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PHOTO: ANNA RUT FRIDHOLM

Professor Tord Berglundh was awarded The Bensow Prize for excellence in research at the 50th congress of the Swedish Dental Society 2014. The prize ceremony was headed by Professor Gunilla Klingberg, President of the Swedish Dental Society

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Introduction

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Use of implant-supported prostheses in edentulous mandibles among prosthodontists in Sweden

ARON ASCHER[1], GUNNAR E CARLSSON[1], MATS KRONSTRÖM[2]

Abstract

◎ The aim of this study was to investigate the production of mandibular implant-supported fixed and removable prostheses among prosthodontic specialists in Sweden and to compare the results with findings in a similar study made in 2001 (17). Questionnaires regarding treatment with mandibular implant prostheses during 2011 were mailed to all specialists in prosthodontics in Sweden (n = 156, according to available data). Of the 156 questionnaires, 129 (83%) were returned and of those 114 were completed. The reported number of treatments with mandibular implant-supported prostheses varied much among the specialists. Fixed implant prostheses were more common than overdentures (means 11 and 3, median values 8 and 2, respectively). However, the range was large for both alternatives. Ten (9 %) of the specialists reported no treatment with fixed implant prostheses while 29 (25 %) had not made any implant overdenture during 2011. The most common anchorage system for overdentures in 2011 (as well as in 2001) was two un-splinted implants with ball attachments or Locator abutments. The most common reasons for choosing overdenture treatment instead of a fixed implant prosthesis in 2011 were the reduced cost and the patient's main wish to improve denture retention. A majority of the prosthodontists (58 %) reported that patients with implant overdentures were as satisfied as those with fixed implant-supported prostheses, whereas 40 % claimed they were less satisfied. Two respondents (2 %) considered that overdenture patients were more satisfied than those with a fixed prosthesis. It can be concluded that the general attitude among Swedish prosthodontists towards implant overdentures has not changed much during the 10-year period between the present and the previous investigation. An overdenture is still a seldom-used option in implant treatment of patients with edentulous mandibles in Sweden. Instead, a fixed implant-supported prosthesis continues to be the preferred option,

Key words

Decision making, dental implants, implant overdentures, treatment cost, treatment demand

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Användning bland protetiker i Sverige av implantatstödda proteser vid behandling av patienter med tandlös underkäke

ARON ASCHER, GUNNAR E CARLSSON, MATS KRONSTRÖM

Sammanfattning

◎ Syftet med föreliggande studie var att utreda användningen av fast protetik och täckproteser på implantat i tandlösa underkäkar bland specialister i Sverige och jämföra resultaten med en liknande studie som gjordes 2001 (17). Frågeformulär angående behandling med implantatproteser i tandlösa underkäkar under 2011 sändes till alla specialister i protetik i Sverige (n = 156, enligt tillgängliga uppgifter). Av de utsända enkäterna återsändes 129 (83 %) av vilka 114 var fullständigt ifyllda av protetiker som varit verksamma under 2011.

Fasta broar på implantat var vanligare än täckproteser (i medeltal 11 respektive 3, medianvärdena 8 respektive 2), men variationen var stor. Tio (9 %) protetiker rapporterade ingen behandling med fasta implantatbroar på tandlösa underkäkar, medan 29 (25 %) inte hade gjort några täckproteser under 2011. Det vanligaste förankringssystemet för täckproteser under 2011 (liksom under 2001), var två separata implantat med kulattachment eller locators. De vanligaste orsakerna till valet av behandling med täckprotes under 2011, såväl som under 2001, var lägre kostnader och patientens önskan att förbättra protesretentionen. I enkäten gällande 2011 svarade 58 % av protetikerna att patienter med täckproteser var lika nöjda som de med fasta implantatstödda proteser, medan 40 % menade att de var mindre nöjda. Två protetiker (2 %) ansåg att patienter med täckproteser var mer nöjda än de med fast protes.

Man kan dra slutsatsen att den allmänna attityden bland svenska protetiker beträffande typ av implantatprotetik i underkäken inte har förändrats mycket under 10-årsperioden mellan den nuvarande och den tidigare undersökningen. En täckprotes är fortfarande ett relativt ovanligt alternativ i Sverige vid implantatbehandling av patienter med tandlösa underkäkar. En fast implantatstödd brokonstruktion fortsätter att vara det föredragna alternativet.

Introduction

Treatment with implant overdentures has been a very successful option for the edentulous mandible (14, 24). Originally, a fixed prosthesis on 5-6 implants was presented by *Brånemark and co-workers* as the preferred treatment of choice for the edentulous mandible and during many years, this was the dominating concept in Sweden (1, 6). However, in the mid 1980's treatments with mandibular implant overdentures were introduced (27). Being less expensive and less complicated but yet equally successful compared to the fixed implant prostheses, mandibular implant overdentures soon became popular in many countries (7). Advantages and disadvantages of fixed implant-supported prostheses and implant overdentures have been discussed extensively in the literature, without consensus on which is the best choice but acknowledging advantages of both options (4, 5, 11, 12, 14, 15, 24).

Many studies have demonstrated that the outcome of treatment with mandibular implant overdentures is successful both in short- and long-term perspectives (14, 23, 25).

Initially multiple implants were used to support and retain mandibular overdentures, but several studies showed excellent results also when using fewer implants (23, 25). Today, the most preferred treatment option seems to be two implants placed in the interforamina area either splinted with a bar or provided with separate attachments (24). In order to further reduce the cost and simplify the treatment, studies using a single implant supporting/retaining a mandibular overdenture have shown promising results. After the pioneering, successful 5-year results presented already in 1995 (10), several studies have been published, although only with short- to medium-long follow-ups but showing mainly favourable results (2, 9, 16, 18, 19, 26).

In 2002, a questionnaire study was initiated in Sweden to examine the use of and attitude towards mandibular implant-supported fixed and removable prostheses among licensed specialists in prosthodontics. The study, referring to the situation in 2001, showed that the vast majority of the prosthodontists preferred treatment with implant-supported fixed prostheses and the average number of implant overdenture treatments was very small (17). At the time of the study, the Swedish dental insurance system offered high reimbursement for people above 65 years of age, allowing many individuals to afford a complete arch fixed implant-supported prosthesis. However, new insurance regulations have resulted in increased treatment costs for the elderly patients and less reimbursement from the national dental insurance system. It is not known what impact the new situation has had on the decision- making for implant treatments performed by prosthodontists.

The objectives of the present study were to assess production and distribution of removable and fixed implant supported prostheses for the edentulous mandible among specialists in prosthodontics working in Sweden in 2011. An additional aim was to compare the results with the findings in the study 10 years earlier (17).

Material and Methods

During the autumn 2012, questionnaires with questions related to the use of implant-supported prostheses in patients with edentulous mandibles were sent to all specialists in prosthodontics in Sweden (n = 156 according to available data). The questions regarding treatment referred to year 2011. Those who had not responded within 5 weeks were sent a new questionnaire. Those who had still not responded within an additional 5-week period were sent a third and final questionnaire. The questionnaire questions were the same as those used in a similar study referring to implant treatment performed in 2001 (17).

Questionnaires were returned by 129 (83 %) specialists. Of the returned questionnaires 12 came from individuals who had not been clinically active during 2011 (retired, on sick-leave, maternity/paternity leave, other reasons). Three of the returned documents were empty/not filled out at all, which means that the data are based on 114 questionnaires (79 %), among which 5 did not contain answers to all questions.

The following seven questions were included in the questionnaire (response options within parentheses).

1. How many treatments with mandibular implant overdentures did you perform during 2011?
2. How many treatments with fixed implant-supported mandibular prostheses did you perform during 2011?
3. Among all your implant treated patients what was the rate of those with an edentulous mandible? Respond in %.
4. How were the retention/attachment systems distributed among the mandibular implant overdentures you performed (a. 2 implants with bar and clips; b. 2 separate implants + attachment. If so what attachment?; c. other system. If so which?).

Table 1. Number of implant-supported prostheses performed by 114 prosthodontists in Sweden during 2011 for patients with edentulous mandible

Question	Mean	Median	Range
Number of implant overdentures	3.4	2	0–100
Number of fixed implant-supported prostheses	11.4	8	0–60
% edentulous mandibles among implant patients	11.8	10	0–100

Tabell 2. Reasons* for choosing implant overdenture instead of a fixed implant-supported prostheses among prosthodontists in Sweden in 2011

Reason	Number of answers	% of respondents (n = 96)
Treatment cost	58	60
Patient's main interest was improved denture retention	48	50
Amount of bone	34	35
Jaw relationship	13	14
Other reason	19	20

* more than one reason could be chosen

5. Which were the main reason(s) for choosing an overdenture instead of a fixed prosthesis? Mark one or more alternative (a. costs; b. amount of bone; c. jaw relation; d. patient was only interested in better denture retention; e. other reason – describe).
6. Has the demand of overdentures increased in relation to fixed implant prostheses during the last few years? (a. yes; b. no; c. do not know)
7. Do you think that, in comparison to patients with fixed implant-supported prostheses, patients with mandibular implant overdentures are a. less satisfied; b. equally satisfied; c. more satisfied?

Results

The reported number of treatments with mandibular implant-supported prostheses varied much among the specialists (Table 1). The mean number of overdentures was 3.4 but the median value was 2, and 29 prosthodontists (25 % of those who answered this question) had not performed any such treatment during 2011.

Fixed prostheses were more common than overdentures but the range was large and 10 (9%) reported no such treatment.

The most common anchorage system was two separate implants with ball attachments or locators, used by 66 % of those who answered this question (n = 106). A system splinting two implants with bar-clip attachment was preferred by 29 % of the specialists. Five per cent used other solutions of which two stated that they used 3 implants with bar-clip-attachment.

Many specialists reported more than one reason for the choice of the overdenture treatment, and the most common ones were reduced cost and the patient's main wish to improve denture retention (Table 2). Amount of bone was the most common anatomical reason, and other reasons for choosing overdenture treatment included patient age and health, improving lip support, easier to clean, and implant failures under a previous fixed prosthesis.

Sixteen per cent of the prosthodontists reported that the demand for implant overdenture had increased during the last few years, while 29 % reported a decrease in demand and 56 % responded, "don't know".

Fifty-eight per cent of the respondents thought that patients with implant overdentures were as satisfied as those with fixed implant-supported prostheses, whereas 40 % claimed they were less satisfied. Two respondents (2 %) considered that overdenture patients were more satisfied than those with a fixed prosthesis.

Discussion

The general attitude among Swedish prosthodontists towards implant overdentures has not changed much during the 10-year period between the present and the previous investigation (17). An implant overdenture is still a seldom-used option in treatment of patients with edentulous mandibles and a fixed implant-supported prosthesis continues to be the preferred option. This is in contrast to the fact that implant overdentures is a common treatment option in other countries (7, 14, 24). It could be verified that the single specialist who reported the performance of > 100 overdentures had worked part of the year in another country, where implant overdentures was a common treatment option. One factor of possible influence on the predominance in Sweden of fixed implant-supported prostheses in treatment of the edentulous mandible may be that the National Guidelines for Adult Dental Care (the Swedish Board of Health and Welfare, 2011; 20) recommends the fixed before the removable implant prosthesis. The conventional complete denture receives the lowest recommendation in the mandible, whereas in the maxilla it has the same level of priority as the two implant options.

In 2001, one fifth of the patients treated with implants in prosthodontic clinics comprised edentulous mandibles; according to the present results this ratio was 10 % in 2011, indicating the on-going rapid improvement of oral health (13, 21). A further evidence of this development is that in the 2011-study 9 (8 %) of the specialists reported that there was no subject with an edentulous mandible among their implant patients. Ten years ago all clinics had such patients.

A recent epidemiological study found that the prevalence of edentulism among 70-year-old subjects in two counties in the middle of Sweden was 3 % (12). In 1975 the rate of edentulism in 70-year olds in Sweden was approximately 65 % (21). During the first period of osseointegration in Sweden rehabilitation of totally edentulous patients was the predominant implant treatment. As a consequence of the dramatic decline in edentulism, partially edentulous individuals make up the major part of patients receiving implant treatments at present.

It is well known that the initial treatment cost is higher for a fixed implant prosthesis compared with an implant overdenture. This is a decisive factor in decision-making, especially in countries without dental insurance systems providing economical support for extensive and costly dental care (7, 22). Cost analyses are rare in prosthodontics but one study documented that the long-term treatment costs for a mandibular overdenture were lower when compared with those for a fixed implant-supported prosthesis (5). According to several recent reports in Swedish media, an increasing amount of individuals complain that they cannot afford more extensive dental care. It is evident that cost of dental treatment continues to be an important issue also in Sweden. The results of the study showed that cost was the most common reason for choosing overdentures. This was true also in the earlier study performed 10 years ago (17). The cost for prosthodontic treatment has of course increased substantially during the last decade, but the Swedish dental insurance system covers a considerable part of more expensive treatments. The total treatment cost for a mandibular 2-implant overdenture, using single-step surgery, 2 separate ball attachments and without a high-noble superstructure is at present ca. SEK 32-35000 (US$ 4.900-5.400) of which the patient fee is about SEK 17000 (US$ 2.600). For a fixed implant-supported prosthesis using one-stage surgery, 4 implants and non-noble framework (titanium is today most common; 3) the total cost is ca. SEK 70-72000 (US$ 11.000) and with the insurance reduction the patient fee is approximately SEK 33000 (US$ 5.100).

The tradition with fixed implant prostheses among Swedish prosthodontists is very strong and has been ever since Dr. Brånemark presented his successful results from studies on osseointegration (6). However, if the prosthodontists could change their attitude and perhaps present strict unbiased information of the pros and cons (including the cost aspect) of the implant alternatives, the rate of overdenture treatment might increase also in Sweden. Such a change in attitude could have economical advantages both for patients and society, and more edentulous subjects would be able to benefit from less expensive implant treatment options.

Furthermore, if a single implant-retained mandibular overdenture was added to the options, more edentulous patients might be able to choose an implant treatment (18). None of the respondents to the questionnaire mentioned that alternative although internationally there are several studies with favorable results published over the last few years (2, 9, 10, 16, 18, 19, 26). Even if these papers report only short- to medium-long results, they indicate that the single-implant mandibular overdenture can be a viable alternative for patients with an edentulous mandible, especially those who are elderly and have limited

economy. It deserves to be used also in Sweden.

At a symposium on implant overdentures in 2002 it was stated, "it is time to ensure that edentulous patients worldwide benefit from implant-based denture therapy" (14, 15). This has been criticized because the great majority of the millions of edentulous people in the world belong to the poorest section of the population, cannot afford implant treatment and must rely on complete dentures (8, 22). In a rich country like Sweden the statement would be more realistic but besides economy other factors such as tradition and prejudice seem to block the way.

Conclusion

Based on the results of this study, it can be concluded that decision-making regarding implant treatment of patients with edentulous mandibles has not changed much among prosthodontists in Sweden during the last 10 years. Implant overdentures are rarely used and fixed implant-supported prostheses are still predominant.

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Oral health-related quality of life and its relationship to self-reported oral discomfort and clinical status

SUSANNE EINARSON[1], ELISABETH WÄRNBRING GERDIN[2] & ANDERS HUGOSON[1]

Abstract

◎ The impact of oral health on quality of life is one aspect when it comes to understanding the significance of oral health. The aim of this study was to analyse the self-reported oral discomfort and clinical status of individuals reporting oral problems never/very seldom affecting quality of life during the last year and compare them with individuals who reported oral problems hardly ever/occasionally or often/very often during the the same period. The study comprised a stratified random sample of 515 individuals who lived in four parishes in the City of Jönköping, Sweden, and turned 20, 30, 40, 50, 60, 70 and 80 years of age in 2003. The impact of oral health on quality of life was examined using the OHIP-14 questionnaire. The individuals were also examined clinically and radiographically. Of the participants, 21% reported no experience of impaired quality of life and 20% of the individuals reported that they had experienced impaired quality of life often or very often during the last year. The highest frequency of oral problems was found among individuals aged 20 and 80 years. Subjective symptoms, such as grinding/clenching and headache, were found among 20- and 30-year-olds. Edentulous individuals and individuals with many missing teeth, individuals with severe periodontal disease or subjective dry mouth answered that they experienced problems according to the OHIP-14 often or very often. A number of individuals, young and old, had thus experienced subjective or clinically verified oral conditions associated with a negative experience of quality of life. This complementary information will provide a deeper understanding of the importance of oral health in the population.

Key words

Epidemiology, OHIP-14, oral health, quality of life

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Oralhälsorelaterad livskvalitet och dess samband med självrapporterade orala problem och kliniskt status

Susanne Einarson, Elisabeth Wärnberg Gerdin, Anders Hugoson

Sammanfattning

◉ Inverkan av oral hälsa på livskvalitet är en aspekt för att förstå vikten av en god munhälsa. Syftet med studien var att analysera självrapporterade orala besvär och kliniskt status hos individer med inga/sällan rapporterade orala problem som påverkade livskvaliteten och jämföra dessa med individer som rapporterade orala problem nästan aldrig/tillfälligt eller ofta/mycket ofta under det senaste året. Undersökningsmaterialet bestod av ett slumpmässigt urval på 515 individer 20 till 80 år gamla. Inverkan av oral hälsa på livskvaliteten undersöktes med hjälp av ett OHIP-14 frågeformulär. Personerna undersöktes även kliniskt och radiologiskt. Av deltagarna rapporterade 21 % att de inte upplevt någon påverkan på livskvaliteten medan 20% av individerna rapporterade inverkan på livskvaliteten ofta eller mycket ofta under det senaste året. Den högsta förekomsten av orala problem återfanns bland 20- och 80-åringarna. Subjektiva symtom som tandpressning/gnissling och huvudvärk återfanns bland 20-och 30-åringar. Tandlösa individer och individer med många saknade tänder, individer med svåra parodontala skador eller subjektivt muntorra svarade att de upplevde problem ofta eller mycket ofta. Ett antal individer unga som gamla, hade således upplevt subjektiva eller kliniskt verifierade orala förhållanden associerade med en negativ inverkan på livskvaliteten. Dessa uppgifter har stor betydelse för en djupare förståelse av betydelsen av oral hälsa i populationen.

Introduction

The frequently quoted definition of health given by the World Health Organisation states that "health is a state of complete physical, mental and social wellbeing and not simply freedom from disease and disability" (26). The statement combines a disease-oriented and an holistic perspective and implies that a complete understanding of an individual's health calls for an insight into both dimensions (7,12).

It is claimed that this model is valid even within the oral health sphere (2). During the last few decades, the impact of oral health on quality of life has attracted increasing interest as one aspect of understanding the significance of oral health. The concepts of oral health have changed and theoretical models linking biological and psychosocial variables have been developed (19). A number of measurements enabling these links to be investigated have been designed and tested with the aim of extending and deepening our knowledge of the individuals' perceptions of the impact of oral problems on their daily life (16,19).

Several studies have investigated the associations between clinical characteristics and the individual's perceptions of the impact they have on quality of life (8). However, only a few studies have explored these associations in randomly selected individuals in adult populations. Some of these population studies have demonstrated associations between the number of teeth and oral health-related quality of life, measured with different questionnaires, such as the OHIP-14 (Oral Health Impact Profile) and OIDP (Oral Impact on Daily Performance) (6,9,18,23,28). Dahl et al. (9) also studied the impact of clinical caries on quality of life but found no such associations.

In an earlier paper, oral health-related quality of life was described in the present adult population, using the OHIP-14 (11). Using the sum of scores, the mean value for the entire population was 6.4 (SD = 7.1), which indicates good oral health-related quality of life (24). However, a number of individuals experienced oral problems that had an impact on their quality of life. Among these individuals, the problems occurred often or very often in two to eight per cent, depending on the dimension in the OHIP-14.

In addition to data from the OHIP-14, a large amount of data on self-reported oral discomfort and clinical status is available for the population in question. In the present study, these data are used to acquire more in-depth knowledge of problems affecting quality of life. This knowledge is essential in order to obtain an insight into and an understanding of the impact on oral health-related quality of life in the population. This deeper knowledge can guide the way dental services could be marketed and help dental caregivers to provide optimal oral care. The aim of this study was therefore to describe and compare the self-reported oral discomfort and clinical status of *i*) individuals experiencing no oral problems or experiencing problems very seldom (Category 1), with *ii*) individuals with problems hardly ever or occasionally (Category 2) and/or *iii*) individuals reporting oral problems affecting quality of life often or very often (Category 3) during the last year.

Material and methods

Sample and procedures

Inhabitants in four parishes (all in the City of Jönköping, Sweden), who turned 20, 30, 40, 50, 60, 70 and 80 years of age in 2003, were randomly selected to participate in the study. There were 130 individuals in each group; in all, 910 individuals. Everyone selected for the study received a personal invitation by letter to take part in an oral health examination. They were informed of the purpose of the investigation and invited to answer a questionnaire, including the OHIP-14. Details relating to the sampling procedure, the number of non-respondents and reasons for not taking part in the study are given elsewhere (13).

Throughout the study, the ethical rules for research as described in the Helsinki Declaration were followed. The study was approved by the Ethics Committee at the University of Linköping, Linköping, Sweden (reference no. 02-376).

Measures

The impact of oral health on quality of life was examined using the OHIP-14 questionnaire, in which the questions are divided into seven dimensions (24) (Table 1). All the questions in the OHIP-14 questionnaire began in the same way: How often have you, as a result of your *oral cavity, teeth, jaw or prostheses*, during *the past year*, experienced the following situations? Each question could be answered using one of the alternative answers, rated as follows: *not applicable to me* = non-response, *never* = 0, *hardly ever* = 1, *occasionally* = 2, *often* = 3, *very often* = 4 points. The total number of points for the OHIP-14 questionnaire (individual) was obtained by adding up the points for the individual questions (max. 56 points).

Depending on the answers, the individuals were

Table 1. The questionaire

The OHIP-14 questionnaire
Functional limitations
Question 1: *have had difficulty enunciating words?*
Question 2: *felt your taste has deteriorated*?
Physical pain
Question 3: *have had pain in your mouth?*
Question 4: *felt discomfort when eating?*
Psychological discomfort
Question 5: *felt uncertain?*
Question 6: *felt tense?*
Physical disability
Question 7: *your diet has been unsatisfactory?*
Question 8: *been forced to interrupt meals?*
Psychological disability
Question 9: *had difficulty relaxing?*
Question 10: *felt embarrassed?*
Social disability
Question 11: *been somewhat irritated with other people?*
Question 12: *had difficulty performing your daily tasks?*
Handicap
Question 13: *felt that life in general has been less satisfactory?*
Question 14: *been totally incapable of functioning?*

Table 2. Number of participants (men and women) in Categories 1, 2 and 3

Respondents:	Category 1	Category 2	Category 3
Total	109 (21%)	301 (59%)	105 (20%)
Men	60 (55%)	151 (50%)	45 (43%)
Women	49 (45%)	150 (50%)	60 (57%)
Mean age (SD)	45 (18.2)	49 (19.1)	47 (20.6)

classified into three categories: no problems = Category 1, at least one question answered with problems hardly ever or occasionally = Category 2, at least one question answered with problems often or very often = Category 3, during the last year (Table 2).

The different questions from the questionnaire and the clinical variables, used in the present study, can be found in Tables 3 and 4.

The participants were examined clinically at dental offices by one of five dentists who were calibrated in terms of the diagnostic criteria below. The radiographic examination in 20-, 30- and 40-year-olds consisted of a pantomogram and six bite-wing radiographs. For the age group of 50 years and older, a pantomogram and a full-mouth, intra-oral radiographic examination, including 16 peri-apical and four bite-wing radiographs, was carried out in dentate individuals (13).

The saliva secretion rate was measured after chewing on a piece of paraffin for five minutes. The secretion rate was expressed as ml/min. Edentulousness and the number of missing teeth were recorded (third molars were excluded). All tooth surfaces available for clinical or radiographic examination were examined for dental caries according to *Koch* (17). The total number of decayed and filled tooth surfaces (DFS) was calculated. Oral hygiene was registered as the presence of visible plaque on four tooth surfaces per tooth, according to the criteria formulated by Löe (1967) for Plaque Indices (PLI) 2 and 3 (21). The presence of gingival inflammation was registered for four gingival units per tooth, according to the criteria formulated by Löe (1967) for Gingival Indices (GI) 2 and 3 (16). Subjects were classified according to the severity of their periodontal disease experience, according to *Hugoson & Jordan* (1982) (14). Based on clinical and radiographic findings, the subjects were grouped according to *Eichner's Index* (10). The index (classified in three groups A, B and C) is based on the number of supporting zones with antagonistic contact in the premolar and molar regions. Classification C with subgroups refer to individuals with one or two edentoulous jaws. Individuals with fixed bridges were counted as "dentate", even in the regions of the bridges. The group classification has thus been based on existing gaps in the different supporting zones.

Statistical analysis

Individuals who had answered all 14 questions were compared with individuals who had answered 1-13 questions. No statistically significant difference was found between the groups. Questions from all individuals were therefore analysed. The results have been reported as mean values and frequencies. Differences in frequencies were studied using a chi^2 test. ANOVA was used when comparing Categories 1, 2 and 3, including a *post-hoc test* according to Sheffé. The significance was set at $p < 0.05$.

Results

The OHIP-14 questionnaire was answered by 515 individuals. These individuals were also examined clinically and radiographically. Of these 515, 421 participants answered all 14 OHIP-14 questions and 94 answered 1 to 13 questions .

Of the participants, 109 individuals (21%) reported no oral problems (Category 1), 301 (59%) reported occasional oral problems (Category 2) and 105 (20%) reported oral problems having an impact on daily life often or very often (Category 3). The number of participants, gender and mean age distribution are presented for the three categories in Table 2.

In Figure 1, the participants (%) are presented according to age and category (Categories 1, 2 and 3). The highest frequency of individuals with no experience of impaired quality of life (Category 1) was found among 30-year-olds (31%). The highest frequencies of individuals with severe experience (Category 3) were found among 20- and 80-year-olds (28%). Among 80-year-olds, 12% of the individuals had had no negative experience of quality of life because of their mouths.

In Figure 2, the distribution of the different answers to the questions in the OHIP-14 questionnaire from individuals in Category 2 (n=301) are presented for men and women. The distribution of the different answers from individuals in Category 3 (n=105) are presented in Figure 3.

Categories 2 and 3 have some results in common. For both categories, oral problems most frequently affected the dimension of "Psychological disability", especially the ability to relax (question 9) (47%). Moreover, in both categories, the question *I have been totally incapable of functioning*, dimension Handicap, obtained the lowest frequency of answers (5-7%).

For individuals in Category 2, oral problems caused pain (question 3) in the same percentage (47%) as inability to relax. For individuals in Category 3, the dimension of psychological discomfort, especially feeling uncertain (question 5) and feeling tense (question 6), obtained the second highest frequency of answers (total 31% and 32%).

In Tables 3 and 4, the individuals in Category 3 are described according to age, self-reported oral discomfort given as answers in the questionnaire or according to clinical status. Almost half the respondents in Category 3 (46.2%) were dissatisfied with their teeth. Around one third experienced grinding/clenching (36.5%), had subjective dry mouth (30.5%) and were daily smokers (29.5%). A quarter (25%) reported having a headache. Grinding/clenching was more frequently reported by 20- and 30-year-olds (55% and 60% respectively). The frequency of individuals experiencing subjective dry mouth was highest in the 50- to 80-year age groups (23-62%). Edentulous individuals and individuals with severe

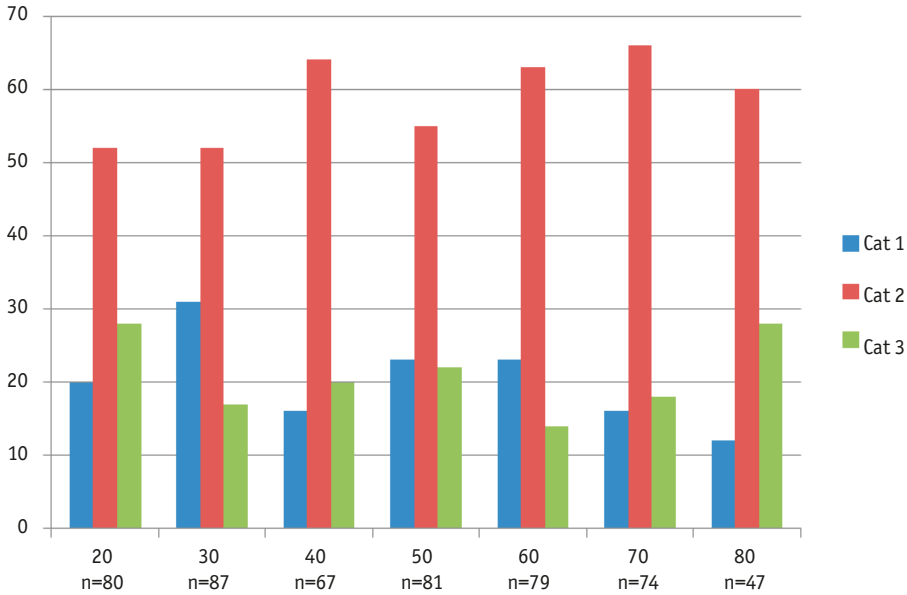

Figure 1. Frequency (%) of participants distributed in age groups and Categories 1, 2 and 3.

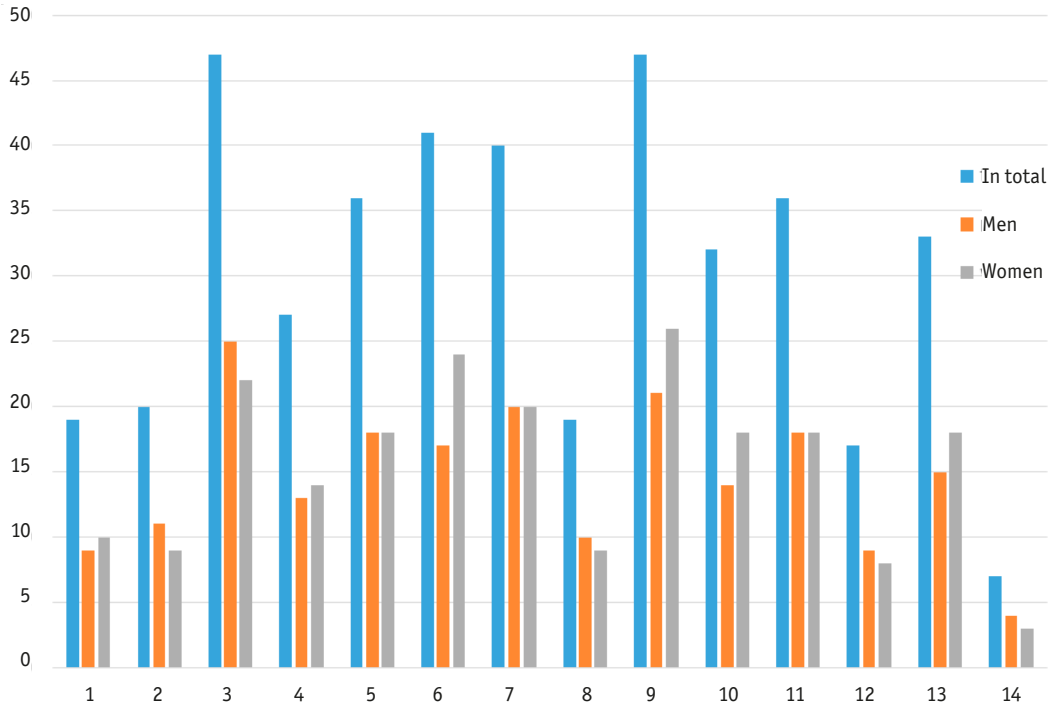

Figure 2. Frequency (%) of participants belonging to Category 2 (n=301, 151 men and 150 women) distributed according to their answers to each question in the OHIP-14 questionnaire.

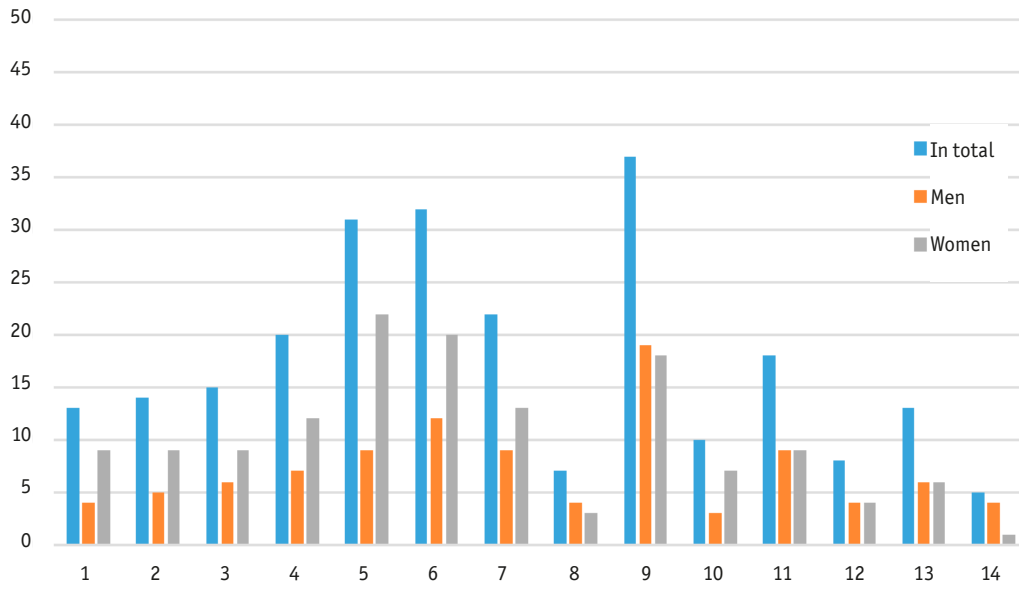

Figure 3. Frequency (%) of participants belonging to Category 3 (n=105, 45 men and 60 women) distributed according to their answers to each question in the OHIP-14 questionnaire.

Table 3. Differences between Categories 1, 2 and 3 as regards answers to questions from the larger questionnaire and clinical and radiographic variables examined. Significance level p = < 0.05

Variable	Category 1	2	3	1-2	1-3	2-3	Chi-2
Questions	**n=109**	**n=301**	**n=105**				
1. Dissatisfied with teeth (%)	5.5	15.9	46.2				p<0.010
2. Hurt when chewing (%)	0.9	3.7	23.3				p<0.010
3. Hurt when opening mouth (%)	3.7	3.0	13.3				p<0.010
4. Grinding/clenching (%)	16.5	20.5	36.5				p<0.010
5. Subjective dry mouth (%)	6.4	9.7	30.5				p<0.010
6. Daily smoker (%)	13.0	14.3	29.5				p<0.010
7. Itching or burning (%)	0.9	0.3	17.3				p<0.010*
8. Difficult to open mouth (%)	5.6	2.7	13.5				p<0.010
9. Pain on jaw movements (%)	0.9	1.7	8.6				p<0.010*
10. Headache (%)	5.5	9.4	25.0				p<0.010
11. Aphte (%)	2.8	2.3	2.9				ns
12. Herpes simplex (%)	2.8	0.7	1.0				ns
13. Lichen planus (%)	1.8	0.3			1.0		ns
Clinical variables							
14. Saliva secretion (mean)	1.6	1.6	1.4	ns	ns	ns	
15. Edent. yes (%)	0.9	3.0	7.6				p<0.010*
16. Part. yes (%)	1.8	4.7	7.6				ns
17. Missing teeth (mean)	1.7	3.3	5.2	0.010	0.010	0.005	
18. Eichner's Index (%)							p<0.010*
a. Index A (%)	90.8	81.7	69.9				p<0.010
b. Index B (%)	8.3	15.7	22.3				p<0.020
c. Index C (%)	0.9	2.7	7.8				p<0.020
19. DFS (mean)	30.4	35.1	31.4	ns	ns	ns	
20. GI (mean)	14.5	13.3	16.7	ns	ns	ns	
21. PLI (mean)	19.3	17.4	22.0	ns	ns	ns	
22. Severe periodontal disease (%)	2.1	12.0	20.0				p<0.010

*Due to low expected frequences, Categories 1 and 2 were dichotomised into one category in the chi-2 test

periodontal disease among those who experienced problems often or very often were found among individuals who were 60 years and older.

In Table 3 Categories 1, 2 and 3 are compared with reference to self-reported oral discomfort given as answers in the larger questionnaire or according to clinical status. Significantly higher frequencies were found in Category 3 for all data associated with self-reported discomfort from the oral cavity, used in the present study, apart from having aphte, herpes simplex and lichen planus.

Statistically significant differences between the categories were also found for the clinical variables of edentulousness, missing teeth, classification A, B and C on the *Eichner Index* and severe periodontal disease experience. These symptoms were found at a higher frequency among subjects in Category 3 when compared with the other categories. Saliva secretion did not differ between the categories and this was also the case with dental caries (DFS), gingival inflammation (GI) and oral hygiene (PLI).

Discussion

This study shows that oral problems have a major impact on the psychological dimensions of oral health-related quality of life, measured by the OHIP-14. These results are in agreement with the study of oral health-related quality of life among adults aged 68-77 years performed in Norway, where psychological discomfort and psychological disability were the most frequently reported problems affecting quality of life (9). Furthermore, the results strengthen the theory that a complete understanding of an individual's oral health calls for an insight into both a disease-oriented and an holistic dimension. The degree of oral health-related quality of life has no

Table 4. Number (%) of participants, distributed in age groups 20-80 years, who had experienced impaired quality of life often or very often in the last year (Category 3) and their symptoms given as answers in the larger questionnaire and according to the clinical and radiographic examination

Age groups (n/age groups)	20 (22)	30 (15)	40 (13)	50 (18)	60 (11)	70 (13)	80 (13)
Questions							
1. Dissatisfied with teeth	6 (27)	10 (33)	8 (61)	8 (44)	4 (36)	5 (38)	7 (54)
2. Hurt when chewing	2 (10)	4 (26)	7 (54)	4 (22)	1 (10)	2 (15)	4 (31)
3. Hurt when opening mouth	3 (14)	1 (7)	3 (23)	2 (11)		2 (15)	3 (23)
4. Aware of grinding/clenching	12 (55)	9 (60)	5 (38)	3 (16)	4 (36)	3 (23)	2 (15)
5. Subjective dry mouth	2 (10)	4 (26)	2 (15)	8 (44)	5 (45)	3 (23)	8 (62)
6. Daily smoker	9 (41)	2 (13)	5 (38)	5 (28)	5 (45)	2 (15)	3 (23)
7. Itching or burning	2 (10)	3 (20)	1 (8)	3 (16)	2 (18)	3 (23)	4 (31)
8. Difficult to open mouth	3 (14)		1 (8)	4 (22)		2 (15)	4 (31)
9. Pain on jaw movements	2 (10)			2 (11)	1 (10)	1 (8)	3 (23)
10. Headache	11 (50)	3 (20)	2 (15)	5 (28)	2 (18)	1 (8)	2 (15)
11. Aphte	2 (10)			1 (5)	1 (10)		
12. Herpes simplex				1 (5)			
13. Lichen planus					1 (10)		
Clinical variables							
14. Saliva secretion							
15. Edent. yes %					2 (18)	3 (23)	3 (23)
16. Part. yes %				2 (11)	1 (5)	2 (15)	3 (23)
17. Missing teeth	1	1	2	3	10	11	13
18 Eichner's Index							
a. Index A	22 (100)	15 (100)	11 (85)	14 (78)	5 (45)	4 (31)	1 (7)
b. Index B			2 (15)	3 (16)	4 (36)	6 (46)	8 (62)
c. Index C					1 (10)	3 (23)	4 (31)
19. DFS	8.8	16.3	29.9	42.3	43.7	47.2	47.0
20. GI	11.7	29.1	18.1	18.7	14.4	15.2	10.3
21. PLI	11.6	30.2	28.8	25.1	21.0	18.5	22.9
22. Severe periodontal disease (%)		2 (13)	2 (15)	4 (22)	5 (45)	3 (23)	5 (38)
23. Oral status (%)	1 (5)	2 (13)	4 (31)	7 (39)	6 (55)	5 (38)	8 (62)

association with clinical data such as dental caries, gingival inflammation and oral hygiene.

Most of the edentulous individuals, individuals with many missing teeth and individuals with severe periodontal disease answered that they experienced impaired quality of life often or very often. As regards missing teeth or periodontal disease, the results of the present study are in agreement with the results of epidemiological studies performed in Norway, Great Britain, Brazil and Sweden, where missing teeth and periodontal disease were negatively associated with quality of life (4,5,6,9,25). However, it is interesting that the same oral situation can be regarded so differently, e.g. edentulous individuals were found in all categories (7,12 and 26), which means that, for some people, edentulousness did not influence their quality of life, whereas it obviously did so for other people with the same oral status. The same situation could also apply to people with herpes simplex and/or aphte, depending on the severity of the disease.

With regard to dental caries and restorations, gingivitis and plaque, no statistically significant differences could be found between categories of individuals. This is in agreement with other studies of associations between quality of life and clinical caries (8).

It is interesting to note that individuals experiencing impaired quality of life are found not only among old people with few teeth but also among young people. However, the problems have quite

another dimension in the different age groups. The high figures among 20-year-olds for headache once a week are alarming. There is no definite diagnosis for headaches and there can be several reasons for them. However, recent reports have shown a relationship between stress and headache and an increase in orofacial pain symptoms that can be seen in the same connection (25), especially among women. These symptoms can result in physical pain or psychological discomfort of importance for quality of life.

As regards awareness of oral parafunctions such as grinding/clenching among 20- and 30-year-olds, the results of the present investigation are in close agreement with the results presented by *Agerberg & Inkapool* (1) and *Anastassaki-Köhler et al.* (3). Furthermore, subjects in the oldest age groups were less frequently aware of bruxism than younger individuals, which also concurs with previous publications (22,29).

Subjective dry mouth was associated with reduced quality of life, which is not surprising in view of the complex function of saliva. However, it is interesting to note that no differences were seen between the three categories in terms of saliva secretion. The highest figures for subjective dry mouth were found in the 50- to 80-year age groups. Subjective dry mouth was especially associated with oral health-related quality of life measured as "have had difficulties enunciating words" and "felt that my taste has deteriorated". These results are in agreement with the results of other studies (15,20,27).

Data from epidemiological studies can be used to illustrate a number of important issues. The results of the present study have been used to provide a broad description of the oral status of individuals reporting oral problems affecting their quality of life often or very often. In many respects, statistically significant differences were found compared with individuals with seldom reported or no oral problems.

The present study is based on a random sample of a Swedish population aged 20 to 80 years. The study population consisted mainly of Swedish-born individuals; about 10% were immigrants (13). One important question is whether the study population can be regarded as representative of a population larger than that studied. The conclusion is that, when comparing the result of the present study with those of other similar epidemiological studies performed in Sweden during about the same time interval, no important differences in clinical variables were found (13). It is therefore reasonable to suppose that the results of the present study could have a broader application.

In epidemiological studies where the variables are presented as mean values, a minority of the population with a higher disease prevalence than the rest of the population will always be present and undetected. In the present study, many of the results are presented as frequencies, which will minimise this effect. However, in some of the questions and the clinical variables, the frequency of numbers is small and caution about drawing conclusions should therefore be shown in these cases. It is also important to consider that only associations between studied variables have been found and they should therefore not be interpreted as evidence of a causal relationship. In conclusion, this study indicates that using measurements of the impact of oral health on quality of life in combination with a clinical examination will provide valuable complementary information and a deeper understanding of the importance of oral health in a population.

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Detectability of normal anatomy in digital panoramic radiographs

HEIDI GROSS[1], MATS NILSSON[2], KRISTINA HELLÉN-HALME[2]

Abstract

◎ The aim of this study was to evaluate the image quality of digital panoramic radiographs and its correlation with the detectability of normal anatomical structures. The effects of image enhancement on the detectability were also studied.

A total of 500 panoramic images (DICOM format) obtained with a storage phosphor-based digital system were evaluated. The image quality and the detectability of selected normal anatomical structures were evaluated in all images. Images with inadequate image quality were subjected to enhancement after which the detectability of the structures was re-evaluated.

Only 9% of the images were classified as having adequate technical quality. The main sources of poor image quality were that the patient's tongue was not held against the palate and incorrect positioning of the patient. Not holding the tongue against the palate was found to have a negative impact on the detectability of maxillary structures. Of the images with horizontal positioning errors the patient's head was rotated to the left in 81% (70 images). The most effective form of enhancement was a combination of increased contrast and decreased brightness. Images in which the tongue was not held against the palate were partially improved, whereas images with positioning errors remained unaffected by this enhancement.

In conclusion, most of the panoramic images showed some technical flaws. The marginal bone level and the maxillary area were the most difficult areas to reproduce. Retakes could be avoided in some cases by using image enhancement. However, this should not be regarded as an option to avoid poor image quality.

Key words

Dental digital radiography, image quality enhancement, panoramic radiography

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Normalanatomi i digitala panoramaröntgenbilder

HEIDI GROSS, MATS NILSSON, KRISTINA HELLÉN-HALME

Sammanfattning

◎ I studien utvärderades bildkvaliteten hos digitala panoramaröntgenbilder och dess samband med synbarheten av normalanatomiska strukturer i bilderna. Påverkan av subjektiv bildbehandling med avsikt att förbättra synbarheten av strukturerna undersöktes.

Totalt 500 panoramaröntgenbilder (DICOM-format) framtagna med ett digitalt bildplattesystem utvärderades. Bildkvaliteten och synbarheten av utvalda normalanatomiska strukturer utvärderades i samtliga bilder. Vid bristande bildkvalitet gjordes en subjektiv bildbehandling varefter en ny utvärdering gjordes.

Enbart 9 % av samtliga bilder var optimala. Felen bland de resterande bilderna dominerades av att patienten inte höll tungan mot gommen och positioneringsfel. Av alla bilder med horisontell rotation var 81 % (70 bilder) roterade till vänster. Den mest effektiva kombinationen vid bildbehandling i studien visade sig vara ökad kontrast och minskad ljusstyrka vilket förbättrade bilder där tungan inte hade varit mot gommen under bildtagningen. Bilder med positioneringsfel var dock opåverkade av bildbehandling.

Sammanfattningsvis visade det sig att de flesta panoramabilderna innehöll tekniska fel. Marginala bennivån och överkäksregionen var svårast att avbilda. Omtag kunde undvikas i vissa fall genom bildmanipulering. Detta ska dock ej anses vara ett alternativ för att undgå bristfälliga avbildningsprocedurer och därmed bristfällig bildkvalitet. Det bästa sättet att utöva bättre panoramabildtagning är genom att noga följa instruktioner för bildtagning och ha kunskap om teknikens svagheter vad gäller avbildning.

Introduction

Panoramic radiographic imaging is a helpful tool in dentistry, giving an overall view of the maxillofacial area. However, the technique has some inherent shortcomings associated with the reproduction of specific structures. As a dentist it is important to be aware of these shortcomings in order to ensure good image quality. To obtain the best possible results, and thus avoid retakes, it is important to follow the guidelines for imaging carefully. This involves careful positioning of the patient and correct settings on the imaging unit. It has been reported previously that panoramic images do not always have the required quality (8, 13, 18). According to Gijbels et al. (9) the most common defects are blurring and overlapping structures. These directly influence the detectability of diagnostically important structures and thus the possibility of detecting pathological changes. In a recent study by *Ekströmer & Hjalmarsson* it was concluded that panoramic images showed many different errors (8). However, this did not greatly affect the diagnostic usefulness of the image due to the ability to enhance the image.

Previous studies have mostly been carried out using analogue film (3, 12, 14-17, 19). Digital techniques offer many useful functions, not available when using conventional film, one of which is the possibility of enhancing and modifying images digitally to improve the perception of the structures in the image. Digital images can be modified in several different ways, e.g. enhancement using algorithms on a theoretical level, or through subjective image enhancement using manual manipulation. *Hellén-Halme et al.* (11) investigated the level of understanding and use of digital radiography in general dental practices in Sweden, and found poor quality in both areas. They concluded that general dental practitioners must undergo further training in digital radiographic techniques in general, and particularly to avoid the kinds of problems that can occur in practice (11). Software-based methods of enhancement make it even more difficult for the staff operating the imaging systems to understand image processing and its effect on the image and the structures reproduced.

Few studies have been carried out exclusively on digital panoramic radiography (1, 5, 8). The aim of the present study was therefore to evaluate the image quality of digital panoramic radiographs and to investigate how it affects the detectability of normal anatomical structures. The effects of image enhancement on the detectability were also studied.

Material and methods

A total of 500 panoramic images from the year 2005 (DICOM format) (6, 7) were selected from an unsorted and anonymized database. Every second image was selected from the database. The images had been produced at the Faculty of Odontology, Malmö University (Malmö, Sweden) using a Cranex III panoramic unit (Soredex, Tuusula, Finland) and storage phosphor plates (Dürr Dental AG, Bietigheim-Bissingen, Germany). The VistaScan Plus scanner (Dürr Dental AG, Bietigheim-Bissingen, Germany) used to scan the storage phosphor plates was operated at 5 lp/mm, according to the manufacturer's recommendations. The database included images with a normal (adult) and a smaller (child) field of view (FOV). The temporomandibular joints (TMJs) were intentionally not included in the smaller-FOV images in order to reduce the irradiation of the patient. Since the images were anonymized, it was not possible to determine whether the use of the normal or smaller FOV was based on age or indication.

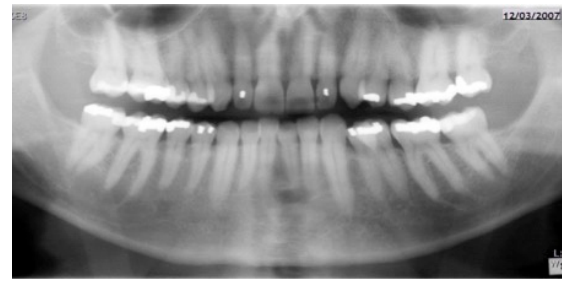

Figure 1. An image with a small FOV.

All images were evaluated in a viewing room with a maximum ambient illuminance of 50 lux (2) on a Barten-calibrated (4), 18 inch Barco MFGD 1318 (LCD) monitor (Barco N.V., Kortrijk, Belgium) using the same monitor display settings throughout the evaluation procedure, with an average luminance of 141 cd/m2 (range 138-147 cd/m2). The images were displayed with the software Synedra View (Synedra IT GmbH, Innsbruck, Austria). The observer was a dental student in their final year of studies, with some training in panoramic radiography. The first fifty images were evaluated together with a specialist in oral and maxillofacial radiology. The specialist was consulted when in doubt as to how an image should be evaluated.

Technical image quality ("first evaluation")

The images were evaluated using the criteria *acceptable* or *unacceptable* (10)

Patient setup
Acceptable:
– The patient was correctly placed in the panoramic unit, so that all structures were imaged, the teeth proportions were correct, and/or no local sharpness degradation was observed.
– The tongue was held against the hard palate.
– The chin had to be included.
– No patient-related artifacts in the image.
– In the images with a normal FOV, the TMJs had to be included.

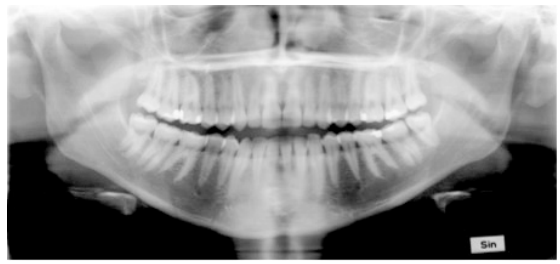

Figure 2. An image with a normal FOV, showing an example of an image with optimal technical quality according to the criteria used in the study.

As images with a smaller FOV did not include the TMJs the demand on imaged TMJs was excluded in the assessment of these images.

Unacceptable:
– Structures were outside the image. The teeth proportions were incorrect and/or local sharpness degradation was observed due to the patient being incorrectly positioned in the imaging unit.
– The tongue was not held against the palate.
– The chin was not included.
– The spinal column was not extended.
– Patient-related artifacts, such as ghost shadows (due to foreign, radiopaque objects).
– The TMJs were not imaged in the images with normal FOV.

Figure 3. An image in which the patient did not hold his or her tongue against the palate, and with a vertical positioning error.

Table 1. Protocol for the evaluation of technical image quality

Parameter	
Chin included	Yes/No
Tongue held against palate	Yes/No
Spinal column extended	Yes/No
Sagittal position	Anterior/centered/posterior
Horizontal position	Rotated right/centered/rotated left
Vertical position	Head downwards/centered/head upwards
Right TMJ included	Yes/No
Left TMJ included	Yes/No
Artifacts	Yes/No

The evaluation protocol is presented in Table 1.

Sharpness
Acceptable: Generally sharp image.
Unacceptable: The image was blurred due to movement of the patient during exposure

Contrast
Acceptable: Periapical and marginal structures were visible.
Unacceptable: The image had generally too low or too high contrast.

Brightness
Acceptable: Periapical and marginal structures were visible.
Unacceptable: The image was generally too dark or too bright.

Images in which all the above-mentioned criteria were rated as *acceptable* are referred to below as images with *optimal technical quality*.

Detectability of anatomical structures ("second evaluation")
The detectability of specific normal anatomical structures was assessed qualitatively using a three-point scale: *(1)* definitely visible, *(2)* possibly visible, and *(3)* definitely not visible. Each anatomical structure/region was observed separately. The following anatomical structures were assessed:
– the inferior and anterior borders of the maxillary sinus
– the mandibular canal
– the mental foramen
– the marginal bone level
– apical structures
– the inferior border of the nasal cavity
– the mandibular collum.

When teeth were missing the loss of structures were accounted for in the evaluation. Images in which all the above mentioned normal anatomical structures were rated 1 (definitely visible), are referred to below as images with *optimal detectability*.

The four most common causes of poor image quality identified in the evaluation of the technical image quality were chosen for further investigation using image enhancement.

Image enhancement ("third evaluation")

Images in which anatomical structures were rated as 2 or 3 were subjected to a third evaluation. The images were digitally enhanced by varying the contrast and/or brightness in an attempt to improve the detectability of the anatomical structures. The structures were assessed in the same way as in the second evaluation.

Results

A normal FOV was found in 226 images, and the smaller FOV in 274 images. Optimal image quality was only found in 47 of the 500 images (9%): 27 of those with a normal FOV (12%) and 20 of those with the smaller FOV (7%). At least one of the quality criteria was not fulfilled in 455 of the images (91%).

Technical image quality ("first evaluation")

The most common problems were: 1) the chin was not imaged, 2) the tongue was not held against the palate, 3) horizontal rotation of the head to the left, 4) vertical misplacement, with the head tilting downwards, and 5) low brightness. These findings are summarized in Table 2.

Detectability of anatomical structures ("second evaluation")

Optimal detectability of anatomical structures was found in 34 of the smaller-FOV images (12%) and in 38 of the normal FOV images (17%). Among the smaller-FOV images with optimal detectability, 3/34 were also assessed as having optimal image quality, while at least one imaging quality criterion was rated as unacceptable in the remaining 31. When the requirement of an imaged chin was excluded, 14 of these images had an optimal imaging quality. Among the normal FOV images with optimal detectability, 8/38 were assessed as having optimal image quality, while in the remaining 30 at least one image quality criterion was rated as unacceptable. Table 3 summarizes the results regarding the detectability of the normal anatomical structures studied.

Table 2. Causes of poor image quality in 500 digital panoramic radiographic images

Cause	Number	Fraction
Chin not in image	287	57%
Tongue not held against palate	277	55%
Left TMJ not in image	44	9%
Right TMJ not in image	27	5%
Spinal column not extended	2	0%
Artifacts	5	1%
Horizontal positioning error, rotation left	70	14%
Vertical positioning error, head tilted downwards	49	10%
Vertical positioning error, head tilted upwards	41	8%
Sagittal positioning error, posterior	28	6%
Horizontal positioning error, rotation right	17	3%
Sagittal positioning error, anterior	13	3%
Low brightness	67	13%
High brightness	33	7%
Low contrast	20	4%
High contrast	1	0%
General sharpness degradation	0	0%

The three main causes of poor image quality selected for further investigation were: the tongue not being held against the palate, horizontal rotation to the left, vertical misplacement with the head tilting downwards, and the chin not being imaged.

In 55% of the images (277) the patient's tongue was not held against the palate during exposure, while the maxillary marginal bone was definitely visible in 163/277, i.e. in 59%. In images where the tongue was held against the palate (223), the maxillary marginal bone was definitely visible in 178 images, i.e. 80%. The maxillary apices were definitely visible in 57% (right), 38% (front) and 54% (left) of the images in which the tongue was not held against the palate, compared to 75% (right), 52% (front) and 70% (left) of the images when the tongue was held against the palate.

In 14% of the images (70/500), the patient was placed asymmetrically, slightly rotated to the left in the panoramic unit, while rotation to the right was found in 3% (15/500) of the images.

The predominant vertical positioning error, with the patient's head tilted downwards, was seen in 10% of all the images (49/500). In 36 of these 49 images (74%), the extremity of the chin was not depicted. In images without this particular vertical positioning error, the extremity of the chin was missing in 59% (251/500). In the images with a normal FOV, the

Table 3. Number of images in which certain normal anatomical structures were detectable

Anatomical structure	Score				
	1	2	3	0	L
Inferior/anterior border of maxillary sinus, right	467	29	0	4	-
Inferior/anterior border of maxillary sinus, left	461	34	1	4	-
Mandibular canal, right	435	56	5	4	-
Mandibular canal, left	442	51	3	4	-
Mental foramen, right	416	41	38	5	-
Mental foramen, left	437	30	33	0	-
Maxillary marginal bone level	341	131	27	0	-
Mandibular marginal bone level	289	16	2	0	-
Maxillary apical structures posterior to the canines, right	454	24	0	0	22
Maxillary apical structures, front	258	224	8	0	10
Maxillary apical structures posterior to the canines, left	447	29	0	0	24
Mandibular apical structures posterior to the canines, right	327	134	4	0	35
Mandibular apical structures, front	221	217	29	1	32
Mandibular apical structures posterior to the canines, left	305	146	9	0	40
Inferior border of the nasal cavity	421	58	6	15	-
Mandibular collum, right	224	19	3	254	-
Mandibular collum, left	217	21	3	259	-

Detectability: 1- definitely visible, 2 - possibly visible, 3 - definitely not visible.
0 indicates that the structure was outside the image.
L indicates regions in the alveolar bone which were

TMJs were not depicted in 12% of those with this vertical positioning error (6/49). In the 451 images without this vertical positioning error, only 3% did not show the TMJs in images.

Image enhancement ("third evaluation")

Out of the 500 images assessed, 61% (305) were re-evaluated using subjective image enhancement. Eighty-five images did not require image enhancement and 110 had technical flaws that made them unsuitable for image enhancement (e.g., local sharpness degradation or positioning errors).

The visibility of the maxillary marginal bone level improved to be definitely visible in additional 54 images (improvement of 21%) The maxillary apical structures were definitely visible in an additional 74 images (improvement of 27%) for structures to the right, 35 images (improvement of 23%) for structures in the front, and 97 images (improvement of 35%) for structures to the left. The visibility of structures such as the mandibular apical structures was reduced by 59 images (impairment of 27%) for the structures to the right and by 65 images (impairment of 31%) for the structures to the left.

The most successful combination of parameters was increased brightness and decreased contrast, leading to improved detectability in 131 of the 305 images (improvement of 43%). The visibility of the maxillary marginal bone level improved to definitely visible in an additional 26 images (improvement of 22%). The maxillary apical structures became definitely visible in an additional 29 images (improvement of 37%) for the structures in the front and 20 images (improvement of 20%) for the structures to the left. The visibility of structures such as mandibular apical structures to the left was reduced by 10 images (impairment of 8%).

Discussion

Panoramic radiography has many intrinsic sources of error due to the complex superposition of anatomical structures, but it is still a valuable tool for dentists. The quality of the image is very dependent on correct patient alignment. The results of a previous study (11) revealed that digital techniques are often not fully understood by the user, resulting in images of poor quality.

The evaluations presented in this study were made by a dental student with limited training in panoramic radiography, but since the purpose of this study was not to investigate diagnostic accuracy, limited experience was not considered to be a problem. The choice of anatomical structures together with the close contact with a specialist in oral radiology, make the findings of this study reliable. However, the difficulty in determining whether an image has a normal FOV or a smaller FOV may cause inaccurate classification of some images.

Only 9% of the images in this study were found to be of optimal image quality. The most common problem was that the patient had not held his or her tongue up against the palate during exposure. The effect was that the detectability of anatomical structures in this area was impaired. This is in agreement with the findings in previous studies (1, 5, 8). It was mostly the maxillary bone level that not could be properly analyzed due to the dark spot from the air space between the tongue and the palate. Some of

these images also had the problem with low brightness level which could contribute to inferior image quality. In addition, a vertical positioning error resulted also in lower detectability of the marginal bone level caused by overlapping of the crowns in premolar and molar regions.

Another major source of positioning error was that many patients were positioned with a minor rotation of the head to the left. One possible explanation of this could be distraction of the patient, for example, a window in the screening room. Another, rather frequent problem was downward tilting of the head, which meant that the image often did not include both TMJs in images with a normal FOV. The above is clear evidence that it is difficult to position the patient correctly, and that this problem should be addressed.

The combination of increased brightness and decreased contrast was found to be the most effective form of enhancement and was particular useful for images where the tongue was not held up against the palate and/or the image was rated as having low brightness. However nearly a quarter of the images in this study showed that some structures had inadequate detectability and were not improved by subjective image enhancement. This was not in correlation with a recent study (8) that concluded that the major part of images with errors could be corrected by enhancement possibilities. In this study some images suffered from sharpness degradation, saturation or underexposure, which all led to extensive loss of information. These defects could be the result of positioning errors (outside the focal trough) or incorrect X-ray tube voltage setting in relation to the size of the patient, deviating anatomy in relation to the image field, and alternative angulation, positioning/location of the teeth

In conclusion, most of the panoramic images showed some technical flaws. The marginal bone level and the maxillary area were the most difficult areas to reproduce. Retakes could be avoided in some cases by using image enhancement. However, this should not be regarded as an option to avoid poor image quality.

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Abstracts

of free communications and posters presented at the 50th Annual Congress of the Swedish Dental Society, Stockholm, November 13–15, 2014

PHOTO: ANNA RUT FRIDHOLM

Professor Tord Berglundh was awarded The Bensow Prize for excellence in research at the 50th congress of the Swedish Dental Society 2014. The prize ceremony was headed by Professor Gunilla Klingberg, President of the Swedish Dental Society

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Oral health status of a male Swedish prison population

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Aim:
The aim of this study was to describe the oral health status, the frequency of risk factors related to oral health and the self-perceived oral health of a male Swedish prison population.

Materials and Methods:
The sample consisted of 186 inmates admitted to Fosie prison in Malmö March 2012 - March 2013. A further 215 individuals restricted to high security department or being non-Swedish citizens were excluded. A clinical oral examination and a face-to-face interview were carried out in order to collect information on DMFT, CPI, oral health related risk factors and self perceived oral health.

Results:
The DMFT for the prison population was similar to the DMFT of an adult male Swedish population of the same age. However in the prison population the DMFT was largely made up with DT and MT components with the FT component only contributing to a lesser extent. Gingivitis was common but periodontal disease was seen only in a quarter of the sample. Risk factors for oral disease were commonly found among the inmates with a majority being smokers and more than half of the group reported daily drug use. Daily consumption of cariogenic foodstuffs between meals was reported by a majority of the inmates. Half the population reported mental discomfort or illness. A majority of the studied population reported low utilisation of dental services. 73 % were dissatisfied with their dental status with the most common reason being appearance and missing teeth. Only 11 % of the inmates had an incarceration time above 24 months, which is the limit for entitlement to dental treatment (except emergency) during sentence execution.

Conclusion:
These results indicate a high prevalence of untreated oral disease and oral health risk factors in the sample. It can be postulated that the incarceration period would offer an opportunity to treat ongoing oral disease and promote oral health. However, the present regulations are not facilitating this for the majority of the inmates.

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Patient satisfaction 10 years after dental implant therapy. A questionnaire study

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Aim:
The aim of this study was to investigate patient's perception of their dental implants 10 years after therapy.

Materials and Methods:
After identifying 599 patients receiving dental implant treatment between 1999 and 2005 at the Specialist Clinic of Periodontology and Prosthetic dentistry at Skanstull, Stockholm County Council, a questionnaire was send by post to 520 patients, 79 patients had deceased before the study was performed. The questionnaire consisted of 28 statements or questions. In 23 of the questions they got to grade how much they agreed with a statement by fixed answers and 5 of the questions were designed with a modified visual analogue scale (VAS) where participants were free to mark their answers on a straight line.

Results:
In total 400 individuals (79%) responded to the questionnaire. The mean time elapsed since implant installation was 10.0 years (range 8-14). The mean of self-reported number of dental implants and teeth was 2.8 and 19.6 respective. A great majority experienced a high chewing comfort without any difference according to comfort between their teeth

and implants. Ninety-two percent was satisfied or enough satisfied with the aesthetic of their implant restorations. Most of the subjects (62%) found that they manage to clean their teeth, yet nearly half of the patients (47 %) have noticed bleeding when they were cleaning their teeth/implants. Thirty-two percent of the individuals had experience of problems with their implants, one third of them reported multiple problems with their implants. One of 10 patients with complications stated that it was unfortunately not possible to resolve their problems. The disadvantage that patients remarked on was the costs of the treatment. Those who have experienced problems with their implants were also less satisfied with the treatment.

Conclusion:
Ten years after treatment with dental implants, the patients experience a high degree of satisfaction in terms of most aspects. One third of the participants reported having experienced complications with their implants. Therefore, it is vital that we as therapists inform the patient that dental implant therapy is not maintenance free and that complications may arise.

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3

Salivary antimicrobial peptide profile

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Aim:
Individual antimicrobial peptides (AMPs) affect the susceptibility of several infectious as well as autoimmune diseases, including periodontitis; however the relative importance of different AMPs is unknown. Through selective reaction monitoring mass spectrometry (SRM-MS) we are able to quantify all salivary AMPs simultaneously. The aim of this study is to investigate the whole human salivary AMP-profile. In the current pilot study we investigate the AMP-profile in periodontally healthy and diseased subjects.

Materials and Methods:
1000 subjects representative of the population of Skåne County in Sweden were selected. Out of these, 451 subjects underwent a full-mouth periodontal examination, including radiographs, and provided saliva samples. Data are available for 57 subjects and included in the present pilot study. Whole saliva was centrifuged. The peptides of the AMP-profile were quantified using multiplex SRM-MS. 340 amino acid sequences targeting 117 AMPs were selected for the assay. ANCOVA analysis in SPSS was used for comparing means, PolySNAP clustering software for the unsupervised cluster analysis.

Results:
57 subjects were included in a pilot study out of which 24 had periodontitis and 33 were periodontally healthy, 35 were smokers and 10 subjects had diabetes. Out of the 117 AMPs included in the SRM-MS assay 63 were detected in saliva and 10 were differentially expressed in periodontitis versus healthy, adjusting for age, sex, diabetes and smoking ($p<0.05$). Out of the differentially regulated AMPs in periodontitis the top up-regulated where S100 proteins A8 and A9, lactoferrin, alpha defensin 1, myeloperoxidase, eosinophil peroxidase and cathelicidin. Bactericidal/permeability-increasing-fold containing family peptide B3 was attenuated in periodontitis. The AMP data was clustered in an unsupervised fashion resulting in 4 groups. Periodontally healthy were overrepresented in group 1, non-smokers in group 2 and periodontally diseased subjects were overrepresented in group 3.

Conclusion:
Out of the differentially regulated AMPs in periodontitis the top up-regulated where granulocyte associated, but also peptides associated with autoimmune dermal diseases. The attenuated peptide is poorly characterized, but has structural similarities with peptides that neutralize LPS and exert bactericidal effects.

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Chemokines in periodontitis

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Aim:
Periodontitis (PD) is a chronic inflammatory disease of tooth supporting tissues resulting in tissue destruction and ultimately loss of teeth. Unfortunately, there are no serologic biomarkers for the diagnosis of periodontitis thus disease is detected only when obvious tissue destruction has occurred. The aim of this study was to map chemokine levels in serum from PD-subjects and healthy controls. Moreover, to investigate if chemokines are detectable in gingival tissue and to study chemokine expression and regulation in gingival fibroblasts.

Materials and Methods:
Serum from 43 PD subjects and 41 periodontally healthy controls was analyzed for a spectrum of chemokines using multiplex ELISA. We evaluated the presence of chemokines and the amount in inflamed gingiva from PD subjects using immunohistochemistry stainings and ELISA. Human gingival fibroblasts were stimulated by the pro-inflammatory cytokines TNF-α and IL-1β and gene expression was analysed by qPCR and protein expression using ELISA. Pharmacological inhibitors of NF-κB were used to study intracellular signaling pathways.

Results:
Multivariate partial least squares (PLS) modeling identified serum levels of the chemokines monocyte chemoattractant protein-1 (MCP-1) and eotaxin as strongly associated with PD along with C-reactive protein (CRP), years of smoking and age, whereas the number of remaining teeth and having high education were associated with being a referent subject.

Interestingly, we found strong expression of eotaxin and MCP-1 in gingival fibroblasts and increased MCP-1 protein levels in inflamed gingival tissue. Primary human gingival fibroblasts displayed strongly increased expression of both MCP-1 and eotaxin mRNA and protein when challenged with pro-inflammatory TNF-α and IL-1β, key mediators of periodontal inflammation. We could also demonstrate that the up-regulation in chemokine expression was dependent on the canonical NF-κB pathway.

Conclusion:
Eotaxin and MCP-1 could serve as potential biomarkers of periodontitis. Furthermore, targeting their expression in gingival fibroblasts could result in reduced leukocyte infiltration and inflammation in periodontitis thus, leading to tooth retention.

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Strontium chloride promotes cell proliferation in a human osteoblast cell line

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Aim:
Strontium ranelate (SrRan) is the active component of drugs currently used for reducing the risk of fractures in patients suffering from osteoporosis. Despite extensive use, the underlying mechanisms of action of Sr^{2+} are not fully understood. In the present study, we assess the impact of $SrCl_2$ on human osteoblast activity and proliferation.

Material and methods:
Cultures of the human osteoblast-like cell line MG63 were treated for 72 h in presence of 0.1 mM, 1 mM, 5 mM and 10 mM $SrCl_2$ or vehicle, used in control groups. Cells were counted manually using a Bürker chamber. Total protein content was determined by colorimetric analysis performed by a microplate reader using Bio-Rad protein assay. Alkaline phosphatase (ALP) activity was determined enzymatically and normalized to total protein content in each sample. Cell viability was assessed using the MTT assay.

Results:
Treatment with 5 mM $SrCl_2$ for 72 h enhanced total MG63 cell protein content by 37% compared to controls ($p<0.01$). A lower concentration (0.1 mM) of $SrCl_2$ had no effect on total protein. Incubation with 5 mM $SrCl_2$ for 72 h increased MG63 cell number by 38% compared to controls ($p<0.001$). The $SrCl_2$-induced increase in cell number was associated with enhanced (+14% compared to controls, $p<0.05$) cell viability. Treatment with a higher concentration (10 mM) of $SrCl_2$ enhanced cell number similar to 5 mM $SrCl_2$ (+54% compared to controls, $p<0.05$). Treatment with 0.1 or 5 mM $SrCl_2$ for 72 h had no effect ($p>0.05$) on MG63 cell ALP activity, while 1 mM $SrCl_2$ reduced ALP activity as well as total protein content by about 25% compared to controls ($p<0.05$).

Conclusion:
The current results demonstrate that treatment with SrCl2 for 72 h, at concentrations higher than 1 mM promotes cell proliferation in human osteoblast-like cells, suggesting that Sr2+ may enhance bone formation through this mechanism.
Keywords: Alkaline Phosphatase, Cell Division/Drug effects, *In vitro*, Osteoblasts, Strontium, Strontium Chloride.

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Influence of saliva, serum, and serum proteins on adhesion and Arg-gingipain expression of Porphyromonas gingivalis. An in vitro study on dentin and titanium discs

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Aim:
Porphyromonas gingivalis, a highly proteolytic bacterial species, is well known to play a crucial role in pathogenesis of periodontal and peri-implant diseases. The aim of the study was to evaluate the adhesion and arginine specific cysteine protease (Arg-gingipain) activity of P. gingivalis on dentin and titanium (Ti) covered with saliva, serum, serum albumin and IgG as major components of gingival crevicular fluid and peri-implant sulcular fluid.

Materials and Methods:
Dentin and moderately rough Ti (SLA, Institut Straumann AG, Basel, Switzerland) discs were coated overnight with: a) 25% human serum, b) saliva, c) 5 mg/ml IgG, d) 10 mg/ml human serum albumin (HSA) and e) 0.9 % NaCl (controls). Thereafter, either P. gingivalis ATCC 33277 or P. gingivalis M5-1-2 (clinical isolate), suspended in nutrient broth, was added for 4 h and 24 h. After an incubation at 37°C in anaerobic conditions, the number of adhered bacteria (colony forming units; CFU) were counted after exposing test specimens to ultrasonication and spreading on agar plates. Arg-gingipain activity was evaluated by using a chromogenic substance (BApNA).
At least 6 independent samples (log10 CFU) were compared with ANOVA followed by post-hoc LSD (various coatings), t-test (dentine, titanium). Spearman correlation correlated the CFU counts with BApNA activity.

Results:
Log10 CFU were higher at Ti than on dentine when coated with saline and HSA after 24 h (ATCC, $p<0.05$). CFU counts were significantly higher when the discs were coated with HSA compared to saliva, both regarding dentine and Ti (ATCC, $p<0.05$).
Log10 CFU correlated significantly with Arg-gingipain activity (ATCC, R= 0.558, p=0.001 at dentine, R=0.556, p=0.001 at Ti; M5-1-2, R=0.398, p=0.046 at dentine, R=0.499, p=0.008 at Ti).

Conclusion:
P. gingivalis, in a serum-rich environment, shows higher adhesion and proteolytic activity on moderately rough Ti surfaces comparing to dentine.

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Aggressive periodontitis - follow-up of treatment. A retrospecitve study

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Aim:
To investigate if choice of treatment differed between patients with aggressive periodontitis and chronic periodontitis at two specialist clinics of Periodontology. Another purpose was to study if differences between the two diseases according to compliance and treatment outcome could be identified irrespective of the effects of background factors and risk factors.

Materials and Methods:
This is a retrospective longitudinal study. The variables were registered from dental records. The population consisted of patients referred to two specialist clinics of periodontology during the period January 2006 to December 2008. A study group was included consisting of 234 patients with the diagnosis aggressive periodontitis. A control group of 234 patients with the diagnosis chronic periodontitis was randomly selected.

Results:
Four percent of the referrals were diagnosed with aggressive periodontitis. Flap surgery was significantly more often performed in patients with chronic periodontitis, while regenerative surgery was a significantly more common in cases with aggressive periodontitis. Adjunctive antibiotic treatment was used for 10% of the patients with aggressive periodontitis and was significantly more frequently used than in the control group. The pocket depth reduction was significantly impaired in smokers and individuals with aggressive periodontitis. In addition, patients with aggressive periodontitis and smokers interrupted ongoing periodontal treatment significantly more often.

Conclusion:
Regenerative surgery and adjunctive antibiotic treatment were performed significantly more often in cases with aggressive periodontitis. The treatment results in patients with the diagnosis aggressive periodontitis showed impaired healing compared to those patients with the diagnosis chronic periodontitis irrespective of smoking habits and other investigated background variables. In addition, this patient group interrupted the periodontal treatment significantly more often which is a major health problem.

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Direct pulp capping procedures versus root canal treatment in young permanent teeth with pulp exposure due to caries. A systematic review

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Aim:
When the pulp is exposed due to caries, a root canal treatment has been proposed as the treatment of choice. This is an invasive, resource intensive and technically difficult treatment to perform, especially on young permanent teeth. A pulp capping (direct pulp capping or a partial pulpectomy) is a simpler procedure which preserves the vitality of the tooth. The aim of this study was to evaluate the available evidence on pulp capping procedures and root canal treatments performed on young permanent teeth with vital pulps exposed due to caries by performing a systematic review of the literature.

Materials and Methods:
Database searches in PubMed, Web of Knowledge, and the Cochrane Library were performed. Reference lists of relevant articles were hand searched. The level of evidence of each publication was rated as high, moderate or low

Results:
Database searches yielded 1638 publications after the elimination of duplicates. We identified twelve relevant original scientific studies according to our inclusion and exclusion criteria and assigned a level of evidence to each study. Ten of the included articles were examining pulp capping procedures and two were examining root canal therapy. The level of evidence was rated as low in all studies. We identified

no article directly comparing pulp capping versus root canal treatment.

Conclusion:
The level of evidence was insufficient to draw any conclusions regarding the effectiveness of the two treatment concepts however the current best evidence presents high success rates for pulp capping procedures as an alternative to root canal treatment. There is a need for high quality studies on the treatment of young permanent teeth with pulp exposures due to caries.

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A preliminary report of the antibacterial effect of Nd:YAG laser irradiation compared to 1% NaOCl irrigation in infected root canals

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Aim:
Nd:YAG laser has been proposed to effectively disinfect root canals, but this has not been shown in a randomized controlled trial. The aim of this study was to evaluate the antibacterial effect of Nd:YAG laser irradiation compared to irrigation with 1% unbuffered sodium hypochlorite (NaOCl) solution in teeth with apical periodontitis.

Materials and Methods:
In this randomized controlled study 34 patients (38 teeth) with apical periodontitis at single rooted, endodontically untreated teeth participated. All patients were recruited at the Specialist Clinic in Uppsala.
Following isolation with rubber dam a microbiological sample was obtained from the working field. The pulp chamber was entered and filled with transport medium. The root canal was instrumented to working length to size K15 and an initial root canal sample was obtained. After block randomisation the patients were allocated to laser or control group. Teeth in the laser group were instrumented with rotary or hand files at least 3 sizes larger than the first apically binding file and rinsed with a saline solution, dried and lased with Nd:YAG laser (Fotona Fidelis II+, Fotona D. D., Slovenia). Each canal was treated 4 times with very short pulse (VSP), 15Hz, 1,5W pulling out the fiber 2mm/s where after a root canal sample was obtained. Teeth in the control group were equally instrumented but irrigated with 1% unbuffered NaOCl-solution, followed by 15% EDTA and a final rinse with 1% NaOCl. Following inactivation of the NaOCl a root canal sample was obtained. No antibacterial dressing was used and after 2-4 days a third root canal sample was obtained in both laser and control group.
The bacterial samples were blinded and immediately sent for culturing and analysis to the Department of Microbiology and Immunology, Institute of Odontology at The Sahlgrenska Academy, University of Gothenburg, Gothenburg.

Results:
Initial infection could be cultured in 18 of 20 in the laser group and 14 of 18 (p=0.395) in the control group.
After initial treatment 10 of 20 in the laser group and 11 of 18 (p=0.532) in the control group yielded negative bacterial samples. After 2-4 days with no antibacterial dressing in the root canals, 4 of 20 in the laser group and 8 of 18 (p=0.164) in the control group yielded negative bacterial samples.

Conclusion:
Preliminary results suggest that Nd:YAG laser treatment of infected root canals do not give more negative root canal samples than conventional chemo-mechanical treatment in combination with NaOCl-solution.

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◎ ◎ ◎ 10

Cone Beam Computed Tomography (CBCT) in Sweden today

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Aim:
To examine the role of CBCT-technology in Sweden today, with regards to its distribution, type of ownership, justification and optimization, and the opinions among users about the economical prerequisites and the legislations in effect.

Materials and Methods:
A web-based survey, constructed using "Google Drive" survey function was distributed to 63 Swedish clinics licensed for CBCT-equipment by The Swedish Radiation Safety Authority. The survey consisted of 37 questions.

Results:
40 clinics answered; 1 university clinic, 15 owned by County Councils and 24 privately owned. Since 2010 at least 7 new equipments per year have been installed. 27 clinics had 3 or less dentists employed. 31 said that they used the competence of the responsible specialist in oral radiology at least every week. 19 used the CBCT-equipment for 100 examinations or less per year. 29 said that the main indication for the examinations was for implant treatment. 23 clinics said the legislation in effect was good. All clinics applied measures in order to optimize the radiation dose. The opinion of the majority of the clinics was that the recovery of costs was hard to manage.

Conclusion:
The number of CBCT-equipments have increased over the last couple of years. Implant treatment was the most common diagnostic reason for CBCT-examinations. The legislation in effect is, by large, to the users´ satisfaction. Possibly a mandatory certification for CBCT-usage should be implemented. For now it seems hard to achieve recovery of costs. The Swedish Social Insurance Agency should consider revising the guidelines for economical compensation, in particular regarding the possibility to consult specialists in oral radiology to a larger extent.

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Radiographic evaluation of third mandibular molar development as an age indicator in a Swedish population

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Aim:
The purpose of the study was to evaluate the development of the third mandibular molar in a sample of Swedish population and to evaluate its age-predicting performance. This data might have relevance in the aspect of establishing population-specific standards in a Swedish population. The National Board of Health and Welfare in Sweden recently published new recommendations regarding this (Migrationsverket, DNR 31156/2011).

Materials and Methods:
A total sample of 1031 panoramic radiographs was analyzed from radiographs exposed in Karolinska Institute, Department of Image and functional odontology. The subjects were 12-25 years old. The mineralization stages of the third mandibular molar was assessed according to Demirjian's method. (A Demirjian, H Goldstein, JM Tanner. A new system of dental age assessment. Hum Biol. 1973;45(2):211-27).

Results:
Comparisons between the left and the right side of the third mandibular molars did not show any statistically significant difference. Statistically significant differences were seen in the mean age between males and females in a few developmental stages (C, D and E). The males reached these stages earlier than females. In our study we found that the minimum age for the complete mineralization of the wisdom teeth was 16 in males. The corresponding value for females seemed to be 17. In general, the individual variation in dental development was larger for older ages than in younger children within the same chronological age. A substantial individual variation was seen. The results of this study have shown that the standard deviation (SD) of a developmental stage can be up to 1.6 years.

Conclusion:
The third mandibular molar is the most variable tooth in the dentition, but since third molars are the only developing tooth in juveniles, they are the only usable tooth for age estimation around the age of 18 years. The data described above may provide preliminary reference values for population-specific standards. Studies from other countries support this study.

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Fracture strength of low translucent and high translucent monolithic zirconia crowns with different thicknesses

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Aim:
There is a trend toward a growing interest in aesthetic and cosmetic dentistry in the general population. This has resulted in an increased use of the more aesthetic all-ceramic materials. Many all-ceramic restorations have excellent clinical longevity on anterior teeth, and on molars, the oxide ceramic yttria-stabilized tetragonal xirconia polycrystal (Y-TZP) may be the most suitable ceramic system due to its outstanding mechanical properties. A commonly reported complication however, is chip-off fracture within the veneering porcelain. Monolithic zirconia crowns could be a way to solve this problem but their low translucency has been a problem. The aim of this study was to investigate the fracture strength of fully anatomical monolithic high translucent Y-TZP crowns with different thicknesses and to compare them with monolithic low translucent Y-TZP crowns.

Materials and Methods:
80 standardized crowns were made out of a master model resembling a first mandibular molar made in composite material. 40 crowns made of Lava Zirconia by 3M ESPE, a low translucent Y-TZP material, and 40 high translucent crowns made of Lava Plus by 3M ESPE were made. In each group ten crowns of the thicknesses 1.0 mm, 0.7 mm, 0.5 mm and 0.3 mm were made. All crowns underwent thermocycling to simulate aging. They were then cemented using Rely-X and thereafter preloaded to simulate normal wear.
Finally the specimens were placed in a testing jig and underwent load to fracture in a universal test machine. All laboratory work was performed by one dentist and one dental technician. All crowns were stored in a humid environment between trials to prevent desiccation.

Results:
No significant difference was found when comparing the materials in each thickness, except for 0.5mm where Lava Plus had a higher mean fracture strength value. A significant difference was seen between the different thicknesses within both Lava Zirconia and Lava Plus. The strength increased with added thicknesses.

Conclusion:
It is possible to design a high translucent Y-TZP crown with a 0,5mm thickness and still achieve excellent strength. The use of Lava Zirconia could result in more aesthetic results and the more minimal invasive preparation could lead to fewer biological complications.

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Virtual planning of reconstructive surgery with haptic and 3D visualization

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Aim:
Virtual surgery planning (VSP) has proven useful for reconstructing head and neck defects. Benefits include improved healing, function, and aesthetics, as well as significant time and cost savings. Our aim is to develop an advanced VSP system which also includes the possibility to design and produce biomaterial needed for reconstructions of sever conditions.

Material and Methods:
UHASP (the Uppsala Haptics-Assisted Surgery Planning) system combines stereoscopic 3D visualization

with haptic rendering. A monitor with stereo glasses gives the user a stereoscopic view of the patient data. The monitor is mounted on a half-transparent mirror which makes it possible to co-locate the stereo graphics and the haptic device workspaces. This allows the user to see and interact with objects in the same virtual space. A head tracker continually tracks optical markers mounted on the stereo glasses, enabling the user to view objects from different angles using head motion. CT patient data are read into UHASP and segmented to identify bones, fractured pieces, and teeth, as appropriate. The user assembles fractured bone segments, designs implants and scaffolds with fixation plates. The resulting data are sent in STL-files for printing patient-specific saw-guides, implants, plates, and scaffolds, as needed for surgery. The surgery plan includes specification of order of action, tools and implants, screw specification, and any other information required during the surgery. The surgery plan is stored with the patient data for access by the entire surgical team.

Results:
UHASP has been found to be an efficient planning tool for reconstructions. It is evident that problems encountered during actual surgery that would require an adjustment or change of the operating plan can be avoided when planning the procedure in advance with UHASP. The testing of alternative reconstructions to arrive at an optimal solution preoperatively in less than an hour, potentially improves patient function and aesthetics, and also significantly will affect time and morbidity for the real time procedure. Our model allows in less than 30 minutes, for designing, testing and adjusting plates needed for osteosynthesis or guides for harvesting bone grafts or designing scaffolds implants that fits a possible residual defect

Conclusion:
The promising results can be attributed to a successful combination of stereo graphics and haptic feedback that guide the surgical planning. Cranio-maxillofacial surgery requires sub-millimeter precision, and small errors may accumulate resulting in an unacceptable reconstruction. For defect situations we have developed a system for designing of biomaterial or designing patient specific plates. The surgeon can generate a complex implant in a few easy interactive steps. Haptics helps the planning process by allowing the surgeon to feel when pieces fit together. Another key feature is that the surgeon may adjust the reconstruction to find facial symmetry and good occlusion. At the end of the planning process the surgeon decides on the optimal order to execute the steps of the plan in the operating room. We attribute the ease by which surgeons have learnt (in less than one hour) to use UHASP to the continual exchange of ideas between the Centre for Image Analysis and the surgeons at the department of Plastic and Oral and Maxillofacial Surgery.

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Indications and frequency of orthognathic surgery among Swedish Oral and Maxillofacial clinics - a questionnaire survey

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Aim:
Orthognathic surgery is today a standard procedure for improving the intermaxillary relationship by moving either one or both jaws surgically. However, statistics for frequency and indication for orthognathic surgery in Sweden are today non-existent. The purpose of the study is to examine the indications, frequency and surgical techniques for orthognathic surgery performed in Swedish Oral and Maxillofacial Surgery clinics.

Materials and Methods:
A questionnaire survey was performed on all Swedish Oral and Maxillofacial clinics for the year 2011 to identify the gender and age of patients, surgical techniques, indications, frequency of operations and whether the patients underwent one- or two-jaw surgery.

Results:
A total of 47 of 50 clinics responded to the survey. According to it, 894 patients were treated with orthognathic surgery. Slightly more women underwent orthognathic surgery than men and 91% of the patients

were 26 years or younger. The most common indication was functional and the most common main jaw discrepancy aimed to correct was of sagittal nature. The survey shows great discrepancies between the counties concerning one- vs. two-jaw surgery.

Conclusion:
The results regarding frequency, age and gender distribution in orthognathic surgery was somewhat expected. However, the spread in frequency regarding one- vs. two-jaw surgery between the counties is concerning. The main indication for performing orthognathic surgery in Sweden is by far functional but there is reason to suggest that aesthetic indication is not negligible.

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Benign osteoblastoma in the temporomandibular joint. A case report

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Aim:
Osteoblastoma is a rare benign bone tumour representing less than one % of all bone tumours. The tumour involves long bones, the spine and sacrum. Less than 10 % of the osteoblastomas are located in the maxillofacial region, mostly the mandible. There is a male dominance and most cases are diagnosed in second and third decade of life. Clinically the osteoblastoma is associated with rapid onset, dull persistent pain and swelling. The tumour has a various radiographic appearance: completely radiolucent to flecks of calcification, radiolucent halo or outer sclerotic rim. More aggressive lesions show rapid growth with poorly defined margins. Resorption of teeth occurs. Histologically, they are characterized by osteoid and woven bone deposition and abundant osteoblasts that are frequently in close association with newly formed bone. Surgical excision of the osteoblastoma is the preferred method with curettage or local excision. Recurrence following adequate surgical intervention is uncommon.

Materials and Methods:
A 17 year old girl was referred after two and a half year with reduced mouth opening, tenderness and swelling from the left temporomandibular joint. Prior to the referral she had been treated with a soft splint, jaw exercises and analgethics. Due to therapy-resistant symptoms the temporomandibular joint was radiographic examined and a lesion was found in the left tuberculum articulare.

Results:
Under general anesthesia the left temporomandibular joint was exposed with a preauricular approach for excess to the tuberculum articulare. The tumour was removed with local excision. In a 6 months follow-up period the patient had no clinical or radiographic signs of recurrence.

Conclusion:
Benign osteoblastoma involving jaw bones is a rare tumour. Surgical excision is the adequate treatment, giving the patient a good prognosis. A long-term follow-up is recommended.

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Observations from a histological study of a granular calcium phosphate compound and a bisphosphonate linked hyaluronic acid hydrogel in comparison with bovine bone in a rabbit sinus lift model

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Aim:
Bovine bone is the most used and evaluated bone substitute material on the market. It is biocompatible and works as space maintainer but has a slow, if any, resorption rate (Mordenfeld, A. et al. 2010). Synthetic bone substitutes are useful alternatives. A synthetic granular calcium phosphate compound (CPC) or a bisphosphonate linked hyaluronic acid (B-HA) hydrogel may induce bone formation and possibly be resorbed. The CPC has been successfully tested and is now in use as a solid scaffold in severe human scull defects and in this study we wanted to explore its properties in granular form in the maxillofacial area. Bisphosphonates (BP) is known to influence bone formation by decreasing osteoclast and

increasing osteoblast activities. In an appropriate scaffold, in this case hyaluronic acid, BP locally can be released in a controlled fashion and may increase bone formation (Hulsart-Billstrom, G. et al. 2013).

The aim of this study was to compare a synthetic granular calcium phosphate compound and bisphosphonate linked hyaluronic hydrogel vs. the control material of bovine bone (BioOssTM). Clinical observations and histological evaluation of the two materials, specifically the amount of the new bone formed around simultaneously installed dental implants and the interaction of the materials and bone, has been evaluated after three months in a rabbit sinus model.

Materials and Methods:
Eighteen rabbits, have undergone bilateral sinus lift surgery with simultaneous implant installation (Kim, Y. S. et al.2012)5 under general anaesthesia. After randomisation, each rabbit received either granular CPC or B-HA hydrogel at one side, and the control material at the other side. The materials were applied around the implants and a collagen membrane was placed over each grafted site. The rabbits were monitored until euthanized after three months. Post mortem, Cone Beam Computer tomography was performed and specimens for histological evaluation were collected.

Results:
Preliminary observations of interaction between bone and the materials in the specimens have been performed and rated by different examiners as a first step in evaluating the materials´ bone inducing properties. On-going evaluation of new bone formation in different predetermined areas of test and control materials will be further discussed.

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Epstein-Barr Virus in Oral Lymphoma

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Aim:
Lymphoma is the third most common group of malignant lesions found in the oral cavity and the maxillofacial region. The common Epstein-Barr virus (EBV), which usually causes infectious mononucleosis, has been associated with various cancer diseases such as nasopharyngeal carcinoma and Burkitt's lymphoma, although only few studies have investigated the relationship between EBV and oral cancer specifically. The purpose of this project was to investigate the prevalence of EBV in oral lymphoma.

Materials and Methods:
Forty-three lymphoma biopsies, out of a total of fifty-six, were retrieved from the biobank of Oral Pathology, Malmö University, and included in the study. EBV was detected with in situ hybridization and the EBV-positive specimens were further analysed with immunohistochemistry to subtype the oral lymphomas that were induced by, or harboured, EBV.

Results:
EBV was detected in five cases, a prevalence of 12 %. The lymphoma subtypes that harboured EBV were plasmablastic lymphoma, anaplastic large T-cell lymphoma and diffuse large B-cell lymphoma.

Conclusion:
Our conclusion is that Epstein-Barr virus does occur in a subset of oral lymphomas. Considering that virus-specific treatments continuously improve, it becomes increasingly important to recognize these EBV-associated diseases, so that proper treatment modalities can be utilized. Through additional research in this area, diagnostic methods may be enhanced and lead to better sub-classification.

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Dental maturity in prematurely born children

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Aim:
Previous studies show that parts of the physical and psychological growth and development in preterm born children are affected by their shorter gestational period. The impact of prematurity on tooth

development is not fully understood. The aim of this study is to investigate if dental development is affected by prematurity and if an individual tooth or a group of teeth are more evidently affected.

Materials and Methods:
Panoramic radiographs were obtained from 116 children born in the south of Sweden; 36 extremely preterm (EPT), 38 very preterm (VPT) and 42 full term (FT) born children. The radiographs were independently assessed by five observers, according to the method of Demirijan et al (1973). The dental maturity was determined through blinded assessment of the 7 left permanent mandibular teeth. The level of development of each tooth is summed up to a dental maturity score that resembles the percentile distribution of dental maturity of the child. Intra- and inter-observer reproducibility and validity was evaluated by re-assessment of 27 randomly chosen subjects. The data was statistically analyzed to compare the three groups and to evaluate if specific teeth are affected.

Results:
The results shows that the EPT had an average dental maturity score of 81.9-86.7 depending on observer, the VPT scored 85.2-89.1 and the controls 88.1-91.0. The statistical analysis of these values showed significant differences only between the EPT group and the control group for all five observers. All observers presented an assessment showing significant delay ($p<0.01$) in the maturity of tooth 37 when EPT was compared to controls. Further analysis regarding intra- and inter-observer variations are under process.

Conclusion:
The findings in this study suggest a general delay in tooth maturity for EPT born children. Lower gestational age seems to indicate a greater delay of tooth maturity compared to full term born children.

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The effect of interceptive orthodontic treatment in general practices evaluated in young adults 20 years of age

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Aims:
The aims of this study were to evaluate the types and effectiveness of interceptive treatments offered in general practices, and to study the need for further treatment with fixed appliances.

Materials and methods:
The charts of patients born in 1993 and examined at orthodontic consultations between the years 2000-2012 were reviewed. The type and number of interceptive appliances, the age at treatment start, treatment time, success or failure of interceptive treatment and number of patients planned and treated with fixed appliances were registered.
Five general practices in the region Västra Götaland were included.
Uddevalla: Folktandvården Uddevalla City, Folktandvården Dalaberg.
Falköping: Folktandvården Falköping, Folktandvården Floby, Folktandvården Floby.

Results:
The number of patients born in 1993 and included in the general dental clinics was 1249. 194 patients (16 %), 98 girls and 96 boys, were treated in total with 272 interceptive appliances (1.4 appliances/ patient). The most common interceptive appliances were plates (21 %), lingual arches (19%) and quad helixes (18 %). The average age at treatment start was 11 years and the average treatment time was 15 months. The mean success rate was 81 %. The success rate of fixed interceptive appliances was higher than removable interceptive appliances. In 51 patients (26 %), interceptive treatment was followed by treatment with specialist fixed appliances.

Conclusion:
Patients may benefit from interceptive treatment, especially with fixed interceptive appliances, as it may give more satisfying results in certain patients.

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◎ ◎ ◎ 20

Health economic evaluations in orthodontics - a systematic review

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Aim:
To systematically reviewing the literature and assess the evidence of the combined economic and orthodontic outcomes.

Materials and Methods:
The literature review was conducted in 4 steps according to Goodmanâ€™s model. A literature search was conducted to identify all studies that evaluate the economics considering orthodontic interventions. The search, covering the period from 1966 to August 2014, was performed by applying the Medline database, Cinahl database and National Health Service Economic Evaluation Database. The inclusion criteria were: Randomized controlled trials or controlled clinical trials that compare at least two different orthodontic treatment interventions including evaluation of economic and orthodontic outcomes, study population of all ages, and full text articles written in English, German or Scandinavian languages. Five independent researchers determined eligibility of potential studies and quality assessment according to preset protocols. The study quality was assessed as limited, moderate, and high. The overall evidence was assessed following the GRADE system.

Results:
Based on applied terms for searches there were 1 351 studies of which 611 were removed because of duplicates. The full text of 26 studies remained based on the inclusion criteria and 8 studies persisted to the final analysis. Three studies had accomplished a cost effectiveness analysis while 5 studies used cost minimization analysis and two of these had a societal perspective, i.e. sum of direct and indirect costs. One study presented incorrectly a cost minimization analysis as a cost benefit analysis. Because of disparities of aims of the majority of the studies and due to few studies of sufficient study quality covering comparison of equivalent treatment methods, evidence as regards economic aspects on orthodontic treatment could not be stated.

Conclusion:
The evidence for combined economic and orthodontic outcomes in studies of health economics was insufficient, and consequently, more studies are needed on this topic.

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◎ ◎ ◎ 21

The dilemma of reporting suspicions of child maltreatment in pediatric dentistry

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Aim:
This study examined the factors that lead specialists in pediatric dentistry to suspect child abuse or neglect and the considerations that influence the decision to report these suspicions to social services.

Materials and Methods:
Focus group discussions were used to identify new aspects of child maltreatment suspicion and reporting. Such discussions illuminate the diversity of informants´ experiences, opinions, and reflections. Focus groups included 19 specialists and postgraduate students in pediatric dentistry. We conducted video-recorded focus group discussions at the informants´ dental clinics. All sessions lasted approximately 1.5 hours. We transcribed the discussions verbatim and studied the transcripts using thematic analysis, a method well-suited to evaluating the experiences discussed and how the informants understand them.

Results:
The analysis process elicited key concepts and identified one main theme, which we labeled 'the dilemma of reporting child maltreatment'. We found this dilemma to pervade a variety of situations and divided it in three subthemes: To support or report, Differentiating concern for well-being from maltreatment and the supportive or unhelpful consultation.

Conclusion:
Reporting a suspicion about child maltreatment seems to be a clinical and ethical dilemma arising from concerns of having contradicting professional roles, difficulties confirming suspicions of maltreat-

ment, and perceived shortcomings in the child protection system.

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◎ ◎ ◎ 22

Prevalence of dental erosion and association to lifestyle in a group of 15- and 17-year olds in Stockholm County

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Aim:
To investigate prevalence of dental erosion and its association to lifestyle factors in a cohort of 15- and 17-year olds in Stockholm County.

Materials and Methods:
Adolescents (n=1071) attending recall examinations at Public Dental Service were screened clinically for dental erosion on marker teeth, of which also were taken photographs. The individuals answered a questionnaire regarding oral symptoms, dietary and behavioural factors. Evaluation of the photographs for prevalence and severity of dental erosion was performed by two calibrated specialist dentists, using the simplified erosion partial recording system (SEPRS).

Results:
Dental erosion was diagnosed clinically in 28.3 % of 15-year olds and 34.3 % of 17-year olds. Severe erosive wear was found in 18.4% of the adolescents based upon the intraoral photographs. Dental erosion was more prevalent and severe among males than among females. The presence of erosive lesions correlated significantly to soft drink consumption ($p<0.001$), the use of juice or sport drinks as thirst quencher after exercise ($p=0.001$) and to hypersensitivity from teeth when eating and drinking ($p=0.001$). Furthermore, self-assessed gastric reflux was a factor strongly associated to dental erosion ($p<0.001$).

Conclusion:
Dental erosion is common among adolescents in Stockholm County. There is an association between erosive wear and several life style factors.

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◎ ◎ ◎ 23

Oral health what information does ICF-CY provide in addition to ICD-DA?

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Aim:
The aim was to describe oral health in children with disabilities receiving pediatric specialist dental care with focus on differences in registration between the International Statistical Classification of Diseases and Related Health Problems, Dental Application (ICD-DA) and the International Classification of Functioning, Disability and Health – Children and Youth (ICF-CY).

Materials and Methods:
Children 0-16 years of age, enlisted within the habilitation services, were invited to participate in the study after informed consent. ICD-DA diagnoses were retrieved from dental records. Oral health data using ICF-CY was determined through interviews and direct observation. Descriptive data analysis was performed.

Results:
Ninety-nine children with disabilities were included in the study. Orthodontic anomalies (30%) and congenital tooth disturbances (20%) were the most common ICD-DA diagnoses and plaque/calculus (19%), tooth wear (12%), gingivitis/periodontitis (11%) and caries (7%) the most acquired oral health conditions noted in the dental records. Impairment in Structure of teeth was the most cited oral structure within ICF-CY component Body structure (45%) followed by impairment in palate (23%) and tongue (19%). Body function impairments of the oral functions concerning food intake dominated.

Conclusion:
While the ICF-CY is not specific enough to fully describe oral health in this group, it is useful to assess children's oral functioning, disability, and health from a biopsychosocial perspective. A dental ICD diagnosis alone is not enough to determine the consequences of oral conditions.

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◎ ◎ ◎ 24

Can a recent whiplash trauma affect chewing ability?

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Aim:
Normal jaw function relies on integrated motor control of the jaw and neck motor systems. Pain and dysfunction in the neck may therefore impair jaw activities such as eating and chewing. A disturbed jaw function has been observed in patients with long-standing neck pain and dysfunction after a whiplash trauma. It is not known if onset of jaw dysfunction develops in close proximity to a neck trauma. The aim was to evaluate chewing ability and neck disability in individuals after a recent whiplash trauma in relation to gender and compared to controls.

Materials and Methods:
63 cases (35 men and 28 women, mean age 36 years) with neck pain following a whiplash trauma in a car accident, were examined within three weeks after the trauma and compared with 70 controls (45 women and 25 men, mean age 38 years).
The participants performed a 5-minute chewing test, where they were instructed to perform unilateral chewing of 3 pieces of chewing gum (V6) and report subjective fatigue/tiredness and pain, if experienced during the task. The neck disability was assessed by the Neck Disability Index (NDI) and these scores were reported as a % score. The statistical analysis was done with Chi-2 test and a P-value <0.05 was considered statistically significant.

Results:
During the chewing test, cases with a recent whiplash trauma more often reported subjective fatigue in the jaws (48% vs. 30%, $p = 0.014$) and more pain (29% vs. 7%, $p < 0.0001$) compared to controls. Women more often reported subjective fatigue during chewing than men, both among controls (36% vs. 20%, $p = 0.012$) and cases (57% vs. 36%, $p = 0.004$). Among the cases, women had a tendency of reporting jaw pain more often than men (34% vs. 21%, $p = 0.057$). Cases who reported development of fatigue and pain in the jaws during the chewing task had a significantly higher NDI (NDI = 24) compared with cases who did not develop jaw symptoms (NDI = 14; $p = 0.02$).

Conclusion:
A whiplash injury with related neck disability appears to affect chewing ability early after the trauma, and more so in women.

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◎ ◎ ◎ 25

The relation between salivary suPAR and arthritis in the temporomandibular joint: preliminary results

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Aim:
To investigate soluble urokinase-type plasminogen activator receptor (suPAR) concentration in saliva, plasma, and synovial fluid in patients with temporomandibular joint arthritis (A-TMJ) and in healthy controls

Materials and Methods:
Five patients with A-TMJ and 6 healthy controls were included. In each subject, saliva, blood, and synovial fluid was sampled, a periodontal examination, and an examination of the masticatory system was performed according to DC/TMD. In addition, the number of painful mandibular movements (PM) was assessed, as well as bleeding on probing (BoP). The saliva, plasma and synovial fluid was analyzed for suPAR.

Results:
The mean ± SD concentration of suPAR in A-TMJ patients and healthy subjects was 4.43 ± 3.91 ng/ml and 4.96 ± 4.8 ng/ml in saliva, respectively; 2.71 ± 0.62 ng/ml and 1.86 ± 0.35 ng/ml in plasma; 1.57 ± 1.5 ng/ml and 0 ± 0 ng/ml in synovial fluid.
The median value for PM was 3 for the A-TMJ patients, and 0 for the healthy subjects.
The mean value of BoP was higher for the A-TMJ patients than the healthy subjects. Due to the small study sample, only descriptive statistics was performed.

Conclusion:
Preliminary results suggests to some degree that A-

TMJ patients have more TMJ pain on jaw movement at the same time as their plasma concentration of suPAR is higher than in healthy individuals. However if they are significant cannot be determined from existing data. Furthermore, suPAR in synovial fluid could only be detected in patients with A-TMJ (2 of 4 samples) and not in synovial fluid from healthy controls, there these results should be interpreted with caution. More research are required to elucidate the association between suPAR in saliva and A-TMJ.

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Pain and disability in the jaw and neck following whiplash trauma

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Aim:
There is a close anatomical and functional relationship between the jaw and the neck regions and it has been suggested that jaw pain and dysfunction can develop after whiplash trauma. Jaw pain and dysfunction may develop over time, appear in close temporal proximity to the whiplash trauma, or both. The purpose of this study was to analyse prevalence of jaw pain, and the relationship between jaw pain and neck pain and dysfunction after whiplash trauma.

Materials and methods:
Fifty individuals (cases; 35 women, 15 men, mean age 36.4 years), who had visited the Emergency department at Umeå University Hospital, Sweden, with neck pain following a car accident, were examined by a questionnaire within three weeks after the accident and compared with 50 individuals without a history of neck trauma (controls; 35 women, 15 men, mean age 39.5 years). The questionnaire included three questions on jaw pain and dysfunction, the Neck Disability index, and rating of current pain in the jaw and the neck regions on a Numerical Rating Scale.

Results:
The median Neck Disability score was higher for cases (11.0), compared to controls (2.0) ($p < 0.0001$). Frequent jaw pain or pain on jaw movement (once a week or more) was reported by 28 % of the cases, and 12 % of the controls ($p = 0.046$). Compared to controls, the cases reported higher current pain ratings for both the neck ($p < 0.0001$) and jaw $p = 0.0225$). There was a moderate positive correlation ($r = 0.59$, $p < 0.0001$) between jaw and neck pain ratings.

Conclusions:
The results indicate that jaw pain can develop in close temporal connection to a neck trauma, as well as a relationship between presence of jaw pain and neck pain. These findings suggest that pain in the jaw-face region may be part of an acute whiplash syndrome.

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◎ ◎ ◎ 27

Effect of excessive chewing on pain perception

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Aim:
Pain and dysfunction in the jaw region may be related to fatigue and delayed onset muscle soreness (DOMS) following overstrain. The aim of the present study was to investigate development and course of subjective muscle fatigue, pain intensity and pressure-pain thresholds (PPT) over the masseter and temporalis muscles in healthy men and women after an intense chewing task.

Materials and Methods:
Twenty healthy subjects (ten males and ten females) aged 18 to 30 years (mean 25, SD 2.5 years) participated and chewed seven pieces of a hard chewing gum (ELMA) for 10 minutes at the pace of 80 beats per minute on their preferred chewing side. Fatigue and pain were rated on a numerical rating scale (NRS). PPT over the anterior temporalis and superficial

masseter muscles were measured with an algometer (Somedic) before (baseline), directly after, one hour after, and 24 hours after the chewing exercise.

Results:
All subjects managed to complete the chewing task. For both men and women, self-rated fatigue and pain intensity peaked directly after the chewing and returned close to baseline values after one hour. The masseter muscle PPT was significantly reduced one hour after chewing in an analysis including all subjects ($p = 0.045$). Directly after chewing, the temporal muscle PPT increased significantly in men ($p = 0.026$) but not in women. Furthermore, compared to women, men had higher PPT directly after chewing in both the masseter ($p = 0.028$) and temporal ($p = 0.04$) muscle sites.

Conclusion:
This study shows that intense chewing induces transient subjective local fatigue and pain but not DOMS in healthy subjects. Pressure pain thresholds remained fairly stable among women whereas a tendency for increased thresholds directly after the exercise was observed in men.

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◎ ◎ ◎ 28

Jaw-neck function in children - a pilot study

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Aim:
A functional integration between the jaw and neck regions has been demonstrated in adults, but it is not known if this exists also in childhood. The aim was to investigate the functional integration between the jaw and neck motor systems during jaw motor tasks in children and to analyse if there are any differences in jaw and neck movement patterns between children and adults.

Materials and Methods:
Jaw and head movements were recorded during two jaw motor tasks with the aid of an optoelectronic 3D recording system in eight healthy 6-year old children and eight healthy adults (mean age: 25 years, SD 2.8). The tasks included paced continuous jaw opening-closing and self-paced chewing on chewing gum. The analysed movement variables were i) the ratio between jaw and head movement amplitudes and ii) the intra-individual cycle-to-cycle variability expressed as coefficient of variation (CV). The statistical analysis was done with Mann-Whitney U test and a P-value < 0.05 was considered statistically significant.

Results:
Head movements were present during all jaw activities for both children and adults. There were no significant differences between children and adults for the mean ratios between the jaw and head movement amplitudes for jaw opening-closing (29.5% vs. 23.7%), or chewing (17.1% vs. 10.3%). Compared to adults, children displayed a tendency for larger intra-individual variation in movement cycles for both jaw and head movements. Thus, during jaw opening-closing, the mean jaw variability was higher for children (CV= 0.14) compared with adults (CV= 0.04; $p = 0.0003$), and also the mean head variability was higher for children (CV= 0.59) compared with adults (CV= 0.32; $p=0.0019$). During chewing, the mean jaw variability was higher for children (CV= 0.30) compared with adults (CV= 0.18; $p=0.004$).

Conclusion:
The results show similarities between children's and adult's jaw-neck motor behaviour indicating that a functional integration between the jaw and neck motor systems is established early in life. The results also show some differences, with more variable movement patterns in children compared to patterns observed in adults, which may be interpreted as immature motor programming of jaw actions in children.

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Central sensitization in orofacial pain

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Aim:
The aim of the study was to investigate the relation between central sensitization in the orofacial region, clinical findings and psychosocial factors in patients with a DC/TMD diagnosis of local myalgia (LM), myofascial pain with referral (MFS) and no muscle diagnosis.
Materials and Methods:
Patient records of 85 patients examined at the Orofacial Pain Unit at Malmö University during September 2012 till the end of the year 2013 were retrospectively examined for DC/TMD data. Examined variables included pain intensity, dysfunction due to the pain, psychosocial factors (depression, anxiety and stress), mandibular movements and pain localization. The patients were divided into groups based on DC/TMD muscle diagnosis as well as extension of pain localization.

Results:
Patients with MFS demonstrated significant correlations between the total number of referred pain sites and dysfunction score ($rs = 0.427$, $n = 49$, $p = 0.002$), depression ($rs = 0.324$, $n = 49$, $p = 0.023$), stress ($rs = 0.390$, $n = 49$, $p = 0.006$) and total number of painful mandibular movements ($rs = 0.393$, $n = 49$, $p = 0.005$). Patients with generalized pain distribution demonstrated a significantly higher degree of stress ($p = 0.020$) as well as higher number of referred pain sites ($p = 0.019$) than patients with local and/or regional orofacial pain.

Conclusion:
The presence of referred pain, as assessed according to the DC/TMD, indicates presence of central sensitization.

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Deficient cytokine control modulates temporomandibular joint pain in rheumatoid arthritis

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Aim:
The aim is to investigate the local and systemic relation between serotonin, cytokines and their endogonous controls in relation to temporomandibular joint (TMJ) pain in rheumatoid arthritis (RA).

Materials and Methods:
Twenty-six consecutive out-patients with TMJ involvement of RA were included. TMJ pain intensity at rest, on maximum mouth opening and on chewing as well as tenderness to palpation were assessed on a numerical rating scale (0-10). Mandibular movement capacity and degree of anterior open bite, a clinical sign of structural destruction of TMJ tissues, were also assessed. The systemic inflammatory activity was assessed by DAS28. TMJ synovial fluid and blood samples were obtained and analyzed for TNF, TNFsRII, IL-1ra, IL-1sRII, IL-6sR and serotonin. In synovial fluid, ratios between the mediators were used in the statistical analysis.

Results:
High TNF and IL-1ra in relation to TNFsRII and IL-1sRII, respectively, correlated to TMJ tenderness to palpation. All mediators were related in TMJ synovial fluid. DAS28 correlated to number of painful regions, to total tenderness to TMJ palpation and to total pain intensity on TMJ movement.

Conclusion:
This indicates that tenderness to TMJ palpation in RA seems to be related to a deficiency in local cytokine control. There is a local increase in production and release of serotonin, proinflammatory cytokines and their endogenous controls in inflammation.

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◎◎◎ 31

The effect of supervised exercise on patients with temporomandibular disorders

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Aim:
Exercise has been advocated as a treatment modality in conditions attributed to temporomandibular disorders (TMD). It is not known if the outcome of exercise differs between patients with localized TMD pain and patients with TMD associated with generalized pain. The aim was to evaluate the effect of exercise in patients with TMD in relation to patterns of local and generalized pain.
Materials and Methods:
Consecutive patients with TMD (130 women and 23 men, mean age 42 years) referred to the Department of Clinical Oral Physiology, Umeå participated in a structured supervised training program based on ten sessions with jaw and neck/shoulder exercises including coordination and resistance exercise. The effect of the treatment was evaluated by the endurance time during the jaw and shoulder exercise tasks, and by ratings of jaw pain intensity on the Numerical Rating Scale (NRS) and of the symptom´s influence on daily activities on a 7-point rating scale.

Results:
After the training programme, there was a significant increase in the endurance time for the jaw opening task ($p<0.0001$) from 83 to 219 seconds. There were also significant differences between the groups, with generalized pain patients showing lower capacity both at baseline (47 vs 101 sec; $p<0.0001$) and after treatment (194 vs 232 sec; $p<0.036$). The reported jaw pain intensity was lower after the training programme (NRS 3.0) compared to baseline (NRS 3.9; $p<0.001$) and there were no differences between the general and local pain groups at baseline or after treatment. There was a decrease in rated symptom´s influence on daily activities after exercise (2.5) compared to baseline (3.3; $p<0.0001$). Furthermore, there were significant differences between the generalized and local pain groups before (3.6 vs 3.1; $p=0.029$) but not after (2.6 vs 2.4; $p=0.380$) training.

Conclusion:
: The results show that a supervised exercise programme can increase capacity and reduce jaw pain in patients with TMD. The improvement was similar in the generalized and local pain groups, although the group with generalized pain had an overall lower capacity. These findings suggest that activation of the jaw motor system with exercise has a similar effect in patients with localized TMD pain and patients with TMD and generalized pain.

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Clinical decision-making related of treatment need owing to temporomandibular disorders

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Aim:
The aim of this cross-sectional study was to analyze the prevalence of treatment need estimation owing to TMD in the adult population and to analyze which factors posed significant influence on the dentist's treatment need estimation.

Materials and Methods:
The study population comprised 1200 individuals, 35-, 50-, 65-, and 75 years old from the County of Västerbotten, Sweden. The study populations were stratified by region; inland and coastal areas. From each of the strata 600 individuals, 150 in each age group, were randomly selected. From the total of 1200 individuals, 987 individuals (response rate 82%) returned a filled-out questionnaire, and 779 (response rate 65%) participated in clinical examination. Information was used from questionnaire regarding symptoms indicative of TMD, headache, socio-demographic factors, general and oral state of health, and from clinical examination regarding signs indicative of TMD, gender of the examiner and treatment need owing to TMD. Clinical examinations were performed in Public dental clinics by 4 calibrated examination teams (one dentist and one chair side assistance) from September 2002 to February 2003. Two dentists were men and two were women, their individual clinical experience was approximately 25 years. After the examination they in-

dividually judged if the subject had a treatment need or not. The data analysis was done by STATA statistical software version 10. Dependent variable was treatment need owing to TMDs. Logistic regression analysis was used to estimate factors associated with treatment need owing to TMD among adult population. The results were presented as odd ratios (OR) with 95% confidence interval (CI). A P-value less than 0.05 were considered statistically significant.

Results:
In total, 8 % was judged to have a treatment need owing to TMD. The highest estimate was found for 50 year olds women (21%) and the lowest estimate was among 50- and 75-year-old men (2%). Twelve percent of the women and 4% of men were judged to have a treatment need owing to TMD with statistically significant difference between men and women in 50 years old sample. In a multivariate analysis age, gender of examiner, pain symptoms in the jaw-face-head region, TMD dysfunction signs, TMD pain signs, and smoking were significantly associated with decision of treatment need.

Conclusion:
The results present new perspectives regarding decision making processes related to TMD. The observation that gender of the examiner had a significant influence of the estimation deserves to be scrutinized further.

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Clinical decision making in relation to presence of jaw pain and dysfunction

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Aim:
The aim of this study was to evaluate the clinical decision making in relation to three screening questions for jaw pain and dysfunction (3Q/TMD).

Materials and Methods:
A total of 23,409 individuals registered with the Public Dental Health in the county of Västerbotten, Sweden answered the three screening questions when they attended for their routine check-up between June 2010 and May 2011. From these, 300 patients who stated ”yes” to one or more of the 3Q/TMD (cases) and 500 who stated ”no” to all of the 3Q/TMD (controls) were randomly selected and their dental records were evaluated by a blinded examiner. Data on diagnosis, treatment carried out, or declined treatment was extracted from the records. The statistical analysis between cases and controls was done with Chi-square test and logistic regression. A p-value < 0.05 was considered statistically significant.

Results:
There was a fairly even distribution between men and women among controls whereas the case group had a majority of women (71%). Treatment related to jaw pain and dysfunction had been carried out for 2% of the controls and 23.5% of the cases (OR 13.6; CI, 7.1-26.2) with bite-splint therapy being the most common treatment utilized. For 6.1% of the cases the records stated that treatment had been proposed but declined by the patient. Furthermore, 13% of the cases had received treatment related to jaw pain and dysfunction free of charge.

Conclusion:
In this evaluation of clinical decision making related to symptoms indicative of TMD we found a relationship between an affirmative answer to a screening question and received treatment. Despite this fact, for the majority of the cases no treatment related to the symptoms was initiated.

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