perceived stress levels increased significantly over time, while salivary cortisol decreased. Significant effects of time were observed for electrical PT and PTL (ANOVA: $P < .050$) and for pressure PT and PTL (ANOVA: $P < .050$), but a significant session difference was only observed for electrical PT (ANOVA: $P < .050$).

Conclusion:
The PASAT evoked significant levels of perceived stress, but also an analgesic effect to mechanical and electrical stimuli. The level of salivary cortisol was significantly higher in the experimental session, but a significant reduction occurred over time, most likely due to the use of oral contraceptives. It seems that the PASAT activated the descending pain inhibitory system. More research are warranted to establish the association between psychological stress and the pain perception.

E-mail: andreas.dawson@mah.se

◎ ◎ ◎ 41

The effect of masseter muscle vibration on jaw-neck motor strategy

B Wiesinger[1,2], B Häggman-Henrikson[1], F Hellström[3], A Wänman[1]

[1]Department Odontology, Clinical Oral Physiology, Umeå University, Umeå; [2]Department Research and Development, Västernorrland County Council; [3]Centre for Musculoskeletal Research, University of Gävle, Umeå, Sweden

Aim:
A functional integration between the jaw and neck regions has been demonstrated with simultaneous jaw and head movements during jaw opening-closing tasks. Previous studies have shown that muscle spindle stimulation by vibration of the masseter muscle may influence jaw movement amplitudes. The possible effect of masseter muscle vibration on the integrated jaw-neck function has not been investigated.

The aim of this study was to investigate the effect of bilateral masseter muscle vibration on integrated jaw-neck movements during a continuous jaw opening-closing task.

Materials and methods:
Sixteen healthy men performed continuous jaw-opening closing tasks to target position, defined as 75% of the individual maximum jaw opening. Each subject performed two trials without vibration (control) and two trials with bilateral masseter muscle vibration (80 Hz). Simultaneous movements of the mandible and the head were registered with a wireless 3-D optoelectronic recording system. Data ▷

from the two control trials and the two vibration trials were pooled respectively. Differences in jaw and head movement amplitudes between control and vibration trials, as well as the achievement of the target jaw opening position, were analysed with Wilcoxon matched pairs test.

Results:
Vibration did not influence the achievement of the target jaw opening position. There were no statistically significant differences in jaw and head movement amplitudes between control and vibration trials, although a co-variation between the jaw and head movement amplitudes was found.

Conclusion:
The results imply a high stability for the jaw motor system in a jaw opening task to a target position, and that the jaw opening-closing task was achieved with the head-neck and jaw working as an integrated system.

E-mail: birgitta@wiesinger.se

Swedish Dental Journal

Contents of Volume 37, 2013

Author, Title	Issue	Page
Anastassaki Köhler, Hugoson, Magnusson Clinical signs indicative of temporomandibular disorders in adults: time trends and associated factors	1	1
Dahlén, Hjort, Spencer Water cleaning systems improves the water quality in dental unit water lines (DUWL). A report from the Public Dental Health of Västra Götaland region, Sweden	4	171
Fagrell, Salmon, Melin, Norén Onset of Molar Incisor Hypomineralization (MIH)	2	61
Frisk, Kvist, Axelsson, Bergenholtz, Davidson, Mejare, Norlund, Petersson, Sandberg, Tranæus, Hakeberg Pulp exposures in adults – Choice of treatment among Swedish dentists	3	153
Haag, Andersson, Nilner, Dérand Porcelain bonding to titanium with two veneering principles and two firing temperatures	3	143
Jansson, Adler, Jonés Adolescents with high periodontal risk in Public Dental Service	4	161
Johansson, Starkhammar Johansson, Ravald The prevalence and alterations of furcation involvements 13 to 16 years after periodontal treatment	2	87
Krekmanova, Hakeberg, Robertson, Klingberg Common experiences of pain in children and adolescents – an Exploratory Factor Analysis of a questionnaire	1	33
Lindskog-Stokland, Hakeberg, Hansen Molar position associated with a missing opposed and/or adjacent tooth: a follow up study in women	2	97
Linné Erixon, Ekberg Self-perceived effects of occlusal appliance therapy on TMD patients: an eight-year follow-up	1	13
Mahmood, Linderoth, Vult von Steyern, Wennerberg Fracture strength of all-ceramic (Y-TZP) three- and four-unit fixed dental prostheses with different connector design and production history	4	179
Mårtensson, Söderfeldt, Axtelius , Andersson Knowledge of periodontitis and self-perceived oral health: a survey of periodontal specialist patients	1	49
Minston , Li, Wennberg, Näsström ,Shi Comparison of diagnostic performance on approximal caries detection among Swedish and Chinese senior dental students using analogue and digital radiographs	2	79
Sahlstrand, Lith, Hakeberg, Norén Timing of mineralization of homologues permanent teeth – an eva¬luation of the dental maturation in panoramic radiographs	3	111
Ståhlnacke, Söderfeldt An interview study of persons who attribute health problems to dental filling materials – part two in a triangulation study on 65 and 75 years old Swedes	3	121
Ström, Behrenth, Ekman, Johansson, Unell, Carlsson Management of tinnitus and jaw-muscle tenderness using an intraoral appliance and acupuncture	3	105
Sundell, Ullbro, Koch Evaluation of preventive programs in high caries active preschool children	1	25
Svensson, Hallmer, Sahlström Englesson, Svensson, Becktor Treatment with local hemostatic agents and primary closure after tooth extraction in warfarin treated patients	2	71
Wahlin, Jansson, Klinge, Lundegren , Åkerman, Norderyd Marginal bone loss in the adult population in the county of Skåne, Sweden	1	39
Östberg, Ahlström, Hakeberg Patients' choice of payment system in the Swedish Public Dental Service – views on dental care and oral health	3	131
Abstracts of free communications and posters presented at the 49th Annual Congress of the Swedish Dental Society, Stockholm, November 14-16, 2013	4	189

Posttidning B

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