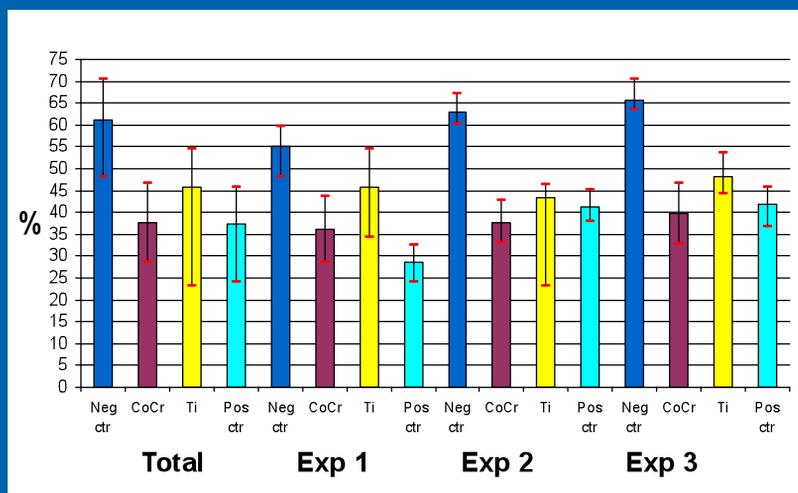


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Cellular responses to cobalt-chrome and CP titanium – an *in vitro* comparison of frameworks for implant-retained oral prostheses

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Self-estimated oral and general health are related and associated with clinically investigated dental health

SEVEK ENGSTRÖM^{1,3}, ANDERS HOLMLUND^{1,2}

Abstract

© The aim was to investigate whether the self-estimation of oral and general health is correlated and related to clinical parameters for dental health. Furthermore, to investigate the influence of socioeconomic factors on the self-assessment of oral and general health.

During 2007 a dental health survey was performed in the Community of Gävle located in central Sweden. 1, 224 subjects randomized from the general population of Gävle (adult population 75, 000) were invited to participate. Seven hundred and forty-eight individuals answered a questionnaire regarding their health and 373 of these subjects participated in a dental examination.

Self-estimated oral and general health was correlated ($p < 0.0001$, $r = 0.35$) and individuals who perceived their oral health as bad had more decayed surfaces, surfaces with secondary caries, fewer teeth and more bleeding on probing than those with good estimated oral health ($p < 0.017$ for all).

In a logistic regression analysis with self-estimated oral health as the dependent variable was related to, the independent variables NT, DFT, self-estimated general health and age were related to self-estimated oral health, but not to income or educational level. However, subjects with low disposable income and low education level had significantly more clinical caries and fewer teeth than subjects with high income or a high educational level.

Conclusions: In the present study, self-estimation of oral and general health was correlated and related to some clinical oral parameters. Subjects in the low socioeconomic group had worse dental health and a tendency to underestimate their need of dental care.

Key words

Caries, health and periodontitis

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Självuppskattningen av oral och allmän hälsa är relaterad och associerad till kliniskt undersökt tandhälsa.

SEVEK ENGSTRÖM, ANDERS HOLMLUND

Sammanfattning

☉ Syftet med studien var att undersöka om självskattning av oral- och allmän hälsa var korrelerad sinsemellan och till kliniska parametrar för tandhälsa. Vidare om socioekonomiska faktorer påverkar självskattningen av hälsan.

Urvalet gjordes genom att 1,224 vuxna individer slumpades ut från Gävle kommuns befolkning. En enkät besvarades av 748 personer och 373 av dessa erhöll en omfattande klinisk undersökning utförd av samma tandläkare.

Den självskattade orala och allmän hälsan var korrelerade ($p < 0.0001$, $r = 0.36$) och personer som upplevde den egna munhälsan som dålig hade mer kariesskador, fler ytor med sekundärskador, färre tänder och mer blödning vid sondering (BOP) än dem som upplevde sin tandhälsa som bra ($p < 0.017$).

I en logistisk regressionsanalys var den självskattade orala hälsan som beroende variabeln relaterad till antalet tänder, DFT och den självskattad allmänhälsan, men inte till inkomst och utbildningsnivå. Däremot hade individer med låg disponibel inkomst och låg utbildning signifikant mer klinisk verifierad karies och färre antal tänder än de med hög inkomst och utbildning.

I denna studie var individers upplevelse av sin orala och allmänhälsa korrelerade. Den kliniska undersökningen indikerade att individer med sämre socioekonomiska förhållanden tenderar att underskatta sitt vårdbehov.

Introduction

How individuals experience their self-perceived need for and satisfaction with dental care and what clinical parameters and socioeconomic factors which might influence this experience has been extensively studied (8, 10, 14). That income and education are factors influencing general as well as oral health has earlier been reported (12). However, whether self-estimation of oral and general health is correlated in the same individual and related to clinical conditions has not been so extensively studied. In the past 20 years, an increasing number of studies have reported that oral conditions might have a systemic effect that could influence general conditions such as cardiovascular disease and diabetes (9). Some authors have argued that the pathways for the social gradient in oral health are similar to those in general health (11).

Epidemiological investigations performed in the county of Jönköping in Sweden between 1973 and 2003 reported continuous improvement over time of the dental health in the population (7). However, reports from other countries and elsewhere in Sweden suggest that the improvement might not be equally distributed in the population, as education and income level could significantly influence both oral and general health in the population (12, 13, 15).

It is known from previous studies that self-estimated oral health correlates to some extent with clinically investigated dental health parameters (1, 16). Questionnaires regarding self-estimated dental health could therefore be one way of obtaining an overview of the dental health status in large populations. The dental health parameter number of teeth (NT) seems to be more correctly self-estimated than others, such as number of fillings, deepened periodontal pockets, and carious lesions (1, 16). Furthermore, NT has also been reported to influence how well individuals self-estimate their need for dental care (16).

The reasons for health seeking behaviour are complex and influenced by a number of factors. The most common oral diseases, caries and periodontal disease, may progress substantially before any serious symptoms occur in the individual. Oral problems that cause tangible difficulties for the individual, such as broken fillings, cavities, loose teeth, teeth with poor aesthetics, and toothache have been found to be strongly related to self-perceived need of dental care (3). However, there seem to be systematic differences in health seeking behaviour between subjects from lower and higher socioeconomic groups (2).

The aims of this study were to investigate if; 1) self-

estimation of oral and general health were correlated; 2) clinical parameters were associated with the self-estimation of oral and general health and; 3) disposable income and educational level influenced the perception of oral and general health.

Material and methods

Study population

In the municipality of Gävle which is situated in the middle of Sweden, a dental health survey was performed during 2007. A randomised sample of 1,224 subjects, stratified by age (25-83 years), income level and sex from the general population were invited to participate. The randomisation and stratification of the sample was made between January and July 2006 by Statistics Sweden (SCB). All participants were asked to answer a questionnaire regarding smoking habits, educational level and how they perceived their oral and general health. Smoking was defined as current or non-smoker.

The questionnaire used in this study has been developed by the Swedish National Institute for Public Health for population based health surveys and used in the national investigation "Health on equal terms 2006". The questionnaires were sent to the 1,224 randomised subjects. Seven hundred and forty-eight subjects answered the questionnaire giving a response rate of 62%. Two reminders were sent to non-responders. The subjects were asked to rate their oral and general health in one of the following five categories: "very good"; "good"; "neither bad nor good"; "bad"; and "very bad".

Socioeconomic factors

The income levels for the subjects were received from the Statistics Sweden, (SCB). Disposable income was divided into three groups (high \geq 40000 Euro/year; medium 20-39000 Euro/year; and low < 20000 Euro/year).

Educational level was divided into three different categories: "nine years or less"; "ten to twelve years"; and "university studies".

Clinical examination

All 748 subjects who answered the questionnaire were offered an extensive dental examination and 373 chose to participate in the examination, giving a participation rate of 50% for those who answered the questionnaire, 31% for the total randomised sample.

The oral examination included assessment of all teeth regarding presence or absence of dental plaque (PLI), bleeding on probing (BOP), tooth mobility,

and probing pocket depth measured (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual and distolingual and the four deepest sites for each tooth were registered) using a UNC 12 manual probe (Hu-Friedy). Pocket depth >4 mm was regarded as deepened. One experienced general dentist performed all clinical investigations.

Statistical method

All statistical analyses were performed with SPSS (version 17.0). Questions regarding oral and general health in the questionnaire were, as described above, divided into five response alternatives. However, in the final statistical analyses, these five groups were reduced to three by merging “bad” with “very bad”, and “good” with “very good” creating the groups “bad” and “good”, leaving the group “neither bad nor good” unaltered.

The *Kruskal-Wallis* test was used to analyse differences between groups as the data were not normally distributed. The *Bonferroni* correction for multiple testing was taken into account where appropriate. A logistic multinomial regression model was used to investigate whether the self perceived oral health was influenced by different oral health parameters, disposable income, educational level, self-estimated general health and smoking. Finally, the *Spearman* rank correlation test was performed to analyse whether or not the perception of oral and general health for the same individual was correlated and Kappa value to get the measure of agreement. A two tailed p-value < 0.05 was regarded as significant. However, when *Bonferroni* correction for multiple testing was applied a p-value of <0.017 was regarded as significant.

The study was approved by the Ethics Committee of Uppsala University Dnr 2005:240.

Results

Self-perceived oral and general health for the same individual divided into bad, neither bad nor good and good was correlated, especially for those who perceived their health as good ($p < 0.0001$, $r = 0.36$, kappa 0.28), (see Figure 1 for the distribution of self-estimated general health in relation to self estimated oral health)

Self-perceived oral health displayed a significant relationship to the investigated clinical parameters, number of teeth (NT), decayed surfaces (DS), surfaces with secondary caries (SSC) and percentage of surfaces with bleeding on probing (BOP%) ($p < 0.017$ for all), (Table 1).

NT, DS and SSC were also significantly related to

different aspects of self-estimated general health (Table 2.).

The three categories of disposable income were significantly related to number of DFT as well as DS, ($p < 0.02$), (Data not shown).

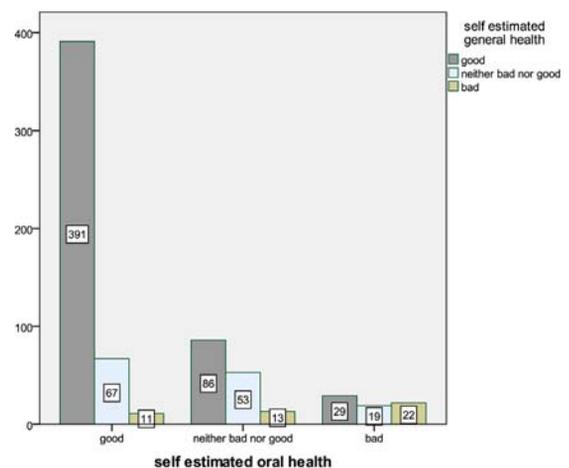
The educational levels were related to NT, DFT, DS, SSC and the number of pockets > 4mm, ($p < 0.02$), (Data not shown).

Compared to men, women estimated their oral health as being significantly better in the total sample and among the clinically investigated subjects, women had less secondary caries, PLI and BOP than men.

In a logistic multinomial regression model with self-estimated oral health as the dependent variable and bad oral health used as the reference category, NT and DFT were both associated with the self-estimated oral health categories “neither good nor bad”, and “good” ($p < 0.0001$). BOP was only related to good self-perceived oral health ($p = 0.02$). Furthermore, there was an association for the self-estimated oral health categories “neither bad nor good”, and “good”, to self-perceived general health ($p = 0.04$ and $p < 0.001$, respectively). (Table 3).

Higher age and income were a positive significant factor for answering the questionnaire ($p < 0.05$). However, those who participated in the oral follow-up examination were significantly younger and had higher education level than the non-participants ($p < 0.001$). However, the income level did not influence the willingness to participate in the clinical examination ($p = 0.09$).

© Figure 1 Relationship between oral and general health divided into good, neither bad nor good and bad health, based on 691 individuals. Nagelkerke R2 0,34



© **Table 1** Self-estimated oral health in relation to clinical oral parameters. Means are given (SD)

	Bad Oral health	Neither bad nor good Oral health	Good Oral health	*P-value
N of individuals	39	80	251	
Number of teeth (NT)	23.2 (6.9)	26.0 (6.4)	27.6 (4.0)	P<0.017
Percent surfaces with plaque	17.4 (23.9)	14.7 (21.5)	10.0 (14.4)	ns
Percent bleeding on probing	23.9 (3.2)	21.4 (9.0)	15.4 (14.7)	P<0.017
Number of teeth pockets > 4mm	1.0 (3.4)	1.4 (4.0)	0.6 (2.3)	ns
Number of decayed and filled teeth (DFT)	14.3 (6.2)	11.0 (5.5)	12.4 (6.3)	ns
Number of decayed surfaces (DS)	1.3 (3.1)	0.7 (1.9)	0.3 (0.8)	P<0.017
Number of surfaces with secondary caries	0.6 (1.5)	0.3 (1.0)	0.1 (0.4)	P<0.017

*P<0.017 was regarded as significant difference between groups after correction for multiple testing with Bonferroni

© **Table 2** Self-estimated general health in relation to clinical oral parameters. Means are given (SD).

	Bad general health	Neither bad nor good general health	Good Oral health	*P-value
N of individuals	20	72	251	
Number of teeth (NT)	22.1 (6.5)	24.0 (7.5)	27.6 (4.0)	P<0.017
Percent surfaces with plaque	21.3 (27.8)	16.1 (19.7)	10.0 (14.4)	P<0.017
Percent bleeding on probing	24.5 (26.8)	20.1 (19.5)	15.4 (14.7)	Ns
Number of teeth pockets > 4mm	1.5 (4.4)	1.2 (3.4)	0.6 (2.3)	Ns
Number of decayed and filled teeth (DFT)	8.2 (5.4)	10.8 (7.5)	12.4 (6.3)	Ns
Number of decayed surfaces (DS)	2.0 (3.6)	0.6 (1.8)	0.3 (0.8)	P<0.017
Number of surfaces with secondary caries	0.7 (1.4)	0.3 (1.0)	0.1 (0.4)	P<0.017

*P<0.017 was regarded as significant difference between groups after correction for multiple testing with Bonferroni

© **Table 3** A logistic multinomial regression analysis based on 369 subjects with self-estimated bad oral health as reference category. OR= odds ratio, CI=confidence interval. Smoking grouped as current=1 and non-smokers=0, Education level, 9 years or less, between 10-12 years in school, and university studies. Disposable income was divided into three groups (high ≥ 40000 Euro/year; medium 20-39000 Euro/year; and low < 20000 Euro/year). All other covariates were used as continuous variables.

	Neither bad nor good self-estimated oral health			Good self-estimated oral health		
	OR	CI	P-value	OR	CI	P-value
N of teeth	1.32	1.13-1.53	<0.0001	1.47	1.26-1.71	<0.0001
N of decayed and filled teeth	0.79	0.70-0.89	<0.0001	0.77	0.69-0.86	<0.0001
N of decayed surfaces	0.94	0.74-1.18	0.58	0.81	0.60-1.05	0.18
% surfaces with plaque	1.02	0.97-1.06	0.46	1.02	0.98-1.06	0.36
% bleeding on probing	0.97	0.93-1.01	0.18	0.95	0.92-0.99	0.02
N of pockets > 4mm	1.06	0.92-1.24	0.43	1.0	0.84-1.18	0.96
Self-estimated general health bad/neither bad nor good/good	2.06	1.03-4.16	0.04	4.14	2.03-8.42	<0.001
Age	1.11	1.04-1.18	0.001	1.15	1.08-1.22	<0.0001
Smoking	0.80	0.23-2.76	0.72	0.34	0.10-1.18	0.09
Disposable income Euro	1.0	0.99-1.0	0.14	1.0	0.99-1.0	0.25
Educational level	1.43	0.71-2.87	0.31	1.58	0.81-3.08	0.18

Discussion

In the present study the self-perception of oral and general health was correlated and also related to some clinical dental health parameters. That self-perceived oral and general health was found to be significantly related is well in line (even if the measure of agreement can be interpreted as just fair) with results from a recent report using data from the third National Health and Nutrition Examination Survey (12). In contrast to the results from that study, the self-estimated oral or general health in the present study was not found to be significantly affected by socioeconomic factors such as disposable income or educational level. One explanation for the discrepancy in the results between the studies could be the differences in the oral and general health insurance systems. In Sweden, a National Dental Insurance system was introduced in 1973 with the purpose of providing good oral health on equal terms for the whole population (17). However, inequalities in oral health and the utilization of dental care were still found two decades after the introduction of the National Dental Insurance in Sweden (4).

Some researchers have suggested that there are systematic differences in health beliefs and health seeking behaviour for subjects from lower socioeconomic groups compared to subjects from higher socioeconomic groups. One effect of such behaviour could be that subjects from lower socioeconomic groups tend to underestimate their health status (2). This could explain why neither disposable income nor education level influenced the self-perception of oral health in the present study, although subjects with lower income or educational level had significantly worse clinically verified oral health than subjects with higher income or education. There seems to be an inequality for clinically verified oral health between different socioeconomic groups in the society which not always is perceived by individuals.

The correlation between self-estimated and clinically verified oral conditions has previously been shown to be quite good for number of teeth (16). In line with these findings, NT was the clinical parameter in the present study that was related to self-perceived oral health, as well as general health. There are few studies investigating self-perception of oral and general health and also exploring whether there are any oral parameters that influence the self-perception of oral and general health in the same individual. It seems that the perception of oral and general health comes from a cluster of feelings influenced by individuals' personal dental and health experiences.

An interesting finding in the present study is that almost the same clinical parameters that were related to the self-estimation of oral health were also related to self-perceived general health, with NT as one of these parameters. In recent studies from our group, NT was related to myocardial infarction, hypertension as well as metabolic syndrome (5, 6). As we do not have any clinical data regarding the subjects' general health in the present study, no evaluation of correlations between the subjects' clinically verified oral status and general health could be made. However, in the future, NT could possibly serve as an easily obtained risk indicator for different cardiovascular disorders.

Limitations

The present study had a low to moderate participation rate. Higher age and income significantly influenced the willingness to respond to the questionnaire. Those who answered the questionnaire and participated in the dental examination were significantly younger than those who just answered the questionnaire.

In health studies, health is often worse among non-participants than participants and the same pattern would probably be seen for oral health. This would, if anything, lead to an underestimation rather than an overestimation of the relationship presented in this study.

Conclusions

In the present study, self-estimation of oral and general health was correlated and related to some clinically oral parameters. Subjects in the low socioeconomic group had worse dental health and a tendency to underestimate their need of dental care.

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References

1. Buhlin K, Gustafsson A, Andersson K, Hakansson J, Klinge B. Validity and limitations of self-reported periodontal health. *Community Dent Oral Epidemiol* 2002;30: 431-7.
2. Dixon A, Le Grand J, Henderson J, Murray R, Poteliakhoff E. Is the british national health service equitable? The evidence on socio-economic differences in utilization. *Journal of health services research & policy* 2007;12: 104-9.
3. Heft MW, Gilbert GH, Shelton BJ, Duncan RP. Relationship of dental status, sociodemographic status, and oral symptoms to perceived need for dental care. *Community Dent Oral Epidemiol* 2003;31: 351-60.
4. Hjern A, Grindefjord M, Sundberg H, Rosen M. Social inequality in oral health and use of dental care in Sweden. *Community Dent Oral Epidemiol* 2001;29:167-74.
5. Holmlund A, Holm G, Lind L. Severity of periodontal disease and number of remaining teeth are related to the prevalence of myocardial infarction and hypertension in a study ased on 4,254 subjects.
6. Holmlund A, Hulthe J, Lind L. Tooth loss is related to the presence of metabolic yndrome and inflammation in elderly subjects:A prospective study of the vasculature in Uppsala seniors (pivus). *Oral health & preventive dentistry* 2007;5: 125-30.
7. Hugoson A, Sjodin B, Norderyd O. Trends over 30 years, 1973-2003, in the prevalence and severity of periodontal disease. *J Clin Periodontol* 2008;35: 405-14.
8. Johansson G, Soderfeldt B, Gerdin EW, Halling A, Axtelius B, Ostberg AL. Measuring oral health from a public health perspective. *Swed Dent J* 2008;32: 125-37.
9. Kinane D, Bouchard P. Periodontal diseases and health: Consensus Report of the Sixth European Workshop on Periodontology. *J Clin Periodontol*. 2008, Sep;35(8 Suppl):333-7.
10. Lundegren N, Axtelius B, Hakansson J, Akerman S. Dental treatment need among 20 to 25-year-old swedes: Discrepancy between subjective and objective need. *Acta Odontol Scand* 2004;62: 91-6.
11. Nicolau B, Marcenes W, Bartley M, Sheiham A. Associations between socio-economic circumstances at two stages of life and adolescents' oral health status. *J Public Health Dent* 2005;65: 14-20.
12. Sabbah W, Tsakos G, Chandola T, Sheiham A, Watt RG. Social gradients in oral and general health. *J Dent Res*. 2007 Oct;86(10):992-6.
13. Stahlacke K, Soderfeldt B, Unell L, Halling A, Axtelius B. Perceived oral health: Changes over 5 years in one swedish age-cohort. *Community Dent Oral Epidemiol* 2003;31: 292-9.
14. Unell L, Soderfeldt B, Halling A, Birkhed D. Explanatory models for clinically determined and symptom- reported caries indicators in an adult population. *Acta Odontol Scand* 1999;57: 132-8.
15. Unell L, Soderfeldt B, Halling A, Birkhed D. Explanatory models for clinical and subjective indicators of periodontal disease in an adult population. *J Clin Periodontol* 2000;27: 22-9.
16. Unell L, Soderfeldt B, Halling A, Paulander J, Birkhed D. Oral disease, impairment, and illness: Congruence between clinical and questionnaire findings. *Acta Odontol Scand* 1997;55: 127-32.
17. Whitehead M, Evandrou M, Haglund B, Diderichsen F. As the health divide widens in Sweden and Britain, what's happening to access to care? *Bmj* 1997;315: 1006-9. *J Periodontol* 2006;77: 1173-8.

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Cellular responses to cobalt-chrome and CP titanium – an *in vitro* comparison of frameworks for implant-retained oral prostheses

LARS HJALMARSSON¹, JAN-IVAN SMEDBERG^{2,3}, GUNILLA ARONSSON⁴, ANN WENNERBERG^{5,6}

Abstract

© The responses of cell types in peri-implant tissues to cobalt-chrome and titanium were studied *in vitro*. Cylinders were made from both a cobalt-chrome alloy and commercially pure titanium (length 6 mm, diameter 7.9 mm). Plastic tubes were placed over the cylinders to create cell culture wells, in which human epithelial cells or mouse fibroblasts were cultivated. Cell viability was studied using the Alamar Blue™ method. The surface structure of two samples of each material was analyzed with optical interferometry. The morphology of cells grown on cylinders of each material was studied with scanning electronic microscopy. Epithelial cells and fibroblasts in the titanium group were more viable than those in the cobalt-chrome group ($p = 0.001$ and $p = 0.000$, respectively). The titanium surfaces had a greater height deviation (S_a , $p = 0.027$) but were less dense (S_{ds} , $p = 0.044$) than the cobalt-chrome group. The scanning electronic microscopy revealed no major deviations from normal cell morphology.

Within the limitations of the present study, the findings indicate that epithelial cells as well as fibroblasts have a stronger negative response to cobalt-chrome alloy than to titanium. We suggest that these differences can be explained only by the material *per se* and not by the minor differences in surface structure. Further and clinical studies are needed to confirm the significance of these findings.

Key words

Viability, epithelial cells, fibroblasts; cobalt-chrome, CP titanium

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Cellreaktioner mot broskelett för implantatretinerade konstruktioner av kobolt-kromlegering och kommersiellt rent titan. En jämförande *in vitro*-studie.

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Sammanfattning

⊙ Kobolt-kromlegeringar används allt oftare som skelettmaterial för implantatretinerade broar. Låg framställningskostnad och goda mekaniska egenskaper kan vara orsaken till detta. Men biokompatibiliteten hos kobolt-kromlegeringar har ifrågasatts och kunskapen om hur dessa material påverkar den implantanära vävnaden är ytterst begränsad. Studier har visat att även ytråheten hos ett material kan påverka hur väl epitelceller och fibroblaster etablerar sig på materialets yta.

Syftet med denna *in vitro*-studie var att undersöka reaktioner hos epitelceller och fibroblaster i kontakt med provkroppar i kobolt-kromlegering eller kommersiellt rent (CP) titan. Cylinderformade provkroppar (höjd 6mm, diameter 7,9mm) i de två materialen framställdes genom att efterlikna Cresco™-metoden för framställning av implantatretinerade broskelett. Provkroppar skapades genom att en plastslang trädades över respektive provkropp och humana epitelceller respektive musfibroblaster odlades i dem. Cellviabiliteten studerades med Alamar Blue™-metoden och experimenten upprepades två gånger. Ytstrukturen hos två provkroppar i vardera material studerades med optisk interferometri. Morfologin hos de odlade cellerna studerades med scanning-elektronmikroskopi (SEM).

Resultaten visade att epitelcellerna och fibroblasterna som hade odlats på titanprovkroppar var mer viabla än de som odlats på kobolt-kromprovkroppar (epitelceller $p = 0.001$; fibroblaster $p = 0.000$). De studerade titanytorna hade en större höjddeviation (S_a , $p = 0.027$) men hade färre toppar och dalar per ytenhet (S_{ds} , $p = 0.044$) än koboltkromytorna. Ingen större avvikelse från normalmorfologin kunde upptäckas vid SEM-undersökningarna.

Trots denna *in vitro*-studies begränsningar indikerar fynden från den att epitelceller och fibroblaster reagerar mer negativt i kontakt med kobolt-kromlegering än i kontakt med CP titan. Vår slutsats blir att detta snarare beror på materialens kemiska sammansättning än på smärre skillnader i deras ytstruktur. Ytterligare studier krävs för att visa den kliniska betydelsen av de aktuella fynden.

Introduction

Commercially pure (CP) titanium has long been the preferred material for intra-oral implant abutments. But the ability to manufacture prostheses directly on implants without abutments has enabled the use of alternative materials. Among these are cobalt-chrome alloys, primarily due to their low cost and favorable mechanical properties.(12, 24) Yet, little is known about the biocompatibility of cobalt-chrome frameworks.(16, 17) To our knowledge, there are no clinical reports on the histology of the peri-implant soft tissue when different metals have been used for the transmucosal components.

The biocompatibility of a dental device is closely connected to how likely it is to corrode. Corrosive processes are known to lead to the release of metal ions from dental or implant supported restorations. (9, 13, 26) Biological responses to corrosion have been associated with toxicity (both local and systemic), hypersensitivity, allergy, mutagenicity and carcinogenicity.(4, 7, 8, 26) Specifically, the cytotoxicity of cobalt to fibroblast cultures(4), and the ability of cobalt-chrome particles to induce the release of inflammatory mediators from macrophages have been described.(16) Almost every metal used in dental devices has been associated with hypersensitivity.(21, 25) Yet, it is not known why some metal ions can cause allergic reactions with various clinical symptoms while others do not.

Corrosion can change both the chemical composition and the surface structure in an implant component.(13) These factors have been discussed in conjunction with reactions in peri-implant soft tissues.(1, 14) Both epithelial cells and fibroblasts can be in contact with the transmucosal part of an oral implant system in vivo, subsequently it is essential to understand how implant components affect these cells. Interestingly, in vitro studies indicate that epithelial cells prefer smooth surfaces and fibroblasts rougher surfaces.(5, 6, 14, 15, 19, 20) So, the surface structures as well as the chemical composition must be considered when comparing the biocompatibility of different materials.

Several techniques are available for fabricating an abutment-free framework, including Computer Numeric Controlled (CNC) milling techniques such as I-Bridge® (Biomain AB, Helsingborg, Sweden) and Procera® Implant Bridge (Nobel Biocare AB, Gothenburg, Sweden). Another procedure is the Cresco™ method (Astra Tech AB, Mölndal, Sweden), a combination of traditional casting, sectioning and laser-welding (10, 11), with a laser-welded joint close to

the soft tissues. Yet, it is not well understood how frameworks made using this method influence the surrounding tissues.

The aim of this in vitro study was to assess possible adverse cellular responses to cobalt-chrome frameworks for implant-retained, intra-oral prostheses. This was done by comparing the viability and morphology of epithelial cells and fibroblasts cultivated on cobalt-chrome (test) and titanium (control) specimens made using the Cresco™ method.

Material and methods

Test specimens

Semicircular specimens (length 6 mm, diameter 7.9 mm) were fabricated in a cobalt-chrome alloy (Wirobond C, BEGO Bremer Goldschlägerei Wilh. Herbst GmbH & Co, Bremen, Germany) and in grade II CP titanium (Sjödings, Stockholm, Sweden) (Fig. 1). After shaping a wax pattern (Gator Wax Blue, WhipMix, Louisville, Kentucky, USA), a silicone mold (Zetalabor, Zhermack, Badia Polesine, Italy) was made for producing the subsequent patterns. The wax patterns were sprued with a 5-mm piece of wax (Yeti Dental Deton, Engen, Germany). The patterns for the cobalt-chrome specimens were then invested in GC Fuji Super (Leuven, Belgium) and those for the titanium specimens in Titavest CB (Morita, Japan). The specimens were cast in a Bego Nautilus (BEGO, Bremen, Germany), and the in a Cyclark II (Morita, Japan) casting machine, respectively.

The cast cobalt-chrome and titanium specimens were laser-welded together with semicircular shaped

© Figure 1. Semicircular cast titanium specimens.



© **Figure 2.** Semicircular specimens ready to be laser-welded together to form a cylinder.



© **Figure 3.** Cylinder with cast half (left), weld joint (middle) and prefabricated half (right).



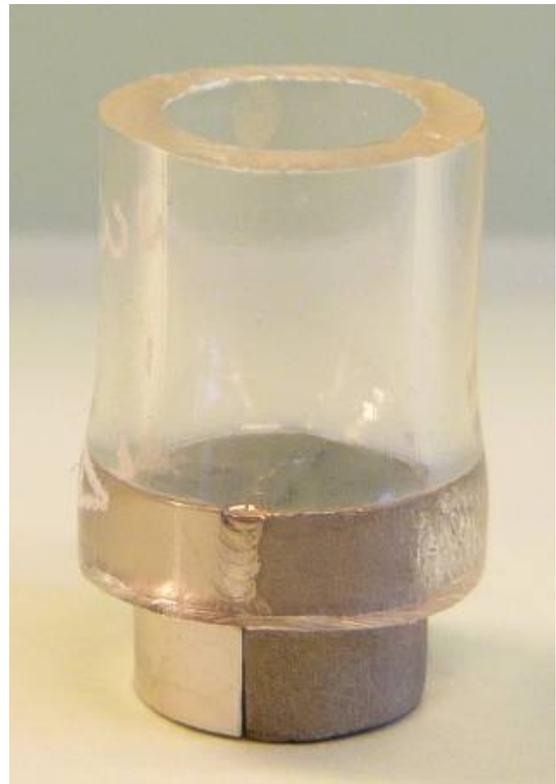
(length 6 mm, diameter 7.9 mm), prefabricated, i.e. milled, specimens in Wirobond SG and titanium grade IV, respectively (Figs. 2-3). Thus, cylinders were produced in cobalt-chrome alloy (Co-Cr) and in titanium (Ti). This procedure imitated the Cresco™ method (10-12) for implant-retained dental prostheses. Laser welding was performed in an experienced laboratory (Titanbron AB, Kristianstad, Sweden). Except for the duration of the laser pulse

and the different welding wires used, the procedures were the same for the two materials. The laser pulse lasted for 7.0 ms at each welding point for Co-Cr and 3.7 ms for Ti. A Co-Cr wire, 0.35 mm in diameter (Denthouse Amann Girrbach, Pforzheim, Germany) was used for the Co-Cr specimens and a grade 1 titanium wire, 0.3 mm in diameter (DSI Laser-Service GmbH, Maulbronn, Germany) was used for the titanium specimens. After laser welding the Ti cylinders were marked T1-75 and the Co-Cr cylinders 1-75, respectively.

Culture wells

Experimental wells were produced by slipping a sterile piece of PVC tubing (Tygon B-44-4x) around each specimen (Fig. 4).(22) Wells in 96-well tissue culture plates (Nunc, Denmark) were used for controls and for absorbance measurements. The specimens and the PVC tubing were washed in 2% Deco-nex 11 universal/tap water, rinsed in Milli-Q water (QPAK®1, Millipore AB, Nödinge, Sweden), sterilized in 70% ethanol, rinsed again in sterile Milli-Q water and dried in a laminar flow hood.

© **Figure 4.** Culture well.



Cell cultures

HeLa (CCL-2) human epithelial cells (ATCC, Manassas, Virginia, USA) and L929 mouse fibroblasts (CCL-1, Biochrome, Berlin, Germany) were used as model cell lines. The cells were cultured in Minimal Essential Medium (Eagle, Biochrome) with Earle's salt supplemented with L-glutamine (200 mM), sodium pyruvate (1 mM), non-essential amino acids (x1), penicillin (100 U/ml), streptomycin (100 µg/ml), and 10 % serum (fetal calf serum, HeLa, or; newborn calf serum, L929; all from Biochrome). The cells were cultured at 37°C in a controlled atmosphere with saturated humidity, 95% air and 5% CO₂. Cells were maintained in 25 cm³ flasks (Sarstedt, Germany). For cell culture experiments, cells were detached with 0.25% Trypsin with 0.02% EDTA solution (Biochrome).

Cell viability

Cell viability was quantified using the Alamar Blue™ bioassay (AB; Biosource, Camarillo, California, USA) as directed by the manufacturer. AB is a colorimetric assay, based on the selective ability of viable cells to reduce resazurin from an oxidized blue color to red color.⁽³⁾ The degree of color change is assumed to be directly proportional to cell numbers.⁽³⁾ In each experiment, 5000 cells were plated in each of six wells from each test material (Ti and Co-Cr) and in 12 control wells in a 96-well tissue culture plate. Six of the 12 control wells were used as negative controls (untreated cells) and six as positive controls (azid treated). The cells were cultured for 72 hours, and the medium was renewed every 24 hours. In the positive control wells, the culture medium was supplemented with 20 mM sodium azid in the final 24 hour-period. Reference wells without cells were used for calculating the reduction of AB. The 10% AB solution in culture medium was added to all wells and the plates were subsequently incubated for 2.5 h (HeLa) and 4 h (L929). The AB solution was then transferred to wells in a 96-well cell culture plate (for each material: test and control wells with cells n = 6; test wells without cells n = 5; control wells without cells n = 6) for absorbance measurement at 570 nm and 600 nm using a microplate reader (Spectra Max 340, Molecular Devices, Sunnyvale, California, USA) and the software SOFT max PRO (Molecular Devices). Three experiments on each test material (Ti and Co-Cr) were performed with each cell line. Reduction of AB by cells was calculated as the percentage reduction from the blue oxidized form of AB to red reduced form. The mean values from the

three experiments on each material were used for comparison between the test groups.

Optical interferometry

To observe any differences in surface structure of the test specimens, optical interferometry was used. The surfaces of four test specimens, two in cobalt-chrome and two in titanium, were examined at 15 locations each: 5 at the cast part, 5 at the weld-joint and five at the prefabricated part (Fig. 3). Surface topography was analyzed in 3D with an interferometer, (MicroXam™, Ade Phase Shift, Tuscon, Arizona, USA).⁽²⁷⁾ All measurements were made at 50 times magnification, with a zoom factor of 0.62 and a maximal measured area of 200 x 260 µm. The maximal vertical range was 5 mm, the horizontal resolution was 0.3 µm and the vertical resolution was 0.1 nm. To separate errors of form and waviness from roughness, a Gaussian digital filter of 50 x 50 µm was used. Six surface parameters were calculated:

S_t - Maximum peak to valley height of the surface (µm);

S_a - The arithmetic mean deviation of the surface (µm), a parameter used to describe height variations;

S_{ds} - The density of the summits of the surface (number/µm²), a parameter used to describe spatial variations;

S_{sk} - Skewness, the symmetry of surface about the average height;

S_{dr} - Developed surface ratio, i.e. the quotient of the measured surface and corresponding totally flat area (%);

S_{ci} - Core fluid retention index.

Scanning electron microscopy (SEM)

For morphology studies, one specimen of each material was prepared with cells (5000 cells/specimen) as in the viability assay. Specimens with adhered cells were transferred to 2.5% glutaraldehyde for 60 min, rinsed with Na cacodylate buffer and postfixed in 1% OsO₄ (15 min). Specimens were then dehydrated in a graded ethanol series and dried with hexamethyldisilazane for 2 x 5 min. All specimens were then sputter-coated with palladium and investigated in a Zeiss DSM 982 Gemini (Zeiss, Oberkochen, Germany) SEM operating at 3 kV. Micrographs were recorded at several defined areas of the discs and at different magnifications.

Statistical Analyses

Alamar Blue

Conventional descriptive statistics were used to present the percentage of reduction in the AB tests. For detecting differences between the four groups, ANOVA was applied. Due to differences in variance, both the Dunnett T3-test and the Bonferroni method were used for detecting groups that differed. The Student's t-test was used when the differences between the two test groups were compared.

Optical interferometry

Conventional descriptive statistics were used to present the surface roughness values for the two groups. The Student's t-test was used for detecting differences between the groups regarding the parameters S_a , S_{ds} , S_{sk} and S_{ci} , and Mann Whitney's U-test was used for detecting differences between the groups for the parameters S_t and S_{dr} . The significance level was set at 5% ($p < 0.05$) for both the Alamar Blue tests and the optical interferometry analyses.

Results

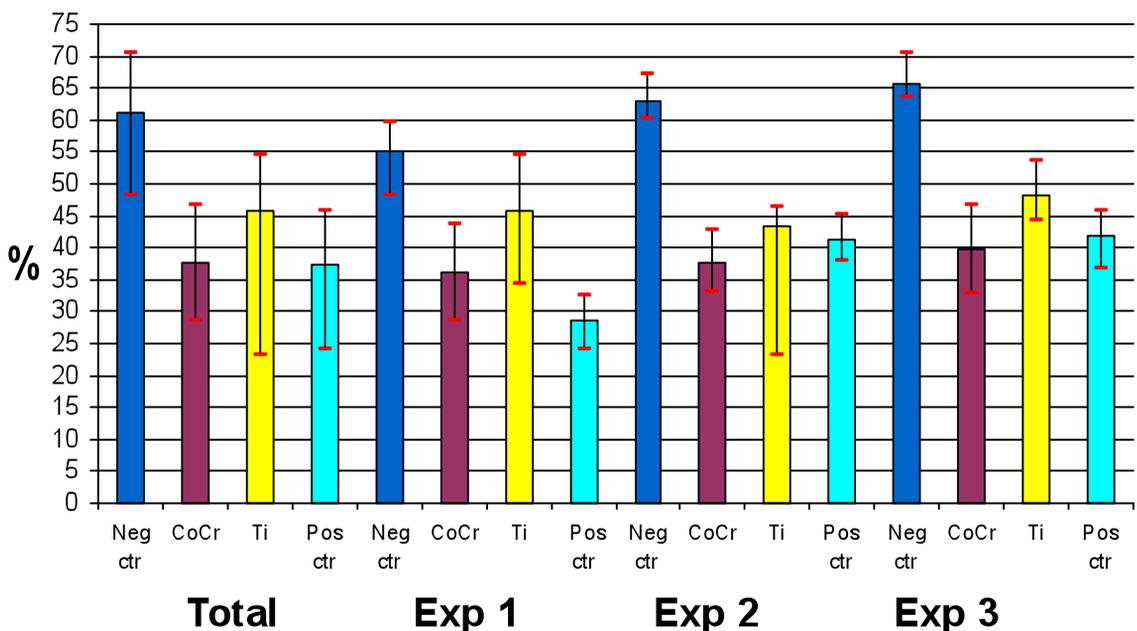
Viability

The biocompatibility of the tested Co-Cr and Ti surfaces was investigated by measuring the reduc-

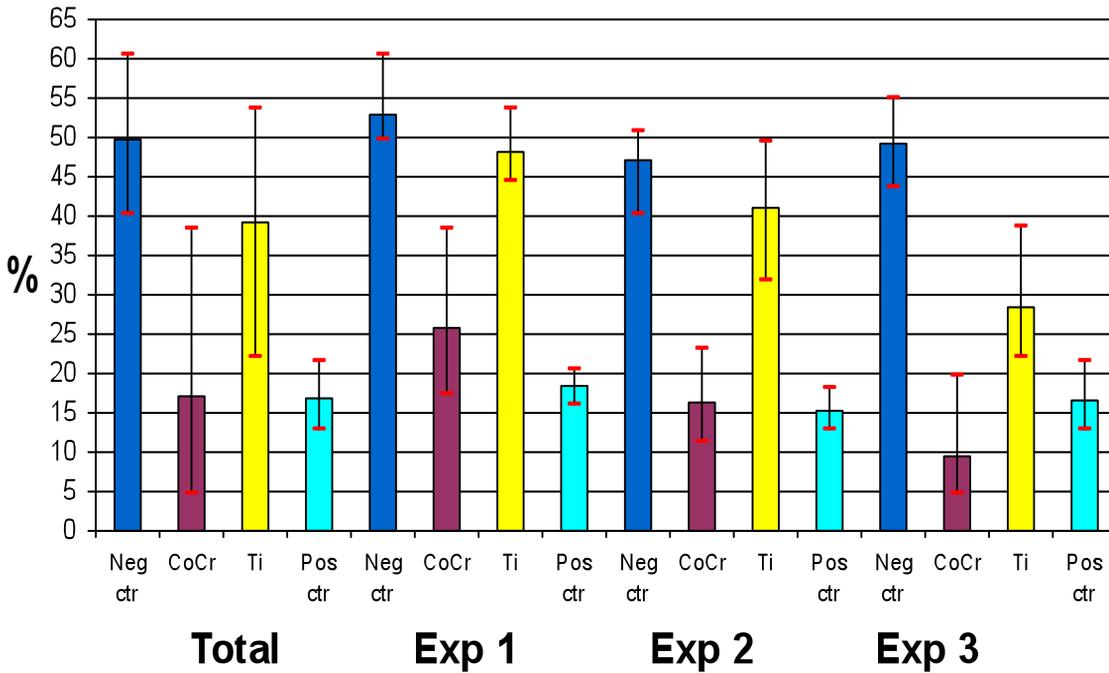
tion activity of the two cell groups by using the AB bioassay. The following levels of percentage reduction, from the blue oxidized form of AB to red reduced form, were obtained for the three experiments on epithelial cells: 36.0% (standard deviation 5.5), 37.7% (3.2) and 39.6% (4.9) for the Co-Cr group; and 45.7% (7.8), 45.4% (9.9) and 48.1% (3.3) for the Ti group (Fig. 5). Taken the three experiments together, we measured a statistically significantly higher cell viability in the Ti group than in the Co-Cr group, ($p = 0.001$, 95% confidence interval (C.I.) 3.76-12.12). In experiment 3, the cells in the Ti group showed statistically significantly higher viability ($p = 0.04106$, 95% C.I. 3.01-13.96) compared to the cells of the Co-Cr group. No such differences were observed in experiment 1 and 2.

The three AB experiments on fibroblasts resulted in the following levels of AB reduction: 25.7% (7.0), 16.2% (4.2) and 9.6% (5.6) for the Co-Cr group; and for the Ti group 48.2% (3.9), 41.2% (7.3) and 28.4% (5.8), respectively (Fig. 6). In total, the three experiments demonstrated a statistically significantly higher cell viability in the Ti group than in the Co-Cr group ($p = 0.000$, 95% C.I. 15.44-28.52). In all three experiments, the cells in the Ti group were statistically significantly more viable than the cells in the Co-Cr group ($p = 0.0009$, 95% C.I. -30.14 - -14.86;

© **Figure 5** Epithelial cell reduction of AlamarBlue™ (%) in total (n=18 for each group) and in experiments 1-3 (n=6 for each group). Mean values and ranges for control groups (neg ctr = negative control, i.e. untreated cells; pos ctr = positive control, i.e. wells where the culture medium was supplemented with 20 mM sodium azide) and test groups (Ti = titanium, CoCr = cobalt-chrome). Exp = experiment. According to the protocol of the experiments a reduction percentage exceeding 60-70% are not realistic.



© **Figure 6.** Fibroblast reduction of AlamarBlue™ (%) in total (n=18 for each group) and in experiments 1-3 (n=6 for each group except for Ti in the second experiment where n=5). Mean values and range for control groups (neg ctr = negative control, i.e. untreated cells; pos ctr = positive control, i.e. wells where the culture medium was supplemented with 20mM sodium azide) and test groups (Ti = titanium, CoCr = cobalt-chrome). Exp = experiment. According to the protocol of the experiments a reduction percentage exceeding 60-70% are not realistic.



$p = 0.0026$, 95% C.I. -33.91 - -16.04; $p = 0.0055$, 95% C.I. -26.14 - -11.52, respectively). No differences were observed between the Ti group and the negative control group in two out of the three experiments. In fibroblast experiment 2, one of the titanium culture wells leaked, so only five titanium culture wells (instead of six) could be analyzed.

Surface structures

The surface parameters for the two groups are presented in Table 1. No statistically significant differences were obtained when differences between the parameters S_t , S_{sk} , S_{dr} and S_{ci} were compared. Yet, the titanium surfaces had a greater height deviation (S_a) but were less dense (S_{ds}) than the Co-Cr surfaces (Table 1).

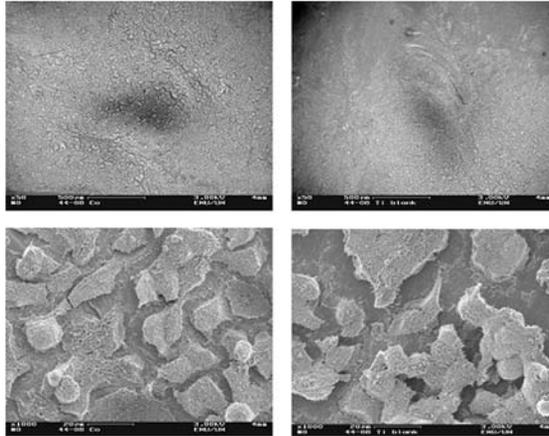
Cell morphology

The SEM studies revealed no major deviations from normal epithelial cell or fibroblast morphology (Figs 7-8). However, the Co-Cr surfaces had tendencies of fewer and more rounded cells compared to the Ti surfaces. All three surface sections, the cast, the

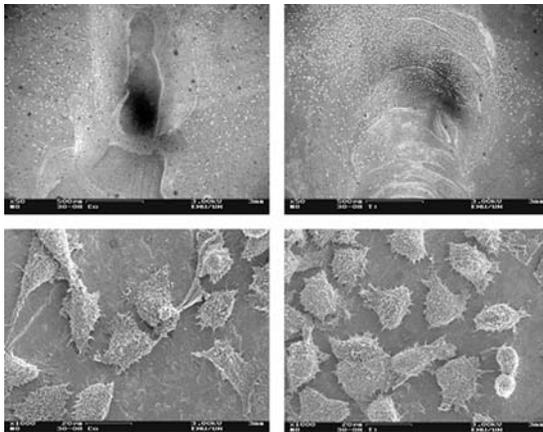
© **Table 1.** Interferometry measurement of surface parameters for the cobalt-chrome and the titanium surface groups. Mean values, standard deviation (SD). Differences between the two groups reported as p values (n.s. = non-significant, * = significant). S_t - Maximum peak to valley height of the surface (μm); S_a - The arithmetic mean deviation of the surface (μm), a parameter used to describe height variations; S_{ds} - The density of the summits of the surface (number/ μm^2), a parameter used to describe spatial variations; S_{sk} - Skewness, the symmetry of surface about the average height; S_{dr} - Developed surface ratio, i.e. quotient of the measured surface and corresponding totally flat area (%); S_{ci} - Core fluid retention index. The Ti surfaces were significantly rougher than the Co-Cr surfaces when S_a values were compared (95% CI -0.13 - -0.01) and the Co-Cr surfaces were rougher than the Ti surfaces when the S_{ds} values were compared (95% CI 0.29 - 20.27). CI = confidence interval.

Parameter	Mean(SD)		p value
	CoCr (n=30)	Ti (n=30)	
S_t μm	7.22 (8.92)	13.26 (19.14)	0.308 n.s.
S_a μm	0.15 (0.11)	0.21 (0.16)	0.027 *
S_{ds} / μm^2	143.21 (19.89)	132.93 (18.75)	0.044 *
S_{sk}	-0.60 (1.68)	0.11 (4.39)	0.566 n.s.
S_{dr}	3.71 (4.34)	4.39 (4.91)	0.469 n.s.
S_{ci}	1.18 (0.37)	1.19 (0.45)	0.384 n.s.

© **Figure 7.** Cobalt-chrome specimen surface (left) and titanium specimen surface specimen (right) with epithelial cells.



© **Figure 8.** Cobalt-chrome specimen surface (left) and titanium specimen surface specimen (right) with fibroblasts. The two upper photographs show fibroblasts on and close to the weld joints. Note the irregularities in the weld joints.



weld-joint and the prefabricated (i.e. milled) of both materials were covered with cells (Fig. 3).

Discussion

The present study demonstrated that both epithelial cells and fibroblasts were more viable when in contact with titanium surfaces compared to cobalt-chrome surfaces. We suggest that these differences can be explained only by the material per se and not by the minor differences in surface structure. In a previous in-vitro study, *Hjalmarsson et al.* (13) examined elemental leakage from implant retained

frameworks to an artificial saliva solution. The same alloys of titanium and cobalt-chrome as in the present study were used for the framework fabrication. In addition, the Cresco™ method was also used. Statistically significant higher leakage of cobalt as compared to chrome and titanium were registered (13). Given these facts, and taken into account the cytotoxicity of cobalt demonstrated by Arvidson and co-workers (4), it seems reasonable to believe that the mechanisms behind the cell reactions in the present study involve material degradation and corrosive processes, leading to elemental leakages on the test specimen surfaces. However, the mentioned studies as well as the present experiments were all made in vitro and hence have their limitations. As a consequence, there is a need for further studies to investigate the clinical significance of the present findings.

Even though several studies have focused on the in vitro behavior and reactions of fibroblasts rather than of epithelial cells, the in vitro environment and conditions for fibroblasts are generally less representative of the normal in vivo situation than are corresponding studies for epithelial cells (18). Furthermore, because both epithelial cells and fibroblasts can be in contact with the transmucosal part of an implant system, we found it interesting to examine both cell types.

Surface roughness was similar for the two materials, except for two surface parameters (Table 1). The mean S_a values in our study were $0.15 \mu\text{m}$ for the cobalt-chrome surfaces and $0.21 \mu\text{m}$ for the titanium surfaces. An animal study demonstrated no influence on soft tissue adhesion regardless of whether titanium abutments were smooth or rough (S_a $0.22 \mu\text{m}$ and $0.45 \mu\text{m}$, respectively). (2) Quirynen et al. suggested that variations in surface roughness (i.e. S_a) of $0.2 \mu\text{m}$ may be regarded as a threshold value, below which no further impact on plaque accumulation and bacterial colonization should be expected (23). Yet, other animal and human studies have failed to find a connection between abutment surface structure and inflammatory response in the surrounding tissues (28, 29).

Titanium is a well-established material for implants as well as for transmucosal components and prosthetic frameworks. Although alternative materials such as cobalt-chrome alloys may be interesting due to low costs and good mechanical properties, this in vitro study raises doubts about their biocompatibility as transmucosal components of an oral implant system. Further studies are needed to confirm the clinical significance of these findings.

Conclusions

Within the limitations of this *in vitro* study, it was concluded that:

- The viability of epithelial cells and fibroblasts was better on titanium surfaces than those made of cobalt-chrome.
- These differences were explained by the material (titanium or cobalt-chrome) *per se* and not by small differences in surface structure.
- No major deviations from normal epithelial cell or fibroblast morphology were revealed by the SEM examinations.

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References

1. Abrahamsson I, Berglund T, Lindhe J. The mucosal barrier following abutment dis/reconnection. An experimental study in dogs. *J Clin Periodontol* 1997;24:568-72.
2. Abrahamsson I, Zitzmann NU, Berglund T, Linder E, Wennerberg A, Lindhe J. The mucosal attachment to titanium implants with different surface characteristics: an experimental study in dogs. *J Clin Periodontol* 2002;29:448-55.
3. Ahmed SA, Gogal R M Jr, Walsh JE. A new rapid and simple non-radioactive assay to monitor and determine the proliferation of lymphocytes: an alternative to [³H] thymidine incorporation assay. *J Immunol Methods* 1994;170:211-24.
4. Arvidson K, Cottler-Fox M, Hammarlund E, Friberg U. Cytotoxic effects of cobalt-chromium alloys on fibroblasts derived from human gingiva. *Scand J Dent Res* 1987; 95:356-63.
5. Baharloo B, Textor M, Brunette DM. Substratum roughness alters the growth, area, and focal adhesions of epithelial cells, and their proximity to titanium surfaces. *J Biomed Mater Res A* 2005;74:12-22.
6. di Carmine M, Toto P, Feliciani C, Scarano A, Tulli A, Strocchi R, Piattelli A. Spreading of epithelial cells on machined and sandblasted titanium surfaces: an *in vitro* study. *J Periodontol* 2003;74:289-95.
7. Evans EJ. Cell damage *in vitro* following direct contact with fine particles of titanium, titanium alloy and cobalt-chrome-molybdenum alloy. *Biomaterials* 1994;15:713-7.
8. Evans EJ, Benjamin M. The effect of grinding conditions on the toxicity of cobalt-chrome-molybdenum particles *in vitro*. *Biomaterials* 1987;8:377-84.
9. Geurtsen W. Biocompatibility of dental casting alloys. *Crit Rev Oral Biol Med* 2002;13:71-84.
10. Helldén LB, Dérand T. Description and evaluation of a simplified method to achieve passive fit between cast titanium frameworks and implants. *Int J Oral Maxillofac Implants* 1998;13:190-6.
11. Helldén LB, Dérand T, Johansson S, Lindberg A. The CrescoTi Precision method: description of a simplified method to fabricate titanium superstructures with passive fit to osseointegrated implants. *J Prosthet Dent* 1999;82:487-91.
12. Helldén LB, Ericson G, Olsson C O. The Cresco Bridge and implant concept: presentation of a technology for fabrication of abutment-free, passively fitting superstructures. *Int J Periodontics Restorative Dent* 2005;25:89-94.
13. Hjalmarsson L, Smedberg JI, Wennerberg A. Material degradation in implant-retained cobalt-chrome and titanium frameworks. *J Oral Rehabil* 2011;38:61-71.
14. Hormia M, Könönen M, Kivilahti J, Virtanen I. Immunolocalization of proteins specific for adherens junctions in human gingival epithelial cells grown on differently processed titanium surfaces. *J Periodontol Res* 1991;26:491-7.
15. Hormia M, Könönen M. Immunolocalization of fibronectin and vitronectin receptors in human gingival fibroblasts spreading on titanium surfaces. *J Periodontol Res* 1994;29:146-52.
16. Howie DW, Rogers SD, McGee MA, Haynes DR. Biologic effects of cobalt chrome in cell and animal models. *Clin Orthop Relat Res* 1996; 5217-32.
17. Hulterström M, Nilsson U. Cobalt-chromium as a framework material in implant-supported fixed prostheses: a preliminary report. *Int J Oral Maxillofac Implants* 1991;6:475-80.
18. Klinge B, Meyle J. Soft-tissue integration of implants. Consensus report of Working Group 2. *Clin Oral Implants Res* 2006;17 Suppl 2:93-6.
19. Könönen M, Hormia M, Kivilahti J, Hautaniemi J, Thesleff I. Effect of surface processing on the attachment, orientation, and proliferation of human gingival fibroblasts on titanium. *J Biomed Mater Res* 1992;26:1325-41.
20. Lauer G, Wiedmann-Al-Ahmad M, Otten JE, Hubner U, Schmelzeisen R, Schilli W. The titanium surface texture effects adherence and growth of human gingival keratinocytes and human maxillary osteoblast-like cells *in vitro*. *Biomaterials* 2001;22:2799-809.
21. Namikoshi T, Yoshimatsu T, Suga K, Fujii H, Yasuda K. The prevalence of sensitivity to constituents of dental alloys. *J Oral Rehabil* 1990;17:377-81.
22. Niederauer GG, McGee TD, Keller JC, Zaharias RS. Attachment of epithelial cells and fibroblasts to ceramic materials. *Biomaterials* 1994;15:342-52.
23. Quirynen M, Bollen CM, Papaioannou W, van Eldere J, van Steenberghe D. The influence of titanium abutment surface roughness on plaque accumulation and gingivitis: short-term observations. *Int J Oral Maxillofac Implants* 1996;11:169-78.
24. Sertgoz A, Guvener S. Finite element analysis of the effect of cantilever and implant length on stress distribution in an implant-supported fixed prosthesis. *J Prosthet Dent* 1996;76:165-9.

25. Tschernitschek H, Borchers L, Geurtsen W. Nonalloyed titanium as a bioinert metal--a review. *Quintessence Int* 2005;36:523-30.
26. Wataha JC. Biocompatibility of dental casting alloys: a review. *J Prosthet Dent* 2000;83:223-34.
27. Wennerberg A, Ohlsson R, Rosén BG, Andersson B. Characterizing three-dimensional topography of engineering and biomaterial surfaces by confocal laser scanning and stylus techniques. *Med Eng Phys* 1996;18:548-56.
28. Wennerberg A, Sennerby L, Kultje C, Lekholm U. Some soft tissue characteristics at implant abutments with different surface topography. A study in humans. *J Clin Periodontol* 2003;30:88-94.
29. Zitzmann NU, Abrahamsson I, Berglundh T, Lindhe J. Soft tissue reactions to plaque formation at implant abutments with different surface topography. An experimental study in dogs. *J Clin Periodontol* 2002;29:456-61.

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Sleeping position and reported quality of sleep. A comparison between subjects demanding treatment for temporomandibular disorders and controls

ANNA-KERSTIN GÖTHE MUNDT¹, MARTTI HELKIMO¹, TOMAS MAGNUSSON²

Abstract

© The aims of the present study were to investigate if there are differences concerning preferred body posture during sleep between 100 patients, 66 women and 34 men, mean age: 49 years (range: 20-85 years) referred to a specialist clinic because of TMD and 100 matched controls from a public dental clinic.

The participants were asked to answer a questionnaire with questions about TMD symptoms and neck or shoulder pain. They were also asked about preferred sleeping position as well as about perceived sleep quality.

No differences could be found between the two groups in respect of sleeping position. However, significantly more individuals in the TMD group compared to the controls had changed their preferred sleeping position due to their face and/or jaw and/or neck-shoulder symptoms. Subjects in the TMD group also more frequently stated that they often felt insufficiently rested at awakening and/or felt tired or sleepy in the daytime because of symptoms from face/jaws. A significant number in the control group reported TMD symptoms indicating a latent need for TMD treatment.

It is concluded that sleep position seems to have little or no significance for the development or maintenance of TMD symptoms. However, the study indicates that TMD symptoms and associated neck- and shoulder pain affect the quality of sleep.

Key words

Sleeping posture, sleep comfort, CMD, questionnaire

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Sovställning och rapporterad sömnkvalitet hos patienter med överbelastningssymtom i käksystemet jämfört med en kontrollgrupp

ANNA-KERSTIN GÖTHE MUNDT, MARTTI HELKIMO, TOMAS MAGNUSSON

Sammanfattning

☉ Syftet med studien var att undersöka om det förelåg skillnader beträffande favoritsovställning mellan 100 patienter, 66 kvinnor och 34 män, medelålder 49 år (Spridning: 20-85 år) som remitterats till specialistklinik på grund av funktionsstörning i käksystemet och en ålders- och könsmatchad kontrollgrupp. Kontrollgruppen bestod av patienter som kommit för revisionsundersökning till en allmäntandvårdsklinik.

Deltagarna ombads att besvara en enkät med frågor om subjektiva symtom på funktionsstörning i käksystemet, huvudvärk och/eller nack- skulderbesvär minst en gång per vecka. De tillfrågades också om sin favoritsovställning och hur de upplevde sin sömnkvalitet.

Ingen skillnad kunde konstateras mellan grupperna avseende favoritsovställning. Däremot hade signifikant fler av de remitterade patienterna ändrat sin sovställning till följd av symtom i ansikte och/eller käkar och/eller nacke/skuldror. De remitterade patienterna uppgav också betydligt mer frekvent än kontrollgruppen att de ofta kände sig ofullständigt utvilade på morgonen och/eller trötta eller sömniga under dagen till följd av symtom i ansikte och/eller käkar.

En förhållandevis stor andel individer i kontrollgruppen rapporterade också uttalade överbelastningssymtom i käksystemet. Detta fynd tyder på att det finns ett dolt behandlingsbehov avseende dessa symtom.

Undersökningens slutsats är att sovställningen synes ha en liten eller ingen betydelse för utvecklande eller vidmakthållande av överbelastningssymtom i käksystemet. Däremot indikerar resultaten att överbelastningssymtom i käksystemet och associerad nack-skuldersmärta har en påverkan på upplevd sömnkvalitet.

Introduction

It has been speculated that sleeping posture might be an important predisposing, initiating and/or perpetuating factor for temporomandibular disorders (2). However, only few studies have focused on this issue. It has also been recommended that all patients with head, neck and shoulder complaints should have their sleeping posture analysed since it is the longest postural activity performed (1).

To sleep on the back with one cervical support pillow has been claimed to be the most ideal sleeping position for proper support of the natural lordotic cervical curve (1). On the other hand, to sleep on the side, using one or two pillows, has also been recommended as the most favourable sleeping position (15, 16).

To sleep on the stomach has been said to be the by far worst sleeping position because of its postural microtrauma (1). The temporomandibular joint and the entire masticatory complex will be traumatized by a continuous loading (1).

According to *Boering* (2), the posture during sleep only seems to influence the symptoms of pain and stiffness in the jaws while the symptom TMJ clicking is less influenced.

Tooth wear is said to be an accurate predictor of the patient's sleeping postures since bilateral or alternate side positions are the most common postures for bruxers (4), i.e. a patient sleeping on the left bruxes to the right and vice versa. Thus, if the right canines are worn, the patient most likely usually sleeps on the left. If both canines are worn, but one more than the other, the patient sleeps on both sides but more on the side opposite the greatest canine wear (4).

Hedrick (7) has reported that a high percentage of patients who had TMJ pain on the left side reported sleeping on the right side and vice versa. Sleeping on one's stomach with a tall pillow is the worst position for straining the TMJ and spreading out one's legs in "spread eagle" position makes the strain even worse (7).

According to a pilot study by *Hibi & Ueda* (9), more than half of the patients with unilateral disc displacement had the ipsilateral habitual body posture during sleep (HBP), while few or none of those had the contralateral HBP. This suggests that unilateral disc displacement may be associated with HBP in general and the lateral positions in particular.

In yet another study it was shown that sleeping on the stomach was equally common among TMD patients and healthy controls (6). However, especially younger women with disc displacement reported this sleeping position statistically significantly more

often compared to women with TMD but without signs of disc displacement. The authors speculated that stomach sleeping might be correlated to disc displacement.

The aim of the present study was to investigate if there are differences concerning preferred body posture during sleep and reported quality of sleep between patients referred to a specialist clinic because of TMD and patients from a public dental clinic. The null hypothesis was that there was no difference in this respect.

Material and methods

Subjects

The participants comprised 100 consecutively recruited patients, 66 women and 34 men, who had been referred for diagnosis/treatment of TMD to the Department of Stomatognathic Physiology at the Institute for Postgraduate Dental Education in Jönköping, Sweden. The inclusion criteria was 20 years of age or older and exclusion criteria was difficulty in understanding the Swedish language. The mean age of both men and women was 49 years (Range: 20-85 years). A clinical examination according to the routines at the department (3) was performed and subjective symptoms were registered. From the clinical findings and the case history, a main TMD diagnose was set. The TMD patients were matched concerning sex and age with 100 patients recruited in connection with their routine dental examination in a public dental clinic.

Questionnaire

All subjects were asked to answer a questionnaire which comprised 15 questions. They were asked if they experienced any subjective symptoms indicative of TMD at least once a week, i.e. TM joint sounds, tiredness in jaw muscles, restricted jaw opening, facial pain and/or pain on jaw movements. From these answers, an anamnestic index according to *Helkimo* was calculated (8). This index is three-graded where grade 0 stands for none of the aforementioned symptoms, grade 1 mild to moderate symptoms and grade 2 severe symptoms. The participants were also asked if they experienced headache and/or neck and shoulder pain at least once a week. Those who reported one or more symptoms were asked to grade their discomfort according to a 5-graded verbal scale (1=insignificant, 2=mild, 3=moderate, 4=fairly severe, 5=very severe).

The questionnaire also included questions such as awareness of any oral parafunctions, preferred

sleeping position, number of pillows used and perceived sleep quality. The questions had restricted alternatives for answers but two questions: “Do you feel insufficiently rested after sleep due to symptoms from face/jaws?” and “Do you feel tired or sleepy in the daytime due to impaired sleep caused by symptoms from face/jaws?” were answered on an 11-graded numerical scale with the endpoints “Never” and “Always”. Grades 0-3 were classified as never/rarely, 4-6 as frequently and 7-10 as mostly.

Statistical methods

Frequency distribution analyses were used for all variables. Data are presented as per cent. Differences between the groups were tested statistically with χ^2 -analysis. The following p-levels have been used: $p \geq 0.05 = \text{N.S.}$, $0.01 \leq p < 0.05^*$, $0.001 \leq p < 0.01^{**}$, $p < 0.001^{***}$.

Results

Ninety-six subjects from the specialist clinic (henceforth called S-group) reported at least one of the TMD symptoms registered. In the control group (henceforth called C-group), 7 men (21%) and 49 women (74%) reported at least one symptom. The frequency distribution of the subjective symptoms occurring at least once a week is presented in Table 1. As can be seen, all symptoms registered were statistically significantly more common in the S-group compared to the C-group ($p < 0.001$ for all variables). In both groups, women more often reported tiredness in jaws as well as neck/shoulder pain compared to men ($p < 0.05$ and $p < 0.01$, respectively). Furthermore, women in the C-group reported headache more often than men ($p < 0.001$). The main diagnoses set for the patients at the specialist clinic are presented in Table 2. The two most common diagnoses were Arthralgia and Myalgia.

The patients in the S-group on average rated their symptoms as more severe compared to the patients in the C-group, and in both groups women rated their symptoms as more severe compared to men (Fig 1a and 1b). Five-teen subjects in the C-group, all women, graded their symptoms as fairly severe or very severe.

Twenty-six per cent in the S-group and 41% in the C-group were not aware of any oral parafunctions ($p < 0.05$, Table 3). Statistically significantly more patients in the S-group were aware of tooth clenching, tongue thrusting and cheek- lip- tongue biting ($p < 0.001$ for all 3 variables), while more patients in the C-group reported frequent chewing of chewing gum ($p < 0.01$). There was no statistically significant difference between the groups in respect of tooth grinding and nailbiting. Statistically significantly more women than men in the S-group were aware of tooth clenching ($p < 0.05$), while there were no sex differences between men and women in the C-group in respect of any oral parafunctions.

The vast majority in both groups said that they used one pillow (78% and 62%, respectively, N.S.) and only few subjects (3% and 8%) used more than two pillows. In both groups, the majority reported that they had bought a new pillow during the last two years (60% and 66%, respectively).

Regarding preferred sleeping position there was no statistically significant difference between the two groups (Table 4). Fifty-eight per cent in the S-group and 47% in the C-group stated that they frequently changed their sleeping position during the night (N.S.). Thirty per cent in the S-group stated that they had changed their preferred sleeping position due to their TMD and/or neck- shoulder symptoms. The corresponding figure among the controls was 7% ($p < 0.001$). However, no conclusive pattern

© **Table 1** Frequency distribution in % of subjective symptoms occurring at least once a week among patients from the specialist clinic and the public dental clinic. p1 denotes statistically significant differences between the groups and p2 between sexes within the groups; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, NS=No statistical difference.

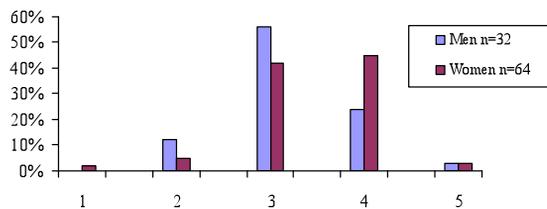
Variable	Specialist Clinic				p1	Public Dental Clinic			
	Men n=34	p2	Women n=66	Total n=100		Men n=34	p2	Women n=66	Total n=100
Joint sound	19	NS	48	67	***	3	NS	15	18
Tiredness in jaws	16	*	52	68	***	2	*	18	20
Difficulty in opening the mouth wide	16	NS	41	57	***	3	NS	13	16
Pain when opening the mouth	18	NS	44	62	***	0	NS	7	7
Pain in the face or jaws	13	NS	37	50	***	0	NS	5	5
Headache	59	NS	70	66	***	3	***	37	26
Neck/Shoulder pain	4	*	70	61	***	14	**	45	34

© **Table 2.** Frequency distribution in % of main diagnoses among the patients from the specialist clinic.

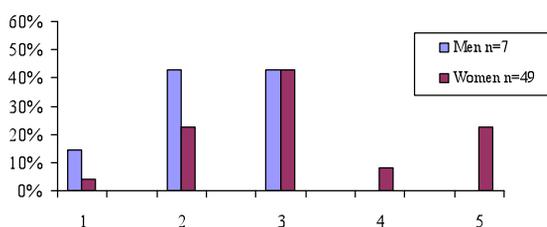
Diagnosis	Men n=34	Women n=66	Total n=100
Arthralgia	20	21	21
Myalgia	20	17	18
Disc displacement with reduction	18	8	11
Arthralgi and myalgia	3	14	10
Disc displacement without reduction	6	11	9
Headache	6	11	9
Arthrosis	9	6	7
Oral parafunction	9	1	4
Rheumatoid arthritis	0	6	4
Other diagnoses *	9	5	7

* Malocclusion, toothache, radiation treatment, facial pain

© **Figure 1 a.** Ninety-six TMD patients estimation of their symptom (1=None, 2=Mild, 3=Moderate, 4=Fairly severe, 5=Very severe)



© **Figure 1 b.** Fifty-six dental patients estimation of their symptom (1=None, 2=Mild, 3=Moderate, 4=Fairly severe, 5=Very severe)



© **Table 3.** Self-reported parafunctions in % among patients from the specialist clinic and the public dental clinic. p denotes statistically significant differences between the groups, *** p<0.001, ** p<0.01, * p<0.05, NS=No statistical difference.

Variable	Specialist Clinic			p	Public Dental Clinic		
	Men n=34	Women n=66	Total n=100		Men n=34	Women n=66	Total n=100
Clenching of teeth	38	61	53	***	15	30	25
Grinding of teeth	12	17	15	NS	24	23	23
Tongue thrusting	24	44	37	***	3	9	7
Cheek-lip-tongue-hand biting	21	29	26	***	3	11	8
Nail-biting	15	11	12	NS	21	15	17
Frequent chewing of chewing gum	6	9	8	**	18	27	24
Not aware of parafunctions	38	20	26	*	41	41	41

could be seen in respect of how the patients in the S-group had changed sleeping position.

Sixteen per cent in the S-group stated that they mostly felt insufficiently rested at awakening because of symptoms from face/jaws and another 26% reported that this happened frequently. The corresponding figures in the C-group was 4% and 9%. This difference was statistically significant ($p<0.001$). Another 35% in the S-group and 26% in the C-group stated that they felt insufficiently rested at awakening because of other reasons than pain from face/jaws. The most common reasons were pain in neck/shoulders or back pain.

Nineteen per cent in the S-group said that they mostly felt tired or sleepy in the daytime due to impaired sleep caused by symptoms from face/jaws and 19% reported that this occurred frequently. In the C-group these figures were 0% and 5%, respectively ($p<0.001$). Thirty-eight per cent in the S-group and 26% in the C-group stated that they felt tired or sleepy in the daytime due to other reasons, most often snoring.

© **Table 4.** Frequency distribution in % in respect of preferred sleeping position among patients from the specialist clinic and the public dental clinic. No statistically significant differences between the groups.

Variable	Specialist Clinic			Public Dental Clinic		
	Men n=34	Women n=66	Total n=100	Men n=34	Women n=66	Total n=100
Stomach	21	9	13	12	15	14
Back	9	7	8	15	0	5
Right or left side	38	47	44	36	57	50
Varying	32	37	35	32	27	29
Don't know	0	0	0	6	2	3

Discussion

Despite the frequently stated opinion that unfavourable sleeping position might be an important factor for TMD, no differences in preferred sleep position could be found in the present study. Our null-hypothesis is thus accepted. This finding is also in agreement with a previous study (6). Of course it can be argued that the common reports among the TMD patients of having changed their sleeping position due to their symptoms might have blurred an original difference between the groups in this respect. However, no conclusive pattern could be seen in how the TMD patients had changed their sleeping position. Some had changed from back to side or stomach sleeping, others had changed from side to back or stomach sleeping, and yet others had changed from stomach to side or back sleeping. It is possible that the sleeping position per se is of no negative consequence unless it occurs in combination with adverse loading e.g. through bruxism in extreme positions (6).

Sleep can be regarded as an active part of human life. In several diseases with pain as a major symptom, different sleep disturbances have been reported with a close relation to pain experience (5). Long-term pain leads to activation of "illness responses" characterized by influence on the sleep. Many patients with long-term pain suffer from sleep disturbance where, above all, the deeper sleep stages (recovery phases) are influenced, which makes most patients with long-term pain to complain about chronic tiredness (14).

Considerably more individuals in the S-group compared with the C-group felt insufficiently rested in the morning or tired/sleepy in the daytime exclusively because of symptoms from face and/or jaws. It is thus likely that TMD symptoms hamper sleep quality.

On the other hand, it can also be the other way around. Sleep bruxism is today acknowledged as a sleep disorder (10, 11) and is observed secondary to a cascade of other physiologic events such as autonomic, cardiac, and respiratory activities related to sleep arousal (12, 13). It can thus not be excluded that an originally impaired sleep quality is partly a reason for sleep bruxism resulting in the development of TMD.

As could be expected, TMD symptoms were much more common in the S-group compared with the C-group and the TMD patients also rated their symptoms as much more severe than the controls. However, a substantial number of the non-patients

reported at least one TMD symptom occurring at least once a week. Furthermore, many of them graded their symptoms as fairly severe or very severe. Although the control group is not purely unselected, our finding strongly supports the opinion put forward by *Wänman & Wigren* (17) that there is a great latent need for TMD treatment in the population.

Another expected finding was that most self-reported oral parafunctions were more common among the TMD patients. It is, however, interesting to note that there were no differences in reports of tooth grinding between the two groups. This indicates that this dynamic activity, in contrast to static clenching, mostly does not result in other symptoms than an increased risk for tooth wear.

More subjects in the control group reported frequent chewing of chewing gum. It is likely that tiredness in jaw muscles as well as pain in the orofacial region results in avoidance of this activity in TMD patients.

In conclusion, no difference could be found in respect of preferred sleeping position among TMD patients and matched controls. However, TMD patients much more frequently reported that they felt insufficiently rested in the morning and/or tired and sleepy in the daytime indicating an impaired sleep quality compared to controls. The study has also shown that pronounced TMD symptoms are fairly common also among ordinary dental patients indicating a latent need for TMD treatment.

References

1. Austin DG. Special considerations in orofacial pain and headache. *Dental Clin N Am* 1997;41:325-39.
2. Boering G. Temporomandibular Joint Osteoarthritis. *Drukkerij Van Denderen* 1994, Groningen. pp.341-4.
3. Carlsson GE, Magnusson T. Management of Temporomandibular Disorders in the General Dental Practice. Chicago: Quintessence, 1999. pp.68-77.
4. Colquitt T. The sleep-wear syndrome. *J Prosthet Dent* 1987;57:33-41.
5. Drewes AM. Pain and Sleep Disturbances. Clinical, Experimental and Methodological Aspects with Special Reference to the Fibromyalgia Syndrome and Rheumatoid Arthritis. Thesis. Aalborg University, Faculty of Health Sciences, University of Aarhus, 1999, p. 49.
6. Elfving L, Helkimo M, Magnusson T. Prevalence of different temporomandibular joint sounds with emphasis on disc-displacement in patients with temporomandibular disorders and controls. *Swed Dent J* 2002;26:9-19.
7. Hedrick PP. Acute unilateral TMJ pain and sleep posture. *J Gen Orthod* 1996;7:21-3.
8. Helkimo M. Studies on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state. *Swed Dent J* 1974;67:101-21.

9. Hibi H, Ueda M. Body posture during sleep and disc displacement in the temporomandibular joint: a pilot study. *J Oral Rehabil* 2005;32:85-9.
10. Kato T, Norman TMR, Huynh N, Miyawaki S, Lavigne GJ. Topical review: Sleep bruxism and the role of peripheral sensory influence. *J Orofac Pain* 2003;17:191-213.
11. Kato T, Rompre P, Montplaisir JY, Sessle BJ, Lavigne GJ. Sleep bruxism: An oromotor activity secondary to micro-arousal. *J Dent Res* 2001;80:1940-4.
12. Lavigne GJ, Khoury S, Abe S, Yamaguchi T, Raphael K. Bruxism physiology and pathology: An overview for clinicians. *J Oral Rehabil* 2008;35:476-94.
13. Macaluso GM, Guerra P, Di Giovanni G, Boselli M, Parrino L, Terzano MG. Sleep bruxism is a disorder related to periodic arousal during sleep. *J Dent Res* 1998;77:565-73.
14. Norrbrink C, Lundeberg T. Om Smärta - Ett Fysiologiskt Perspektiv (In Swedish) Studentlitteratur, 2010 p. 55.
15. Ritter R. Über wenig beachtete Ursachen von Kieferarthropathien. *Dtsch Zahn-, Mund- und Kieferheilk* 1958;29:18.
16. Säfsten L. Bättre sömn och mindre morgonbesvär med två kuddar. (In Swedish) *Sjukgymnasten* 1987;45:18-21.
17. Wänman A, Wigren L. Need and demand for dental treatment. A comparison between an evaluation based on an epidemiologic study of 35-, 50-, and 65-year-olds and performed dental treatment of matched age groups. *Acta Odontol Scand* 1995;53:318-24.

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Dental agenesis patterns in Crouzon syndrome

DIMITRIOS STAVROPOULOS¹, THEODOSIA BARTZELA², PETER TARNOW³, BENGT MOHLIN⁴, KARL-ERIK KAHNBERG⁵, CATHARINA HAGBERG⁶

Abstract

© Dental agenesis may be present in an isolated familiar manner, or occur as a part of a syndrome. To date, this clinical trait seems to have been overlooked in patients with Crouzon syndrome. The aim of the present study was to investigate dental agenesis and dental agenesis patterns in a population of persons with Crouzon syndrome in Sweden. Serial panoramic radiographs of 26 individuals with Crouzon syndrome (20 males, 6 females) were examined. Third molars were excluded from the assessment. The prevalence of agenesis for at least one tooth was 42.3%. Each affected patient was found to have up to 5 missing teeth. Upper and lower second premolars were the most frequently congenitally missing teeth. Eleven dental agenesis patterns of the entire dentition were identified, as described by the tooth agenesis code (TAC). All patterns were unique and asymmetric, with only one exception, a symmetric pattern of the maxillary and mandibular second premolars. In conclusion, persons with Crouzon syndrome were found to have a high prevalence of dental agenesis and a remarkable variability of dental agenesis patterns. It is important to be aware of this clinical situation, especially when orthodontic treatment planning for these patients is performed as early as in the mixed dentition.

Key words

Crouzon syndrome, dental agenesis, fibroblast growth factor receptor-2, patterns of missing teeth, tooth agenesis code

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Agenesi av permanenta tänder vid Crouzons syndrom

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Sammanfattning

© I denna studie studerades förekomst av agenesier och mönster för detta hos personer med Crouzons syndrom. Enligt vår kunskap finns i litteraturen inga tidigare detaljerade rapporter avseende detta fenomen. Panorama röntgen, som tagits fortlöpande på 26 personer, utvärderades med hjälp av ett index (TAC). Tjugo män och 6 kvinnor ingick i studien. Visdomständer exkluderades. Prevalensen för agnesi var 42.3%. Varje person med agnesi registrerades ha upp till fem avsaknade permanenta tänder. Vanligast förekommande var den andra premolaren i över och underkäken. Elva olika mönster för hela dentitionen identifierades med hjälp av det index som användes i studien (TAC). Alla agnesi mönster var unika och asymmetriska, förutom hos en individ. Sammanfattningsvis hade personer med Crouzons syndrom hög förekomst av dentala agenesier. Det fanns en avsevärd variation i det individuella mönstret. Prevalensen i studien var starkt ökad jämfört med den som rapporterats för en allmän population (3.2 till 7.6 %). Vid planering av ortodontisk behandling på barn med Crouzons syndrom är det viktigt att vara medveten om den ökade risken för agenesier. Extraktioner utförs ofta på grund av stora problem med uttalad trångställning främst i överkäken. Detta beror på att överkäken och mellanansiktet som regel är kraftigt tillväxthämmade på grund av en för tidig slutning av suturerna. Panorama röntgen ger en god översikt av dentala förhållanden. Kontinuerliga röntgen kontroller bör ske med start redan i växelbettet.

Introduction

Dental agenesis, defined as the congenital lack of teeth, constitutes one of the most prevalent developmental anomalies in man (15), imposing significant functional, psychosocial and financial burdens on patients. As such, the condition may have a dramatic effect on the oral-health related quality of life of the people affected.

Up to 30% of the population have at least one missing third molar (7). A meta-analysis (12) shows that agenesis of other permanent teeth, excluding third molars, ranges from 3.2% to 7.6%, depending on the demographic and the geographic profiles of the populations studied. The second mandibular premolar is the most affected tooth, followed by the lateral maxillary incisor and the second maxillary premolar.

Dental development is a complex process that involves signalling interactions between the oral embryonic epithelium and the underlying neural-crest derived mesenchyme (21). This process begins early in embryogenesis, approximately in the sixth week (25). Teeth form as epithelial appendages from the ectoderm covering the oral cavity (10).

Dental agenesis may be present in an isolated familiar manner, or occur as a part of a syndrome (4). Crouzon syndrome, or craniofacial dysostosis, is an autosomal dominant congenital developmental deformity, with a birth prevalence of approximately 16.5 cases per million live births (5). Its clinical expression is characterized by craniosynostosis, that is, premature fusion of cranial sutures, causing secondary alterations of the growing and developing facial bones and facial structure (12). Common features include brachycephally, frontal bossing, exophthalmos, hypertelorism, parrot-beaked nose, short and retruded upper lip, maxillary hypoplasia and dental malocclusion, such as Angle's class III occlusion, openbite, crossbites, and severe dental crowding (11). Point mutations in the gene encoding the Fibroblast Growth Factor Receptor 2 (FGFR2) have been found causal to the syndrome (19). Crouzon syndrome with acanthosis nigricans has been attributed to mutations in the FGFR3 gene (16).

So far, only a few literature reports mention dental agenesis in patients with Crouzon syndrome (11,3,19), none of which identifies tooth agenesis patterns, giving different missing tooth combinations according to the examined area. This has been acknowledged as a waste of information (23), as syndromes that include tooth agenesis in their clinical

expression have been found to be very informative for analyzing the genetic basis of non-syndromic forms of congenitally missing teeth (24). Defining these agenesis patterns in relation to specific syndrome clinical phenotypes may contribute to categorize patients for future genetic studies.

The aim of the present study was to identify the prevalence of dental agenesis per tooth type and to look for dental agenesis patterns in persons with Crouzon syndrome.

Material and methods

Data Collection

Panoramic radiographs were evaluated from a population of persons with Crouzon syndrome, born between 1970-1998. All of the patients were treated consecutively at the Craniofacial Centre at the Sahlgrenska University Hospital and registered and therapy planned at the section of Jaw Orthopaedics of the Gothenburg University Clinic in Sweden. The inclusion criteria were defined as follows:

- A medically confirmed syndrome diagnosis.
- Caucasian ethnicity.
- Age of at least 8 years at the time of the last panoramic radiographic examination. A panoramic radiograph from at least 11 years of age had to be available in order to set a diagnosis of agenesis of second premolars.
- Cases with dental agenesis identified on panoramic radiographs were to be verified by the person's dental records in order to exclude premature extractions. The third molars were not included in the study.

The study group, then, was comprised of 26 people with Crouzon syndrome (20 males, 6 females). All patients were at least 11 years old at the time of the last panoramic radiographic examination. Only one patient was 8 years old with no missing teeth observed.

Congenitally missing teeth were registered by tooth number according to the Fédération Dentaire Internationale (FDI) system (17). All radiographs were scored twice by one observer (DS). In a single case, the agenesis of an upper second molar was missed in the second radiographic assessment, and the opinion of a second observer (CH) was sought to reach a consensus.

The study was approved by the Regional Research Ethics Committee of Gothenburg (registration number 149-08).

© **Table 1** Schematic representation of the human dentition and application of binary arithmetic to assign unique values to patterns of dental agenesis.

		Maxillary Right Quadrant (Q ₁)							Maxillary Left Quadrant (Q ₂)							
A	18*	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28*
B	128	64	32	16	8	4	2	1	1	2	4	8	16	32	64	128
A	48*	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38*
		Mandibular Right Quadrant (Q ₃)							Mandibular Left Quadrant (Q ₄)							

*Not included in the present study.

Line A = Tooth numbering according to FDI system.

Line B = Values associated with missing teeth. The tooth value, corresponding to a missing tooth, is determined by calculating $2^{(n-1)}$, in which n = the tooth number (1-8).

Q₁, Q₂, Q₃, Q₄ = First to fourth quadrant of the dentition.

Data Processing

Patterns of dental agenesis were described using a numeric code, the Tooth Agenesis Code (TAC) (23). According to this coding system each missing tooth is assigned a specific value (Table 1). The produced values of missing teeth are summed for each quadrant, generating a unique value per dental agenesis pattern per quadrant, the TAC. Presence of all teeth in a quadrant of the dentition has TAC = 0, whereas the absence of all teeth in a quadrant of the dentition has TAC = 255.

Patterns of dental agenesis throughout the entire dentition of an individual are described with the variable TAC_{overall} (6). It is composed of the TAC of each quadrant, comprising a unique number. For example, when a TAC_{overall} is 100.123.038.001, the number 100 corresponds to the first quadrant of the dentition, the 123 to the second, the 038 to the third, and the 001 to the fourth.

Data Analysis

Descriptive Variables

Dental agenesis and dental agenesis patterns (defined by TAC and TAC_{overall} scores) were described by counts and percentages. Numbers referring to percentages are presented up to the first decimal digit and with the 95% confidence intervals (CI).

Statistical Analysis

Prevalence of dental agenesis was tested against gender by the application of Fisher's exact test. The differences in numbers of missing teeth between the left versus the right quadrant of the dentitions, and the maxillary versus the mandibular dentitions, were evaluated using the Wilcoxon signed rank sum test. P-values of the statistical tests applied are presented in parentheses. The level of significance was set at

5%. The SPSS software was used (version 16.0, SPSS Inc. Headquarters, Chicago, IL, USA) for statistical testing.

Results

Dental Agenesis Prevalence

After the exclusion of the third molars, 11 out of 26 persons with Crouzon syndrome showed agenesis of at least one tooth (prevalence: 42.3%; CI: 23.4% - 63.1%). The number of missing teeth per individual ranged from 1 to 5. Those who missed one tooth only were 7 (prevalence: 26.9%, CI: 11.6% - 47.8%). There were 4 persons who were missing 2 teeth or more (prevalence: 15.4%, CI: 4.4% - 34.9%). The most frequently missing teeth were the upper and lower second premolars. Table 2 presents the prevalence of dental agenesis per tooth type in the study population.

There was no statistically significant difference between prevalence of dental agenesis and gender ($p = 0.179$). Therefore, males and females were pooled for the subsequent statistical tests.

No statistically significant difference was observed in the number of missing teeth between the left versus the right quadrant of the dentitions ($p = 0.593$). Nor was any statistically significant difference identified in the number of missing teeth between the maxillary versus the mandibular dentitions ($p = 0.405$).

Dental Agenesis Patterns

There were two distinct combinations of congenitally missing teeth per quadrant of the permanent dentition for the people studied with Crouzon syndrome. One involved the absence of teeth 31 and 35, and the other the absence of 25 and 27. Frequencies and percentages of dental agenesis patterns per quadrant of

© **Table 2.** Prevalence of congenitally missing permanent teeth per tooth type, for each quadrant of the dentition in 26 persons with Crouzon syndrome.

	Maxillary Right Quadrant (Q ₁)								Maxillary Left Quadrant (Q ₂)							
A	7.6%	0.0%	15.3%	0.0%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.6%	3.8%	7.6%	
	(N=2)	(N=0)	(N=4)	(N=0)	(N=0)	(N=1)	(N=0)	(N=0)	(N=0)	(N=0)	(N=0)	(N=0)	(N=2)	(N=1)	(N=2)	
B	8*	7	6	5	4	3	2	1	1	2	3	4	5	6	7	
A	0.0%	0.0%	11.5%	0.0%	0.0%	0.0%	7.6%	7.6%	0.0%	0.0%	0.0%	11.5%	0.0%	0.0%		
	(N=0)	(N=0)	(N=3)	(N=0)	(N=0)	(N=0)	(N=2)	(N=2)	(N=0)	(N=0)	(N=0)	(N=3)	(N=0)	(N=0)		
	Mandibular Right Quadrant (Q ₃)								Mandibular Left Quadrant (Q ₄)							

*Not included in the present study.

Line A = Prevalence (in percentage) and absolute numbers (in parentheses) of missing permanent teeth in the study population.

Line B = Tooth number (1-8).

Q₁, Q₂, Q₃, Q₄ = First to fourth quadrant of the dentition.

© **Table 3.** Frequencies and percentages of dental agenesis patterns in the permanent dentition per each quadrant in 26 persons with Crouzon syndrome.

TAC	Absent tooth type*	Q ₁		Q ₂		Q ₃		Q ₄	
		N	%	N	%	N	%	N	%
0	None	20	76.9	22	84.6	21	81	21	80.7
1	I ₁	0	0.0	0	0.0	2	7.6	2	7.6
2	I ₂	1	3.8	0	0.0	0	0.0	0	0.0
16	P ₂	3	11.5	1	3.8	2	7.6	3	11.5
17	I ₁ +P ₂	0	0.0	0	0.0	1	3.8	0	0.0
32	M ₁	0	0.0	1	3.8	0	0.0	0	0.0
64	M ₂	1	3.8	1	3.8	0	0.0	0	0.0
80	M ₂ +P ₂	1	3.8	1	3.8	0	0.0	0	0.0
Total		26	100.0	26	100.0	26	100.0	26	100.0

*Third molars were excluded.

TAC = Tooth Agnesis Code.

Q₁, Q₂, Q₃, Q₄ = First to fourth quadrant of the dentition.

I₁ = central incisor; I₂ = lateral incisor; P₂ = second premolar; M₁ = first molar; M₂ = second molar.

© **Table 4.** TAC_{overall} score, frequency and percentage of each TAC_{overall} score, corresponding congenitally missing permanent teeth and number of congenitally missing permanent teeth in the entire mouth for the 26 persons with Crouzon syndrome investigated.

TAC _{overall} *	Frequency	%	Missing teeth	N
0.0.0.0	15	57.6	none	0
16.0.0.0	1	3.8	15	1
2.0.0.0	1	3.8	12	1
0.64.0.0	1	3.8	27	1
0.32.0.0	1	3.8	26	1
64.0.0.0	1	3.8	17	1
0.0.0.16	1	3.8	45	1
0.0.16.0	1	3.8	35	1
16.0.0.16	1	3.8	15, 45	2
0.0.17.1	1	3.8	35, 31, 41	3
16.80.16.16	1	3.8	15, 25, 27, 35, 45	5
80.16.1.1	1	3.8	17, 15, 25, 31, 41	5
Total	26	100		

*Third molars were excluded.

TAC_{overall} = Tooth Agnesis Code for the entire mouth.

the permanent dentition are presented in Table 3.

Using the TAC_{overall}, 11 distinct agenesis patterns were identified. Only one was symmetric, with a TAC_{overall} score of 16.0.0.16, involving the teeth 15, 45 and exhibiting a maxillo-mandibular symmetry at the right side. No left-right symmetries were found in the study population. Frequencies and percentages of TAC_{overall} scores, corresponding to congenitally missing permanent teeth, and number of these teeth in the whole mouth, are presented in Table 4.

Discussion

To the knowledge of the study, this is the first in-depth investigation to address dental agenesis in people with Crouzon syndrome. Since this syndrome has very low birth prevalence, only few craniofacial centres are likely to have such a group of patients adequate enough for clinical research. The Craniofacial Centre at the Sahlgrenska University

Hospital and the section of Jaw Orthopaedics Unit of the Gothenburg University Clinic, have been the national reference centre for treatment of craniofacial anomalies in Sweden. As such, the studied sample can be regarded as a total sample of persons with Crouzon syndrome in Sweden.

In the light of the present results, the prevalence of dental agenesis (42.3%) in the studied population of people with Crouzon syndrome was much higher than the 3.2% to 7.6% reported for the general population (18). It is important for the dental practitioners to be aware of this clinical situation, especially when orthodontic treatment planning for these patients is carried out as early as in the mixed dentition.

Clinical association of dental agenesis and craniofacial syndromes may be explained on the basis of the common developmental pathways that orofacial structures and teeth share during morphogenesis and subsequent growth and development of the craniofacial region (14). The observation of a high prevalence of dental agenesis in the studied group may indicate a possible correlation between Crouzon syndrome and dental agenesis, not described in literature so far. In particular, the mutated FGFR2 or FGFR3 gene in Crouzon syndrome can be speculated to be a causative factor of tooth agenesis, since Fibroblast Growth Factors (FGFs) have been found to be expressed throughout all stages of dental morphogenesis (21). Therefore, dental agenesis may result from failure of FGFs in the oral epithelium and/or in the mesenchyme and their respective receptors required as targets during early tooth development (7).

However, in literature sources referring to dental anomalies in people with Crouzon syndrome, dental agenesis does not seem to be acknowledged at all (8). In a relevant comprehensive study, only 5 dental agenesis cases were found of the 61 investigated (11). It has to be noted, though, that the identification of dental agenesis was not among the primary aims of the above cited study. A possible explanation for the previously reported low prevalence of dental agenesis in people with Crouzon syndrome could be that dental agenesis seems to be underestimated in large sample sizes, especially when it is one of the multiple aims of a big research project (18).

Although there are reports which indicate that dental agenesis is more common in women than in men (18,6,13), we found no gender predilection regarding congenitally missing teeth in our Crouzon syndrome study group. This could be attributed to the fact that the referred reports investigate non-syndromic forms of dental agenesis, as well as to the specific charac-

teristics of the present group (males dominating over females in a rather small sample size).

Most cases of dental agenesis described in the current study are only missing one tooth, which most often is a second premolar, and agrees with reports for non-syndromic forms of dental agenesis (7,18,13). The prevalence rate of a second premolar per quadrant was found to be 11.5% for each of the quadrants Q1 and Q4, which is three times higher than reported in the mandible, and 8 times higher than reported in the maxilla for the general population (18). The clinical relevance of these findings in the orthodontic practice, besides the fact of the tooth agenesis per se, is that the dental sequelae of Crouzon syndrome do not seem to be restricted to the maxillary region, but also to affect the mandible as well. The observation of the congenital absence of maxillary molars and mandibular central incisors was surprising, since these teeth are usually stable in the general population, accounting for less than 0.5% of all cases of dental agenesis (18).

All dental patterns for the entire mouth, as described by the TAC_{overall} scores in Table 4, were unique, meaning that each pattern was observed only once in the group. The dental patterns were also asymmetric, with only one exception, the one with a TAC_{overall} score of 16.0.0.16 (missing 15, 45). Such dental phenotypic variability may be attributed to the genetic heterogeneity, since more than 30 different FGFR gene mutations have been found to cause Crouzon syndrome (2). The phenotypic expression of this syndrome is variable, ranging from mild to very severe cases. Unexpectedly, identical FGFR2 mutations affecting cysteines 278 and 342 have been reported to cause both Pfeiffer and Crouzon syndromes (20), therefore, implying possible epistatic gene expressions that interfere with the phenotypic expression of these clinical entities and accounting for some of the variability observed.

Multi-centre studies are needed to increase sample sizes of children with Crouzon syndrome and investigate if some dental agenesis patterns in the form of TAC scores appear more often than others. This could be a starting point to subphenotype Crouzon syndrome populations and look for genotype-phenotype relationships. Dental agenesis patterning would also help to categorize gene mutations, such as FGFR2 mutations. For instance, such information might shed some light on why the same FGFR2 mutation may produce mostly craniofacial defects (Crouzon syndrome) or skull and limb abnormalities (Pfeiffer syndrome).

In the present study, TAC scores were used to describe this population of persons with Crouzon syndrome. These scores allow the identification of individual dental agenesis patterns. This method has already been used to characterize a population of oligodontia patients (6). *Bartzela et al.* (1) used TAC scores to describe a population with a bilateral cleft lip and palate disorder in a multi-centre study. These values, that identify dental agenesis patterns are readily available to other research groups for meta-analysis or genetic research purposes. Finally, treatment strategies, in orthodontics and prosthodontics, may be better evaluated on the grounds of the information that TAC scores provide.

In conclusion, persons with Crouzon syndrome were found to have a high prevalence of dental agenesis and a remarkable variability of dental agenesis patterns, as described by TAC values. By increasing awareness and knowledge about this clinical situation orthodontic treatment planning can be better formed and evaluated, especially when it is carried out as early as in the mixed dentition. The results from the present study may be used for future research purposes to perform meta-analytic studies and to subphenotype populations with Crouzon syndrome.

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References

- Bartzela TN, Carels CE, Bronkhorst EM, Ronning E, Rizell S, Kuijpers-Jagtman AM. Tooth agenesis patterns in bilateral cleft lip and palate. *Eur J Oral Sci* 2010; 118: 47-52.
- Bonaventure J, El Ghouzzi V. Molecular and cellular bases of syndromic craniosynostoses. *Expert Rev Mol Med* 2003; 5: 1-17.
- Burzynski NJ, Escobar VH. Classification and genetics of numeric anomalies of dentition. *Birth Defects Orig Artic Ser* 1983; 19: 95-106.
- Cobourne MT. Familial human hypodontia--is it all in the genes? *Br Dent J* 2007; 203: 203-8.
- Cohen MM, Jr., Kreiborg S. Birth prevalence studies of the Crouzon syndrome: comparison of direct and indirect methods. *Clin Genet* 1992; 41: 12-5.
- Creton MA, Cune MS, Verhoeven W, Meijer GJ. Patterns of missing teeth in a population of oligodontia patients. *Int J Prosthodont* 2007; 20: 409-13.
- De Coster PJ, Marks LA, Martens LC, Huisseune A. Dental agenesis: genetic and clinical perspectives. *J Oral Pathol Med* 2009; 38: 1-17.
- Gorlin RJ, Cohen MM, Hennekam RCM. Syndromes of the head and neck. New York: Oxford University Press, 2001.
- Jefttha A, Stephen L, Morkel JA, Beighton P. Crouzonodermoskeletal syndrome. *J Clin Pediatr Dent* 2004; 28: 173-6.
- Koch G, Thesleff I. Developmental disturbances in number and shape of teeth and their treatment. In: Koch G, Poulsen S, eds. *Paediatric Dentistry: a clinical approach*. Copenhagen: Blackwell Munksgaard, 2001: 253.
- Kreiborg S. Crouzon Syndrome. A clinical and roentgencephalometric study. *Scand J Plast Reconstr Surg Suppl* 1981; 18: 1-198.
- Kreiborg S. Postnatal growth and development of the craniofacial complex in premature craniosynostosis. In: Cohen MM, ed. *Craniosynostosis: diagnosis, evaluation, and management*. New York: Raven Press, 1986: 157.
- Larmour CJ, Mossey PA, Thind BS, Forgie AH, Stirrups DR. Hypodontia - a retrospective review of prevalence and etiology. Part I. *Quintessence Int* 2005; 36: 263-70.
- Matalova E, Fleischmannova J, Sharpe PT, Tucker AS. Tooth agenesis: from molecular genetics to molecular dentistry. *J Dent Res* 2008; 87: 617-23.
- McKusick VA. *Mendelian Inheritance in Man*. Baltimore: The Johns Hopkins University Press, 1994.
- Meyers GA, Orlow SJ, Munro IR, Przylepa KA, Jabs EW. Fibroblast growth factor receptor 3 (FGFR3) transmembrane mutation in Crouzon syndrome with acanthosis nigricans. *Nat Genet* 1995; 11: 462-4.
- Peck S, Peck L. Tooth numbering progress. *Angle Orthod* 1996; 66: 83-4.
- Polder BJ, Van't Hof MA, Van der Linden FP, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. *Community Dent Oral Epidemiol* 2004; 32: 217-26.
- Reardon W, Winter RM, Rutland P, Pulleyn LJ, Jones BM, Malcolm S. Mutations in the fibroblast growth factor receptor 2 gene cause Crouzon syndrome. *Nat Genet* 1994; 8: 98-103.
- Rutland P, Pulleyn LJ, Reardon W, Baraitser M, Hayward R, Jones BM et al. Identical mutations in the FGFR2 gene cause both Pfeiffer and Crouzon Syndrome phenotypes. *Nat Genet* 1995; 9: 173-6.
- Thesleff I. The genetic basis of normal and abnormal craniofacial development. *Acta Odontol Scand* 1998; 56: 321-5.
- Thesleff I. The genetic basis of tooth development and dental defects. *Am J Med Genet A* 2006; 140: 2530-5.
- van Wijk AJ, Tan SP. A numeric code for identifying patterns of human tooth agenesis: a new approach. *Eur J Oral Sci* 2006; 114: 97-101.
- Vieira AR. Oral clefts and syndromic forms of tooth agenesis as models for genetics of isolated tooth agenesis. *J Dent Res* 2003; 82: 162-5.
- Zhang YD, Chen Z, Song YQ, Liu C, Chen YP. Making a tooth: growth factors, transcription factors, and stem cells. *Cell Res* 2005; 15: 301-6.

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Fluoride toothpaste and toothbrushing; knowledge, attitudes and behaviour among Swedish adolescents and adults

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Abstract

© The most effective way to administer fluoride is through the regular use of fluoride toothpaste. Adolescents and adults seem to have low awareness of toothbrushing procedures and use of fluoride toothpaste despite frequent dental care. The aim of this study was to describe knowledge, attitudes and behaviour concerning toothbrushing and use of fluoride toothpaste in three age groups in a Swedish population. A qualitative study design was used with the purpose of achieving a deeper understanding of the issue. Data were collected through interviews. A manifest and latent analysis of the text was performed using qualitative content analysis (Grounded theory). The informants were selected strategically to obtain the greatest possible variation in the data. Three age strata representing different stages in life were chosen: 15-16, 30-35 and 60-65 years. Informants were interviewed with support from an interview guide. Open-ended questions were used to focus on the individual's knowledge, attitudes and behaviour concerning toothbrushing and fluoride toothpaste. Five people from each age group were interviewed in the study. The content areas were knowledge, attitudes and behaviour and the latent analysis identified the areas of empowerment, driving force and guidance as categories. Although the informants showed little knowledge about the reasons for and techniques of using fluoride toothpaste effectively, they described toothbrushing as important and the habit as a priority, giving the theme of this study: toothbrushing with fluoride toothpaste was a priority, despite the lack of knowledge about how to use toothpaste effectively and its positive effects on oral health. In conclusion the state of knowledge concerning toothbrushing and fluoride toothpaste needs to be improved. In addition, people's desire for a fresh-feeling mouth and to fit in socially must be affirmed and utilized by dental staff in health promotion.

Key words

Attitudes, behaviour, fluoride toothpaste, knowledge, oral health, toothbrushing

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Fluortandkräm och tandborstning; kunskap, attityder och beteende hos svenska ungdomar och vuxna

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Sammanfattning

© Det mest effektiva sättet att tillföra fluor är användning av fluortandkräm. Ungdomar och vuxna borstar tänderna med fluortandkräm regelbundet, men kunskapen om hur människor borstar och hur de använder fluortandkräm är bristfällig. Syftet med denna studie var att beskriva kunskaper, attityder och beteende när det gäller tandborstning och användning av fluortandkräm i tre åldrar i en svensk befolkning. En kvalitativ studie-design användes för att uppnå en djupare förståelse av ämnet. Data samlades genom intervjuer och dessa analyserades med hjälp av en kvalitativ innehållsanalys (Grounded theory) där en manifest och latent analys av texten genomfördes. Informanterna valdes ut strategiskt för att uppnå största möjliga variation i insamlad data. Tre åldersstrata som representerar olika skeden i livet valdes: 15-16, 30-35 och 60-65 år. Informanter, fem personer från varje åldersgrupp, intervjuades med stöd av en intervjuguide. Öppna frågor användes för att fokusera på individens kunskaper, attityder och beteende om tandborstning och fluortandkräm. Analysen av innehållet i intervjuerna kunde delas in i områdena kunskap, attityd och beteende. Den latent analysen identifierade kategorierna empowerment, drivkraft och vägledning som de områden informanterna valde att tala om. Informanterna visade bristande kunskap om tandborstning, användning av fluortandkräm och vilken roll fluoren har i kariesprocessen. Även om informanterna hade låg kunskap om fluorens effekt och hur man använder fluortandkräm beskrev de tandborstning som viktig och som ett beteende man prioriterade. Temat för denna studie var därför: tandborstning med fluortandkräm var en prioriterad vana, trots brist på kunskap om fluortandkrämens positiva effekter på oral hälsa och hur den bör användas för att uppnå bästa effekt. Slutsatsen är att kunskapen om tandborstning och fluortandkräm bör förbättras. Dessutom bör människors önskan att följa sociala normer och metoder för att stärka deras tilltro till sin egen förmåga att åstadkomma god oral hälsa inkluderas i det hälsofrämjande arbetet.

Introduction

Even in the twenty-first century dental caries remains a health problem for many children, adults and elderly people [17]. Until the 1990s, caries gradually declined in the general population, mostly thanks to the positive effects of fluoride in toothpaste, but also other preventive measures [13, 23]. After several decades of reduced caries incidence there are now signs that caries is on increasing rise again [5]. The individual's risk of having caries is influenced by several factors where knowledge and socio-economic circumstances are strong determinants in the process [2, 12].

The most effective way to administer fluoride is through the use of fluoride toothpaste regularly [16, 23]. The most important factors for positive effects of fluoride toothpaste seem to be brushing frequency, the concentration of fluoride in the toothpaste, the amount of toothpaste on the toothbrush, brushing time and subsequent rinsing with water [8, 21, 25]. Although fluoride toothpaste is generally available in the Nordic countries, about 25 percent of 14-year-olds do not brush their teeth daily [7, 14]. In Sweden, 90% of adults report daily toothbrushing at least once per day [12]. Few studies describe the brushing time but a recent study showed that almost half of the adults brushed more than two minutes [24], a result in contrast to a study by Saxer et al. [20], where observed brushing time was just over one minute. In the former study only nine percent of the adults used a modified post-brushing rinsing procedure.

Knowledge and attitudes affect adolescents' oral health behaviour [18], lifestyle and social norms seem to influence the frequency of toothbrushing [15]. In school-children rationalizations for toothbrushing are seldom found. Instead social circumstances impact the toothbrushing routines [9]. Adults in Sweden have low awareness of toothbrushing procedures and use of fluoride toothpaste despite frequent dental care [24]. The knowledge about toothbrushing, toothpaste habits and motivation for oral hygiene routines among people in older ages is strongly limited. Thus the aim of this study was to identify knowledge, attitudes and behaviour concerning toothbrushing and the use of fluoride toothpaste in three age strata in a Swedish population.

Material and methods

The Regional Ethical Review Board at the University of Gothenburg, Sweden, approved the study. Informed consent was obtained from all participants before the study began. Consent from informants

below the age of 18 was obtained from both the adolescents and their parents. With the purpose of achieving a deeper understanding and obtaining a rich and diverse description of the issue, a qualitative study design was used.

Study population

The informants were residents in a municipality in western part of Sweden and came from both urban and rural areas. Three age strata representing different stages in life were chosen: 15-16 years, 30-35 years and 60-65 years. The participants were selected strategically in order to obtain the greatest possible variation in the data. The aim of the selection process was, within the three age intervals, to acquire subjects of both sexes with different educational backgrounds and experience of dental care.

Interviews

The interviews were performed by a dental hygienist (OJ) experienced in performing preventive measures in patients of all ages but not involved in the treatment of the informants in this study. The first two interviews were guided by a dentist (PG) experienced in qualitative research. The interviews were supported with an interview guide to secure that all perspectives of interest were included. The guide was structured in two sections: the first part asked about personal background and the second part contained questions about individual perceptions concerning dental care habits with a focus on toothbrushing and fluoride toothpaste. With the purpose of allowing the informants' own choice of words, and in order to enable follow-up perspectives, the questions were open-ended. The focus was on the informants' own descriptions of their thoughts, feelings and actions. As the informants expressed new views on the subject during the interviews, the interview guide was adapted to the new perspectives.

The duration of the interviews was 15-40 minutes (median 34 minutes) and they took place in an office at a dental clinic. The interviews were all recorded (Sony IC recorder) and transcribed verbatim by a trained secretary who was otherwise not associated with the study. The interviews were performed in Swedish, transcribed in Swedish and the analysis was conducted with the Swedish text as a basis. A professional translator translated the quotations used in this paper from Swedish into English.

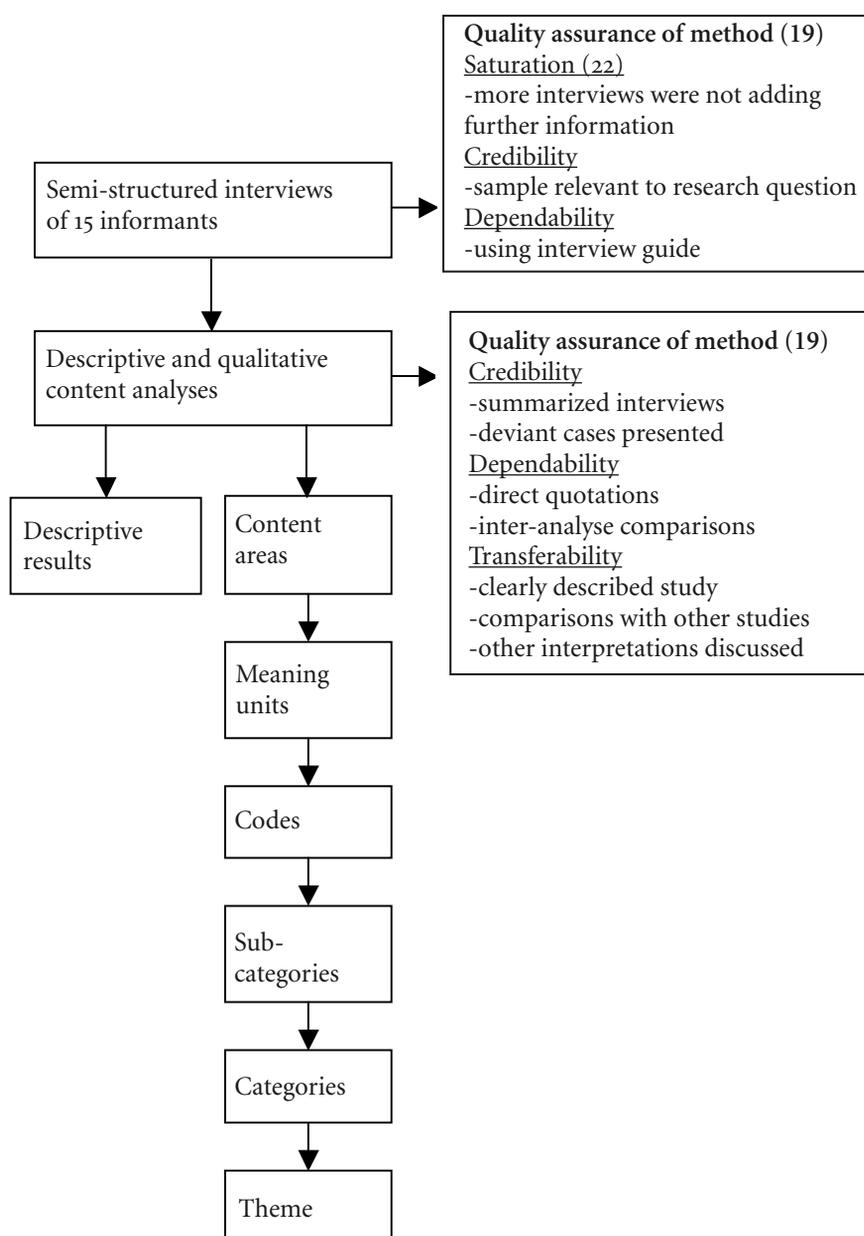
Analysis

Background data is presented descriptively. Other

data were analysed using manifest and latent qualitative content analysis, which both deal with interpretation but in varying depths and levels of abstraction (Fig 1). Three content areas were identified using the manifest analysis: knowledge, attitudes and behaviour. Each interview text, or unit of analysis, was divided according to these areas. The text was sub-

sequently dissected into meaning units, groups of words or statements with the same central meaning. The analysis was continued by further condensing the meaning units to form codes, which can be described as labels for the meaning units with the aim of disclosing new and different aspects. Thereafter the codes were sorted into sub-categories (threads

© Figure 1. A summary of sampling, analysis and quality assurance procedures in the study.



© Figure 2. The organization of codes, sub-categories and categories identified in the analysis.

Codes	Subcategories	Categories
- recognize own responsibility - confirmation - satisfied with own performance	Self-efficacy	Empowerment
- positive to comply - negative to comply	Compliance	
- respect the autonomy - feelings of inadequacy and shame - been taught right behavior previously	Wish for other conditions	
- oral hygiene for my own sake - pleasurable - feeling as a driver	Pleasant feeling	Driving force – why performing oral hygiene
- smell good, look good - show a behaviour - gender perspective	Social norm	
- keep it healthy - the mouth is part of the body - teeth are the most important thing	Health promotion	
- chewing function - not be toothless - fear of dental care - great expense	Avoid disease	
- learned in childhood - predictive skill - difficulties learning new - attitudes	Force of habit	Guidance –how oral hygiene is performed
- population lacks knowledge - individual lacks knowledge - is knowledge needed?	Lack of knowledge	
- price of the product - choose as before - practical packaging - select what is available	Practical aspects	
- confidence in the messenger - ambivalent about the impact	Information and advertising	
- start at early ages - dental care should be taught - Internet - use humour - frighten a little	Future knowledge transfer	

of meanings), and clustered into categories. Data and codes were compared with each other, and one section of data was used to explore other sections. The latent analysis is a way of linking together the underlying meanings into categories, or of finding a common strand through condensed meaning units, codes and categories. The analysis could be described as a process of abstraction that emphasizes descriptions and interpretations at a higher logical level compared to the manifest analysis [10].

Two authors (OJ and PG) conducted the initial analysis by reading the texts several times and gradually becoming more familiar with them. These authors also did the preliminary coding of the text. With the purpose of reaching a consensus about categories and subcategories and how they were compiled using the codes, all authors analysed the transcribed interviews. To some extent codes and subcategories were revised during this process. The categories in this study were identified as empowerment, driving force and guidance (Fig. 2). The concept of empowerment refers to an individual's confidence in his/hers own capacities. The sub-category of self-efficacy included personal responsibility, confirmation and satisfaction with one's own performance. A theme that revealed the patients' opinions and conceptions was identified. The theme of the present study was toothbrushing with fluoride toothpaste was a priority, despite the lack of knowledge about how to use toothpaste effectively and its positive effects on oral health. All categories and the theme were grounded in the data by selection of explorative text quotations.

Quality aspects of the method

The concept saturation originates from the tradition of Grounded Theory [22] and means that continued data collection no longer adds any further relevant information. After 15 interviews the research group concluded that the study was saturated.

The term trustworthiness is commonly used to describe the quality of a qualitative study, and consists of credibility, dependability and transferability [19]. Credibility means how well the data address the intended focus, and was achieved by collecting data from informants of chosen ages who had practiced oral hygiene. People with different experience were included and deviant cases presented. Dependability, or to the extent to which the data changes over time was addressed by using an interview guide without excluding the option of comparing data and introducing follow-up questions to narrow the focus

of the research. Transferability refers to the extent to which research findings can be extrapolated to a different context. In this study this was achieved by clearly describing the research process and context so that the reader can follow the process and decide whether the findings are transferable to other contexts or whether the data might be open to alternative interpretations [10]. Quotations from all participants were used in the manuscript. In figure 1 the sampling, analysis and quality assurance procedures are summarized.

Results

Fifteen people were interviewed in the study, five from each age group 15-16 years, 30-35 years and 60-65 years. Five informants were men and ten were women. Adult informants had experience of restorative dental care and periodontal treatments, while the adolescents mainly reported experience of examinations and preventive measures. Most informants received dental care regularly but several had periods in which they avoided dental care. The majority was satisfied with their oral health, and several reported dental fear. The descriptive data are summarized in Table 1.

Content analysis

Three content areas were identified in the interviews: knowledge, attitudes and behaviour.

Knowledge

Some informants showed good knowledge about the importance of fluoride: "I suppose the idea is to get the fluoride ... well, because it strengthens your teeth and ... it's very preventive. And when you use fluoride you can even get rid of small cavities." Others, however, had poor knowledge: "... there must be something in the toothpaste that sticks and keeps your teeth clean, I guess. No, well, I just don't know. No idea."

There were different opinions about why one should use toothpaste: "it's good for your teeth ... there's fluoride in it, it helps your teeth. ...it strengthens them, I think... and it has a taste." Another informant explained: "I guess you think more about how it tastes than what good it does." The knowledge about whether or not to rinse with water after brushing also differed: "... that you aren't supposed to rinse off the toothpaste, that's news to me" while another informant stated: "Afterwards I usually don't rinse with water ... you're supposed to use toothpaste

© **Table 1** The informants' sex, level of education, self-perceived oral health and prevalence of dental fear.

Sex		
Women	10	67%
Men	5	33%
Education		
Primary school ¹	7	48%
High School/vocational education	4	26%
Higher education	4	26%
Self-perceived oral health		
Completely satisfied	10	67%
Fairly satisfied	2	13%
Dissatisfied	3	20%
Attitude to dental visits		
Visit without discomfort	6	40%
Visit with discomfort	5	40%
Experience dental fear	3	20%

¹ Informants aged 15-16 years could not possibly have higher education than primary school

to brush your teeth and then not rinse afterwards." There were also informants who were not at all sure whether or not rinsing with water was good: "Some people do say you aren't supposed to rinse ... But I don't know whether or not that's a good idea. ... no dentist has ever told me not to rinse it off ... I think I prefer to rinse a bit."

Attitudes

Many informants said that they used toothpaste because of the fresh sensation: "... and it makes your mouth feel clean afterwards... But now that you have the chance of using toothpaste, you do, for the taste." Another informant described the feeling: "it's become a habit for me, never to brush without toothpaste. And I think it feels good too, and nice and clean after ... And your breath feels fresher." Some informants stated that toothpaste is something that is natural to use: "It feels natural. It's just what you do. It isn't really anything I think about."

The consistency of the toothpaste was important to some informants as one stated: "It's definitely the consistency, because the taste doesn't matter." Some chose fluoride toothpaste because they thought the toothpaste had a cleansing effect.

For some informants the price of the toothpaste was important: "In the past I would buy any kind, as long as it was fluoridated ... I've just taken whatever was available ... But since I developed some problems, I've started using Sensodyne... Even if it does cost a little more." Many informants described

that they avoided toothpaste containing grindstone: "Something I've been warned about is the toothpastes like Ultra White and others that contain a lot of abrasives. ... Still, you don't go around checking on the content, except for that warning to watch out for the abrasives" and "There were little granules in it, I don't like that."

Behaviour

The informants described different brushing frequencies: "I brush morning and evening ... never miss" or "I skip almost every morning, only brush in the evening. Evenings are 100%." The excuse for not brushing in the evening was explained by one informant: "If I'm too tired and don't feel up to it, just want to go right to bed, I don't bother with toothbrushing." Some informants were aware of the amount of toothpaste they used and were specific about it: "A long strip. Sometimes I might take a bit too much, but I enjoy using toothpaste" and "I take like a little glob on top. A narrow strip on the toothbrush. Once." Others were not sure at all or had never thought about it: "I guess I take a good amount. I don't really know."

Many informants described that they did not know the length of time they usually brushed: "Gosh, that's a hard one.... Thirty seconds or maybe a minute. I ought to start thinking about that." But some seemed to take the time at brushing while doing other things: "I always walk around while I brush my teeth ... five minutes at least, I brush them." Several informants answered that they methodically rinsed the toothpaste off with water: "... then like at the end I have a little water, I rinse it all out, yes I do." There were also informants who did otherwise: "I don't rinse my mouth afterwards. The dental hygienist told me, I'm not supposed to rinse too much, instead I'm supposed to leave it on."

All informants expressed a wish of not eating or drinking after brushing their teeth in the evening: "No, never. I always go to bed." and "I don't feel like eating... because I couldn't be bothered to brush again." In addition, several informants described use of interdental aids and fluoride mouth rinse.

Categories

The categories in this study were identified as empowerment, driving force and guidance (fig. 2).

Empowerment

Most informants mentioned the perspective of empowerment in a positive or negative way. One in-

formant expressed responsibility as: "I have to take care of my teeth, nobody's going to do it for me." As described by several informants confirmation and feedback strengthen behaviour: "When your dental hygienist tells you do a good job, and that you should just go on the same way, well then of course you do go on" and "it's been very easy just to go to the dentist and show off your teeth and be told that everything is fine." Some informants expressed that they were pleased with their own performance concerning oral hygiene: "I must say I'm pleased, since I don't feel I have to do things better. No, I'm doing fine" and "I think I'm doing all right and I don't want to spend any more time at it." A positive response to the hygienist's advice was described by an informant: "I've learned as I went along by going to the dental hygienist, and when I see her do things I think that's how I should do it myself, too." But other informants describe negative feelings concerning compliance: "I don't like brushing my teeth, but it's just one of those things you have to do." The informants had thoughts about conditions that could be different. Respect for autonomy was mentioned: "you have to watch out not to be too much of a know-it-all." and inadequacy with regard to oral hygiene: "I'm not happy with myself if I haven't brushed" and "if I could I'd want to brush after meals during the day too ...but you can't take your toothbrush everywhere." One informant asked for learning in childhood: "when I think back to when I was a child, I wish I had been taught how to brush and do everything right."

Driving force

The reason for performing oral hygiene – the driving force – consisted of the subcategories pleasant feeling, social norm, health promotion and avoid disease. The sense of well being after toothbrushing is mentioned by several informants: "I often brush just for the taste" and "it makes your mouth feel really nice." One informant stressed the association with pleasure in oral care situations: "it's important to do it as something that makes you happy, to make it fun beginning in childhood." Social expectations were often expressed as a driver for toothbrushing: "when I was working I always brushed before leaving home." Good breath was stated as important: "of course toothbrushing does give you better breath but in the long run it doesn't matter what toothpaste you use, you have to get some real mouthwash instead". The informants often stated that having white teeth was not a driver for brushing but this was still often mentioned: "my friends say they brush their

teeth when they are yellow" and "of course it would be nice to have whiter teeth." One informant wanted to impress others with her good behaviour: "I have dental floss in my handbag at work to show off." Women were supposed to be more interested in their health: "I think it's easier to reach women than men, maybe because women are fussier about the state of their mouth. They want nice white teeth." Health promotion as a driver was mentioned by several informants: "It keeps your teeth healthy, you're going to have them for your whole life" and "our teeth are the most important thing we have. I've never had any trouble since I started taking care of my teeth." Another frequently mentioned driver was to avoid oral diseases and dental treatment. Informants talked about keeping their chewing capacity: "I want to be able to chew my food well" and "You keep your teeth clean so you won't have to have them pulled and get dentures", as well as about avoiding dental treatments because of dental fear: "You keep your teeth clean so you won't have to have them pulled and get dentures, you don't want some dentist drilling your teeth. I've heard from my friends that it hurts and that scares me." One informant stated that pain and the high cost of dental care were reasons for performing oral hygiene: "toothaches are really really awful ... and it's very expensive, too, to get implants and bridges."

Guidance

How oral hygiene is performed is determined by many factors such as habits, knowledge, practical aspects, information and advertising. All informants spoke about habits that were founded during childhood: "It was Mama who taught me some time when I was little" and that it was difficult to learn new "I've heard about not rinsing but I just rinse automatically." Lack of knowledge influenced behaviour: "The dental care services don't teach you how to use toothpaste ... you put in on and you brush" and "I rinse 'til it feels good and I know I don't have any toothpaste left in my mouth." One informant questioned whether knowledge was necessary for brushing: "So do we need to know about toothbrushing?"

Several practical aspects of toothbrushing and toothpaste were discussed by the informants. The price was mentioned: "when you're in the store, the price might end up being what decides it" and the practicality of the tube "I think it has a better top so you don't end up dropping it all the time." Informants also stated that they had no preferences but chose the product that was easiest to find. Informa-

tion and advertisements influence the informants although they were ambivalent about or unaware of the effect: "I've heard it or seen on TV that you're supposed to leave the toothpaste" and "all the commercials are about whiter teeth, that's all you hear". The informants had little confidence in companies selling oral hygiene products: "Ads don't affect me at all ... ads are so silly ... ads do everything to make their products sound good" and "who's going to fool me ... this one tastes good, this one whitens your teeth, but you have no idea which toothpaste really works." In contrast the informants expressed confidence in the dental staff: "You can only find out from a neutral dentist, not sponsored by any company or anything ... you don't listen to the message if there is a company logo on it."

The informants suggested future methods to inform people about oral care habits. They talked about starting at early ages and that dental staff should be active in teaching at different arenas than the office. The informants suggested the use of modern communication, but the message must attract attention: "If it's funny and sillier you remember it more easily" and "it would be funny to see someone with really bad teeth... that might make you sit up and listen." One informant suggested that the information should frighten people to motivate them.

Discussion

In this study 15 individuals in three age groups were given the opportunity to describe their oral hygiene habits and explain the reasons for their behaviour. The interviews showed that several informants lacked knowledge regarding toothbrushing, the use of fluoride toothpaste and the role of fluoride in the caries process. The informants considered oral health important as well as oral hygiene procedures, and their behaviour concerning toothbrushing was better than expected given the state of their knowledge.

Most of the informants were of the opinion that toothbrushing reduce the number of bacteria and this was the main reason for brushing. The reason for using toothpaste and the effects of fluoride were very uncertain, findings in line with a study by *Wikén & van Dijken* [24]. Although the informants did not know much about fluoride in toothpaste, their knowledge about abrasive effects of toothpaste was extended. The common opinion was that toothbrushing was more important for oral health than the use of fluoride toothpaste, possibly a logical conclusion if oral hygiene was performed with the

purpose of preventing both caries and periodontal diseases.

Parents were ranked as the main source of learning oral hygiene habits irrespective of the age. Several studies have shown that parents' behaviour influence adolescents' oral hygiene performance [4] and the statements of the informants in this study indicate long term compliance in oral self-care to be a result of parents influence. Only single informants reported that they got information from their parents or the dental staff about toothpaste or learned how to use toothpaste by practice and these issues seems to be a subordinate area for dental care personnel and research [24]. Why do the dental staff members not talk about the importance of fluoride in the toothpaste, how much toothpaste should be applied to the brush or for how long toothbrushing should go on, etc? Perhaps the dental staff members take matters of toothpaste technique, such as brushing time and how much toothpaste that should be used, for granted and assume that patients already know these things. There is limited understanding of the processes that guide dental staff members' willingness and abilities to transfer knowledge to patients and large populations. In a study by *Hedman et al.* [11], where dental staff members involved in health work in schools were interviewed, it became clear that they focused more on disease prevention than on attracting young people to maintaining their oral health. Oral care professionals and promoters need to better inform about the importance and use of fluoride toothpaste when giving oral health training and promotion, as this is considered the most cost-effective tool for the preventing of caries [23].

The difficulties in learning new behaviour and in changing behaviour established in childhood were described. Even when informants received information about a more effective method of toothbrushing, they found themselves still acting in line with their old pattern. Educational objectives have been divided into three different domains: cognitive, which relates closely to knowledge, affective, which is about the way people react emotionally, and motor, which describes the ability to manipulate a tool, for example a toothbrush [3]. Learning facts is the first step in changing behaviour, but a person also has to pass through understanding, application and analysis before he can develop his own strategies. One reason for not changing habits in spite of new knowledge may be that feelings and practise do not agree with the transfer of knowledge.

The informants assumed that advertisements were

not honest and that their aim was to deceive. However, despite the negative attitude towards advertisements, the informants were still influenced by them. They denied, and rejected, an aesthetic driving force, but at the same time admitted that that they bought and tested products, such as whitening toothpaste with abrasive effects. The informants were aware of the risk of harmful effects on the teeth, but still they used the products, at least during certain periods. In this context, the facts say one thing but the feelings take over. Several informants state that confidence in the messenger is important and that companies whose goals are to make money are not reliable. Instead, they relied mainly on the dental staff. In this study the interviewer was a dental hygienist and it can not be excluded that the informants were influenced when answering questions since they had great confidence in dental personnel. However, it was necessary that the interviewer had some understanding about the studied issues.

The driving forces – why the informants performed oral hygiene – were a pleasant feeling and social norms as well as factors related to health and disease. The older the person the more important it seemed to avoid disease. One explanation could be that losing teeth is a more real threat when you are older. The strong influence of social norms may explain why behaviour was sometime better than expected in view of the level of knowledge. The health behaviour model “Theory of Planned Behaviour” [1] identifies attitudes, social norms and perceived behaviour control as guiding the intention to perform certain behaviour. Social norms are defined as the extent to which a person experiences social pressure from others. In this study several informants in all the age-groups expressed social norms as driving forces although they were seldom aware of these expressions themselves. However, they suggested just as often that the reason for toothbrushing was the pleasant feeling, i.e. that oral hygiene was performed for their own sake. A pleasant feeling can improve habits since people who rate the taste of toothpaste as high brush their teeth longer [24].

In many interviews the informants talked about their own performance. They were sometimes satisfied, sometimes disappointed in themselves. Few informants mentioned their own responsibility for their oral health, but no one stated that it was someone else’s responsibility. Statements about being talented and capable indicate self-efficacy, a belief in one’s ability to exercise control over one’s health [6]. Confirmation and feedback were considered im-

portant in this process. Other informants expressed shame and sorrow about their oral health and poor oral hygiene habits. According to the social cognitive theory, unless people believe that they can manage to produce the desired effects they have little motivation to act. People with a high sense of efficacy can succeed with minimal guidance while persons with a low sense of efficacy believe that their health is beyond their control. Therefore, to successfully change behaviour, improved sense of efficacy is helpful [6].

Through optimal use of fluoride toothpaste the incidence of caries in the population can decrease. Informants in this study showed lack of knowledge about the reasons and technique for using fluoride toothpaste effectively. In addition they lacked awareness of their behaviour and the reason for acting, giving the theme of this study: toothbrushing with fluoride toothpaste was a priority, despite the lack of knowledge about how to use toothpaste effectively and its positive effects on oral health. In conclusion the state of knowledge concerning toothbrushing and fluoride toothpaste needs to be improved, and simple and clear advice, easy to adopt, should be given. However, increased knowledge is only one part of influencing oral health behaviour. People’s desire for a fresh-feeling mouth and to fit in socially must be affirmed and utilized by dental staff in health promotion. In addition, methods to increase people’s self-efficacy must be part of health promotion as used by dental staff.

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References

1. Ajzen I. The theory of planned behaviour. *Organ Behav Hum Decis Process* 1991; 50: 19-30
2. Alm A, Wendt LK, Koch G, Birkhed D. Oral hygiene and parent-related factors during early childhood in relation to approximal caries at 15 years of age. *Caries Res* 2008; 42: 28-36
3. Anderson LW, Krathwohl DR. A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom’s Taxonomy of Educational Objectives. Boston, MA: Allyn & Bacon (Pearson Education Group), 2001
4. Astrøm AN. Parental influences on adolescents’ oral health behavior: two-year follow-up of the Norwegian Longitudinal Health Behavior Study participants. *Eur J Oral Sci*. 1998; 106: 922-30
5. Bagramian RA, Garcia-Godoy F, Volpe AR. The global increase in dental caries. A pending public health crisis. *Am J Dent* 2009; 22: 3-8

6. Bandura A. Health promotion by Social Cognitive Means. *Health Educ Behav* 2004; 31: 143-64
7. Bruno-Ambrosius K, Swanholm G, Twetman S. Eating habits, smoking and tooth-brushing in relation to dental caries: a 3-year study in Swedish female teenagers. *Int J Paediatr Dent* 2005; 15: 190-6
8. Davies RM, Ellwood RP, Davies GM. The rational use of fluoride toothpaste. *Int J Dent Hyg* 2003; 1: 3-8
9. Gill P, Stewart K, Chetcuti D, Chestnutt IG. Children's understanding of and motivations for toothbrushing: a qualitative study. *Int J Dent Hyg* 2011; 9: 79-86
10. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today* 2004; 24: 105-12
11. Hedman E, Ringberg K, Gabre P. Oral health education for school children; a qualitative study of dental care professionals' view of knowledge and learning. *Int J Dent Hyg* 2009; 7: 204-11
12. Hugoson A, Koch G, Gothberg C, Lundin SA, Norderyd O, Sjödin B, Sondell K. Oral health of individuals aged 3-80 years in Jönköping, Sweden during 30 years (1973-2003). I. Review of findings on dental care habits and knowledge of oral health. *Swed Dent J* 2005; 29: 125-38
13. Hugoson A, Koch G, Götberg C, Helkimo A, Lundin SA, Norderyd O, Sjödin B, Sondell K. Oral health of individuals aged 3-80 years in Jönköping, Sweden during 30 years (1973-2003). II. Review of clinical and radiographic findings. *Swed Dent J* 2005; 29: 139-55
14. Koivusilta L, Honkala S, Honkala E, Rimpela A. Toothbrushing as part of the adolescent lifestyle predicts education level. *J Dent Res* 2003; 82: 361-6
15. Maggregor ID, Balding J, Regis D. Toothbrushing schedule, motivation and "lifestyle" behaviours in 7,770 young adolescents. *Community Dent Health* 1996; 13: 232-7.
16. Marinho VC, Higgins JP, Sheiham A, Logans S. Fluoride toothpastes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2003; CD002278.
17. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral disease and risks to oral health. *Bull World Health Organ* 2005; 83: 661-9
18. Poutanen R, Lahti S, Hausen H. Oral health-related knowledge, attitudes and beliefs among 11 to 12-year-old Finnish schoolchildren with different oral health behaviours. *Acta Odontol Scand* 2005; 63: 10-6
19. Rowan M, Huston P. Qualitative research articles: information for authors and peer reviewers. *CMAJ* 1997; 157: 1442-6
20. Saxer UP, Barbakow J, Yankell SL. New studies on estimated and actual toothbrushing times and dentifrice use. *J Clin Dent* 1998; 9: 49-51
21. Sjögren K, Birkhed D. Effect of various post-brushing activities on salivary fluoride concentration after toothbrushing with sodium fluoride dentifrice. *Caries Res* 1994; 28: 127-31
22. Strauss A, Corbin J. Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park: Sage Publications Inc, 1990
23. Twetman S, Axelsson S, Dahlgren H, Holm AK, Kallestal C, Lagerlöf F, Lingström P, Mejare I, Nordenram G, Norlund A, Petersson LG, Söder B. Caries preventive effect of fluoride toothpaste: a systematic review. *Acta Odontol Scand* 2003; 61: 337-55
24. Wikén Albertsson K, van Dijken J. Awareness of toothbrushing and dentifrice habits in regularly dental care receiving adults. *Swed Dent J* 2010; 34: 71-8
25. Zero DT, Creeth JE, Bosma ML, Butler A, Guibert RG, Karwal R, Lynch RJM, Martinez-Mier EA, Gonzalez-Cabezas C, Kelly SA. The effect of brushing time and dentifrice quantity on fluoride delivery in vivo and enamel surface microhardness in situ. *Caries Res* 2010; 44: 90-100

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Oral health in obese patients undergoing weight-reducing treatment

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Aim: To investigate general and oral health in obese patients and matched controls and study the influence of weight-reducing treatment on oral health.

Material and Methods: 38 patients participated in the study. 22 were obese (mean BMI 36.7, mean age 50 yrs) and 16 were of normal weight (mean BMI 22.9, mean age 45 yrs). At follow-up (mean 14 months) 12 out of 22 obese patients participated. A clinical examination was done at baseline and at follow-up including bitewings, DMF index, caries activity (D1-D3), stimulated salivary secretion, plaque accumulation and counts of Lactobacilli and Str.mutans. In addition a general and oral anamnesis was registered. For statistical analysis of data non-parametric methods were used (Chi2 test, Sign test and Wilcoxon Signed rank sum test, SPSS, 17.0)

Results: General health was significantly affected in the obese group compared with the control group ($p < 0.05$). Prevalence of secondary diseases due to obesity, i.e. high blood pressure ($p < 0.001$) and asthma ($p < 0.05$) was significantly overrepresented in the obese group. Forty-three% of obese patients had diabetes type 2 compared with 13% in the control group. The oral health was lowered in the obese group compared to the control group. We found a statistically significant difference in the total number of deep carious lesions (D3) in the obese group ($p < 0.05$) and a significantly lower stimulated salivary secretion ($p < 0.05$). However, there were no significant differences between the groups concerning plaque accumulation or the quantity of caries-associated microorganisms. We also found that obese patients had more irregular dental appointments compared to normal weight patients ($p < 0.01$).

Conclusion: Obesity appears to be a risk factor for impairment of oral health as well as general health status. However, the size of this study does not allow multivariate analysis. Accordingly, the question

if obesity per se is an independent risk factor for impaired oral health is still open. Anyhow, it is important that dental care teams pay extra attention to obese patients because of a higher risk for impaired oral health.



General dentists' attitudes to treatment alternatives in teeth with extensive loss of substance. An explorative questionnaire survey

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Aim: The aim was to describe attitudes among general dentists related to treatment alternatives of teeth with extensive loss of substance and the possible influence of continuing education.

Material and Methods: Questionnaires with 13 structured and open questions about treatment, opinions and experience, of teeth with extensive loss of substance were sent to all 112 general dentists at all 19 public dental service clinics in a county. Participation in a continuous education course, "Sustainable crowns", was thereafter offered. Eleven interested dentists at 11 clinics completed a six days training course. Identical questionnaires were answered by all general dentists, anonymously again, one year later.

Results: The response rates were 86% and 82% for the first respectively second questionnaires. Forty-three percent of all dentists made some conventional indirect crowns per week or more often at baseline compared to 52% at the second questionnaire. At clinics, with a continuous educated dentist, the corresponding proportion was 56% the second time. Specified advantages with indirect crowns, mentioned at baseline, were sustainability, favourable appearance and financially beneficial for the patient. Disadvantages mentioned were high costs, according to the patients, and improper therapy on teeth with dubious prognosis. Preparation and impression were considered as the most difficult moments. These variables did not change over time.

Some composite resin crown per week or more often were done by 42% and 31% respectively. Advantages mentioned were low costs and useful on teeth with dubious prognosis. The results were often believed to be poor and conventional indirect crowns were considered better. No particular group of teeth dominated for any replacement. The portion of all dentists who specified composite as the prime replacement in teeth with extensive loss of substance declined from 50% to 20% over time while conventional indirect crowns increased from 50% to 80% ($p < 0.001$).

Conclusions: Despite substantial response rates, interpretation of the answers should be done cautiously. Technical skills and contentions were rated similarly but the approach to treatment of teeth with extensive loss of substance might have changed over time. The attitude to conventional indirect crowns became more positive among all dentists and particularly so in clinics with a continuous educated dentist. A change in attitudes might thus be possible to achieve with education and a certain diffusion of new knowledge appears to take place in the clinics. Attitudes measure what an individual believe, think or feel. If an actual shift in intervention occurred must be decided in future investigations.



Loss of dental attendance among elderly Swedish people

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Aim: Regular dental checkups are likely to be an important factor for maintaining oral health. Dental practitioners often experience that older patients tend to lose the regularity in dental checkups. It is likely that contact with the dentist co varies with the patient's increasing age together with physical and psychical health. The objective of this study was to study dental attendance among subjects 65 years and older and a possible age trend.

Material and Methods: Data were collected from the electronic journal system in three public dental clinics, in the Region of Västra Götaland, Sweden.

Data from 3646 independently living persons 65-96 years of age were studied over a period of 6 years (2004 – 2009). The patients were enrolled in a recall system, being called every year for a dental checkup. From every record, data concerning gender, medication, dental contacts, and dental status was extracted.

Results: Among the elderly, 65 years and older, a clear association between age and loss of regular dental attendance was found. Between 2004 and 2009 13% of the elderly had lost their contact with dental care. In the youngest age group (65-79 years) the proportion was 10% and among the oldest (>80 years and older) 21%.

Conclusion: A considerable number of subjects lose their dental contact despite being enrolled in a dental recall system. With increasing age regular dental contact tend to decrease. Reasons for this loss of contact remain to be analyzed in future studies. It is likely that in addition to old age social and medical factors have to be considered.

Aknowledgement: This study was supported by the Västra Götaland Region , Sweden



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

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Acasia Research and Education

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

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

Results: Increased NPY-LI was found in the medial eminence and pituitary ($p < 0.05$). In the hypothalamus there was tendency to increase and in the hypothalamus a decrease ($p < 0.005$). A negative correlation was found between running and the decrease in

▷ NPY-LI in the hypothalamus ($R = -0.510, p < 0.05$).

Conclusion: We suggested that long-time running in the SHR alters autonomic neuropeptide such as NPY in the HPA-axis that may reflect that muscular exercise exert and effect on the neuroendocrine axis.

⑤

Oral status, oral hygiene and patient satisfaction in the elderly with dental implants dependent on substantial needs of care for daily living

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Aim: This study is to examine how oral hygiene, function and comfort works in elderly people with dental implants and substantial needs of support for daily living.

Material and Methods: The study covered twenty-six persons older than 65 years and who also had substantial needs of support for daily living. Data on number of teeth and implants, plaque-index, bleeding index and oral care habits was registered. In addition self-rated knowledge about oral care and satisfaction with dental status were registered.

Results: These elderly persons had totally 148 natural teeth and 140 implants. Few signs of oral diseases were registered and the implants showed fewer signs of oral diseases than the teeth. No correlation was registered between oral habits and plaques- and gingival score. The majority of the elderly persons were satisfied with their implants.

Conclusion: Dental implants show satisfactory function even in elderly with substantial needs of support for daily living.

⑥

Adult attention deficit hyperactivity disorder symptoms and dental anxiety

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Aim: Adult attention deficit hyperactivity disorder (ADHD) is a common and disabling disorder in the general population with high rates of comorbidity with anxiety disorders. Today the frequency and impact of ADHD in adults with dental anxiety (DA) is unclear. This study was designed to investigate if the presence of ADHD symptoms is related to DA and psychosocial impact of DA in adults.

Material and Methods: Preliminary data from an ongoing consecutive study on patients referred to a specialised dental anxiety clinic is presented. Forty-five patients (mean age 44 years, 33 female, 12 male), were screened for ADHD symptoms using the Adult ADHD Self-Report Scale (ASRS) Screener. Self-report data on DA and its psychosocial impact was obtained using the Dental Fear Scale (DFS), Dental Anxiety Scale (DAS) and the clinic's standard intake questionnaire. Two different scoring methods have been suggested for the ASRS screener. This study applies the method proposed by Kessler and colleagues [Kessler R.C., Adler L.A., Gruber M.J., Sarawate C.A., Spencer T., Van Brunt D.L. (2007) Validity of the World Health Organization Adult ADHD Self-Report Scale (ASRS) Screener in a representative sample of health plan members. *International Journal of Methods in Psychiatric Research*, 16, 52–65.] where a positive screen is defined as a score of 14 or higher.

Results: Patients with a positive screen for ADHD felt more anger because of their DA ($p < 0.05$) and their DA interfered more with their family-life ($p < 0.05$). They also reported higher levels of shame and depression because of their DA and that DA interfered more with friends and dating relationships. Both groups showed high levels of DA but patients who screened positive for ADHD believed to a lesser degree that their DA could be cured. These differences however did not reach statistical significance.

Conclusion: The results indicate that ADHD symptoms may increase the psychosocial consequences of dental anxiety in adults. These patients may be a special risk group in dental care that acquires extra attention.



Dental anxiety: manifestations and impact on daily life

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Aim: Dental anxiety is associated with avoidance of dental care in approximately 5 % of the population. This explorative study investigated the association between oral health and impact on daily life in patients with dental anxiety.

Material and Methods: Preliminary data from an ongoing study is presented. Thirty-seven consecutive patients (mean age 44 yrs, range 20-69, 10 male, 27 female) referred to a special dental fear clinic participated. The patients were asked to answer a battery of questionnaires and underwent an adapted clinical examination including a radiological survey. Dental anxiety was measured with Dental Fear Survey (DFS), oral health quality of life aspects were captured by the Oral Impacts on Daily Performances (OIDP) (higher scores represent more problems). The clinical variables used in this study were number of missing teeth and decayed teeth. In the analysis, the clinical variables were dichotomised (no missing vs. one or more missing teeth, no decayed vs. one or more decayed teeth).

Results: The patients reported a high level of dental anxiety (DFS total score $M=72.9$). A majority ($n=30$) reported at least one oral impact that affected their daily life. Patients with missing teeth had higher OIDP scores than those with no missing teeth ($M=32.8$, $SD=32.3$ vs. $M=11.0$, $SD=15.6$, $p=0.01$). Patients with decayed teeth had higher OIDP scores than those with no decayed teeth ($M=26.3$, $SD=29.5$ vs. $M=11.4$, $SD=21.1$), although the difference was not statistically significant. The differences were substantial and relevant, but due to a highly skewed distribution of OIDP scores and the small sample size the caries variable did not reach statistical significance.

Conclusion: The results indicate that poor oral health has a substantial impact on oral health related quality of life in individuals with dental anxiety.



Applications and results using the Nordic Orofacial Test–Screening protocol.

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Aim: Orofacial function includes a multitude of actions, some of them vital, such as breathing, chewing and swallowing, and also acts as the basis for social interaction in terms of speech, emotional communication, facial expression and appearance. Impaired orofacial function is a common feature in many inherited disorders or may be acquired as a consequence of disease and trauma. The Nordic Orofacial Test–Screening (NOT-S) is a comprehensive method for screening of orofacial function developed by a Scandinavian network of dentists and speech and language pathologists. NOT-S comprises evaluation of twelve domains of orofacial function. They are assessed from a structured interview and a clinical examination with a picture manual illustrating the different tasks in the examination. A method study of 120 individuals with chronic disease or disability compared to 60 healthy controls showed good intra- and interexaminer agreement. The aim was to present current applications and results from publications on the use of NOT-S.

Material and Methods: Beside the method study published in 2007 to date four studies has been published. One was a study in individuals with Parkinson's disease ($n=15$), two were studies in individuals with rare disorders; Ectodermal dysplasia ($n=46$), and Prader-Willi Syndrome ($n=45$), and one was a study evaluating surgical treatment in children with tonsillar hypertrophy ($n=67$). In order to visualize to what degree the domains of orofacial function are affected in different conditions, connected plots were made from the mean NOT-S scores for the twelve domains of NOT-S, here called dysfunction profiles.

Results: The groups with different diagnoses showed specific dysfunction profiles indicating patterns of domains with impaired orofacial function. The use

▷ of NOT-S to assess orofacial function before and after surgery in children with tonsillar hypertrophy showed that the method can also be used to evaluate interventions.

Conclusion: Screening with NOT-S proved to be a quick and reliable way of making a comprehensive assessment of orofacial function. NOT-S discriminated between groups with different diagnoses and also in evaluation of treatment. The results indicate that NOT-S has good reliability and discriminant validity.



Strategies for living with facial disfigurement

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Aim: Individuals with rare craniofacial disorders seem to be particularly at risk of negative social experiences and are often confronted with staring, questions and prejudice. Impaired speech, vision, hearing, and sometimes also cognitive abilities can make communication difficult. Ten years of involvement with a multi-professional network, The Swedish network for craniofacial disfigurement, whose purpose is to improve the way individuals with craniofacial disorders are received in health care, day care, and school situations, has disclosed dissatisfaction among affected individuals and families. The aim of this project was to sum up the experiences from conferences on living with facial disfigurement into recommendations aimed to improve the reception of affected individuals in health care and daily life.

Material and Methods: To capture their views, focus groups were formed with young affected individuals and with parents to children with facial anomalies. The main themes at the meetings were: – What makes you feel as if you are an active participant in your/ your child's treatment and in decisions being made about treatment? – What makes you/ or your child feel as if the persons you meet respect you? Suggestions for strategies expressed by affected individuals and families in the focus groups were compiled and divided into categories.

Results: The views expressed in the focus groups were grouped into three categories: strategies for parents,

for teenagers, and for professionals. The aims of the strategies are to empower persons with facial disfigurement and their families in treatment planning and performance, and to strengthen affected persons by teaching them to be proactive. The three sets of strategies are well in line with international recommendations in health care and with the UN Convention on the Rights of the Child.

Conclusion: The general conclusion was that it is not lack of specific knowledge but rather lack of implementation of existing recommendations that still makes living with facial disfigurement difficult for many individuals and families.



Patients' perceptions of and attitudes to a new dental insurance- and treatment system in the Public Dental Service of a Swedish region – a qualitative study

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Aim: Background and aim The Public Dental Service (PDS) in Region Västra Götaland, Sweden introduced a new option for individuals to pay for their dental care, i.e. a capitation plan. The individual can choose to pay a fixed risk-related annual premium after a dental examination including a risk assessment, or to remain in the traditional fee-for-service system. The aim of the present study was to generate new knowledge of considerations and factors impacting the patients' choice of payment system, and which attitudes they have to a prepaid risk-related payment system.

Material and Methods: Methods A qualitative design was chosen. Individuals were strategically sampled with reference to gender, age (older/younger adults), residence (rural/urban) and choice of payment system. Data was collected in sixteen oral interviews. The main areas of the interview protocol were how the informants perceived the information given by the PDS about the new prepaid risk-related payment system and their considerations before choosing system. Moreover, their views on oral health and experiences of

received dental care within the chosen system were explored. The data was analyzed by basic principles in Grounded Theory.

Results: Preliminary results The informants were often hesitant about which treatment was included in the prepaid risk-related payment system. Also, they were uncertain of the grounds for risk assessment. Age was considered as a factor, and they could see pros and cons for both older and younger persons to choose the new system. Their awareness of and reasoning about own resources to influence their own oral health were somewhat stereotyped, and mainly included tooth-brushing. Some informants expressed thoughts about economic incentives for the dentists. However, the confidence for the Public Dental Service and the dental personnel was strong as a whole.

Conclusion: The PDS should communicate the information about the prepaid risk-related payment system in a clear way. A health promotion perspective should be applied, empowering the patients to develop their own resources.

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Relationship between dental anxiety, self-reported oral health and oral health-related quality of life

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Aim: The objective of this exploratory study was to reveal the association and impact of dental anxiety on patients' oral health and quality of life.

Material and Methods: Adult patients referred to a special dental fear clinic in a hospital setting in Jönköping, Sweden were consecutively asked to participate in the study. The study is in progress and preliminary data from N= 68 (47 females) individuals with a mean age of 43.1 yrs (SD=12.4) are reported in this analysis. After informed consent, the patients answered a battery of questions and psychometric tests. In this report we used the Dental Anxiety Scale (DAS), the Dental Fear Survey (DFS), Oral Health Impact Profile

(OHIP-14) and Oral Health-Related Quality of Life uk (OHRQLuk) to assess level of dental anxiety, self-reported oral health and quality of life. Higher scores on these measures represent more anxiety and lower levels of health and quality of life, respectively.

Results: Last dental visit was on average 3.8 yrs (range 1-25) and DAS and DFS mean scores were 17.2 (SD=2.9) and 79.3 (SD=15.6), respectively. About 90% of the sample had higher DAS and DFS sum of scores than accepted cutoff scores for extreme dental anxiety levels. The OHIP-14 score was 38.2 (SD=13.8) while OHRQLuk was 53.2 (SD=14.1). There were no significant statistical differences with regard to gender except for DFS ($t=2.1$, $df=65$, $p=0.043$) and there was no significant age effect with regard to dental anxiety. Level of dental anxiety with DAS and DFS correlated significantly with OHIP-14 and OHRQLuk: DAS; $r=.34$ and $r=0.31$ and DFS; $r=0.44$ and $r=0.27$, respectively.

Conclusion: The referred patients at this special clinic for dentally anxious individuals reported parallel levels of dental anxiety as compared to a standard special clinic in Gothenburg, Sweden. Moreover, high dental anxiety had a clear impact on patients' reported quality of life and perceived oral health.

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Sense of coherence, dental anxiety and self-rated oral health

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Aim: According to the salutogenic theory of Antonovsky, individuals with strong Sense of coherence (SOC) experience life stressors as comprehensible, manageable and meaningful, and thereby are more able to address these stressors constructively. Several studies have shown that this psychological construct is related to health and health behaviors. Less is known about how SOC is related to oral health. The aim of this study was to investigate the relationship between SOC, dental anxiety and self-rated oral health.



▷ Material and Methods: Data from 493 women participating in the Population study of Women in Gothenburg 2004-2005 is presented. SOC was measured with the 13-item version of the Sense of coherence questionnaire (SOC-13) (a high score is favorable), dental anxiety with Dental Fear Survey (DFS) (a high score represents more dental anxiety) and self-rated oral health with a single-question.

Results: Poor self-rated oral health was reported by 23% of the subjects. Subjects with poor self-rated dental health reported more dental anxiety and weaker sense of coherence than subjects with good oral health (DFS $M=46.0$ $SD=21.1$ vs. $M=33.2$, $SD=12.9$; SOC $M=67.1$, $SD=13.4$ vs. $M=72.2$, $SD=11.8$) ($p<0.01$).

Conclusion: These results from a population based study indicate that self-rated oral health is related to Sense of coherence and dental anxiety. The results may be interpreted as a further indication of the vicious circle of dental anxiety, psychosocial factors and poor oral health.



Future challenges for the Swedish Public Dental Health Service (PDHS)

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The number of dentists in Sweden is predicted to fall till the year 2023 from 7400 today to 5400. At the same time the population is predicted to have increased by half a million, mainly due to net immigration.

The suggested remedies to fewer dentists are less need due to increased oral health in the population, increased proportion of dental hygienists and immigration of dentists from other countries.

Less need in the population is based on data of less disease among the younger to middle-aged generations. However the older generations have a considerable need for maintenance of fillings and constructions. It is difficult to envisage total less need among those older than perhaps 50. The generation now retiring has an average reminding life span of some 20 years. The specific need among the increasing proportion of immigrants in the general population is difficult to calculate.

Consumerism or patient empowerment and participation will also be more powerful in the future. This means that patients will have a strong view on treatment choices and more time must be spent on discussions with patients and on documentation of these and other procedures. Cosmetic dentistry will increase, as will the demand for more sophisticated solutions to oral health problems. All this added leads to demand for more dentistry.

Immigrant dentists has been employed in the 1950s and 60s by the PDHS with varying results, and a recent study has found less overall job satisfaction among PDHS dentists not born in Sweden.

The main challenge for the PDHS will be the problems of recruitment and retention of dentists in the major parts of the country. Regions, except the cities with Dental Colleges, will have problems, and within all regions more remote areas will face problems. The market solution stipulates that city dentists will have to move to the more remote areas due to less demand. That will not work; there will always be unmet demands also in the city centres.

An increased proportion of dental hygienist can hardly be expected to deal with those challenges.

So a worst-case scenario for the PDHS could be no dentists outside the major cities, dentists stay only short term in their positions, and the PDHS will not be able to offer access to good dental care on equal terms for the whole population.



Treatment of caries as a disease. Does that occur?

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Aim: The purpose of this study is to find out the proportion of patients that remember questions or advice related to caries disease at the last visit to the dental care and if the proportion is different between age groups. A further aim was to see if there were differences in the questions and advice reported from

individuals with perceived problems regarding caries or not.

Material and Methods: The results derived from two surveys. The first is "Life & Health 2008". This study was conducted in a population aged 18-84 years in five Swedish counties with a response rate of 59.2% (n=68710). The second is the "1942-year study" which is a longitudinal comprehensive study in two Swedish counties to those born in 1942. In 2007 the response rate was 73.6% (n=8313).

Results: Life & Health 2008 Differences occurred between different age groups in the proportion who got questions and advice related to dental caries. It was more common among younger people (19-29 years) to receive questions and advice than the older (65-84 years). Only 4% of the older group who felt that they had problems with caries received dietary advice, while 6% of the same group was asked about dietary habits. For the younger group the corresponding figures were 19% and 28%. Some differences concerning questions and advice were also found between those who felt that they had problems with dental caries compared with those who did not. 2% of the older group who themselves did not think they had problems with tooth decay received advice on dietary habits. For the younger group the corresponding proportions were 10%. Study born in 1942 33%, 3% and 17% of 65-year-olds got information at the last visit about oral hygiene, diet or fluoride. Generally men got more information than women. Whether they were satisfied with their teeth or not, there were no clinically relevant difference in the proportions receiving information. Information about diet was administered more often to those with low treatment costs than those with high treatment costs.

Conclusion: If tooth decay is a life style disease it must be treated in that way. The patient must have such insight into the problem that he/she may choose to change his/her habits. The study shows that relevant advice and information about disease treatment are diminishing when the patient gets older, and the information seems to be given routinely, rather than patient-tailored.

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The mechanism of action of inhibition of salivary secretion by antidepressant drugs

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Aim: Depression is a disorder that requires long-term treatment. A number of antidepressant drugs are used to treat depressive episodes and to prevent relapse. Dry mouth is a commonly reported adverse effect. The aim of this study was to investigate by which principal mechanism three different antidepressant drugs, a tricyclic antidepressant (TCA), a selective serotonin reuptake inhibitor (SSRI), and a serotonin norepinephrine reuptake inhibitor (SNRI) induce oral dryness.

Material and Methods: In 71 anaesthetized rats (pentobarbitone 20 mg/kg IP and ketamine 50 mg/kg IM) a catheter was inserted into the femoral vein for drug administration. The parotid duct was cannulated and all saliva secreted was collected. In the first series of experiments, secretion was induced by intravenous injections of the cholinergic agonist metacholine (5 µg/kg), before and after increasing doses of clomipramine (n=9), citalopram (n=9), venlafaxine (n=9) or placebo (n=9). In the second series of experiments, secretion was induced by the application of citric acid on the tongue of the animal (reflex stimulation) before and after increasing doses of clomipramine (n=6), citalopram (n=6), venlafaxine (n=6) or placebo (n=6). In a separate series of experiments (n=11) the effect of α - and β -adrenoceptor antagonists on citalopram- and venlafaxine-induced increases of the metacholine-evoked secretory responses was investigated.

Results: Neither clomipramine (1.0-5.0 mg/kg IV), citalopram (1.0-5.0 mg/kg IV) nor venlafaxine (1.0-5.0 mg/kg IV) had any inhibitory effect on metacholine-induced salivary secretion. However, citalopram and venlafaxine caused an increase of the fluid response to metacholine. This flow increase was abolished in the presence of the α - and β -adrenoceptor antagonists phentolamine (1 mg/kg) and propranolol (1 mg/kg). In contrast to the metacholine-evoked secretion

of saliva, the reflex-evoked secretion was reduced by intravenous injections of the antidepressants in a dose-dependent way. Clomipramine 2 mg/kg and 5 mg/kg reduced the flow by 32% ($p < 0.05$) and by 61% ($p < 0.01$) respectively. Citalopram 5 mg/kg reduced the flow by 44% ($p < 0.01$). Venlafaxine 2 mg/kg and 5 mg/kg reduced the flow by 32% ($p < 0.05$) and by 42% ($p < 0.01$) respectively.

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

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Outcome of root-canal treatments performed before and after education in Ni-Ti Rotary technique for GPs

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Aim: To retrospectively study the frequency of tooth extractions, and the periapical status and root-filling quality >4 years after treatment, in root-canal treatments performed before and after an education for general practitioners in Ni-Ti Rotary technique (Ni-TiR).

Material and Methods: The randomly selected sample constituted 824 patients, each participating with one root-canal treated tooth, 409 performed 2002, before, and 415 performed 2005, after the education. Information about teeth that had been extracted was obtained by e-mail, phone or letter by patients not attending the follow-up examination or by the dentists at follow-up. Periapical status of the root filled teeth was assessed according to the periapical index (PAI). Root-fillings were judged as adequate or non adequate based on quality of seal and apex distance. This preliminary report presents findings from a clinical and radiographic follow-up examination in 2009.

Results: 207 (51%) of the 409 treatments performed in 2002 and 288 (69%) of the 415 treatments performed in 2005 were examined in 2009. At follow-up 52 (13%) of the teeth root filled 2002 and 14 (3%) of the

teeth root filled 2005 were extracted. The frequency of apical periodontitis judged as PAI 3+4+5 was 34% in teeth root filled before and 36% in teeth root filled after the education. The more evident periapical lesions judged as PAI 4+5 seemed to be less frequent (11%) in teeth root filled in 2005 after the education in NiTiR compared to in the teeth root filled 2002 before the education (16%). However the difference was not statistically significant. Significantly more of the root-fillings performed 2005 were adequately sealed (50%) compared to of the root-fillings performed 2002 (37%).

Conclusion: A better technical quality of root-fillings performed after the education in NiTiR-technique compared to before the education was found in this study. A subsequent significant improvement of the periapical status was not observed. Possibly, the more frequent extraction of teeth root filled before compared to after the education may have influenced the periapical status at follow-up.

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Hypermobility and trauma as etiologic factors in patients with disc derangements of the temporomandibular joint

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Aim: The aim of the study was to investigate temporomandibular joint (TMJ) disc derangement patients with its two clinical variants, reciprocal clicking (RC) and chronic closed lock (CCL) with regard to the etiologic factors previous jaw trauma, general (GJH) and local (LJH) joint hypermobility.

Material and Methods: The material comprised 42 patients (21 with RC and 21 with CCL) and 20 control individuals. Patients and controls were age and gender matched. The patients and controls were asked whether they had sustained any jaw trauma in the past and were then examined for the presence of GJH and LJH, using defined criteria. Patients and controls were then compared. Statistical evaluation included Chi-square test and paired Student's t-test. Odds ratio (OR) was calculated in order to assess the relative risk to develop RC and CCL when the etiologic factor was present.

Results: The results showed a significant association between RC and GJH (OR=9.6, p=0.0010) as well as LJH (OR=38, p=0.0001). Also CCL was clearly associated with GJH (OR=7.5, p=0.0030) while its association with LJH was not significant (OR=9.5, p=0.0582). No significant association with a previous trauma was found.

Conclusion: The results indicate that a previous trauma to the jaw may not be a strong etiologic factor for development of TMJ reciprocal clicking and chronic closed lock. GJH, on the other hand seems to be an important etiologic factor for development of reciprocal clicking of the TMJ.

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Condylectomy with interposition of temporalis muscle-fascia flap is compared with condylectomy only in patients with advanced chronic arthritis and ankylosis of the TMJ.

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Aim: To compare the outcome of two surgical methods for treatment of advanced chronic arthritis/ankylosis of the TMJ.

Material and Methods: 15 patients were surgically treated with removal of ankylotic bone and condylectomy (so-called gap-osteotomy) and interposition with a temporalis muscle-fascia flap. 13 patients surgically treated with gap-osteotomy only were used as control. Outcome assessment was done as follows: The patient was asked to mark the level of pain during mandibular movements on a 10-graded VAS-scale before surgery and at follow-up. In the same way functional impairment (opening, speaking and chewing) was assessed. Cut-off points were > 40% improvement and follow-up level less than 5. Moreover, maximum interincisal opening, occlusal changes and other complications were recorded. For maximum interincisal opening the cut-off points were 40 % improvement and > 29 mm.

Results: In the gap-osteotomy only group 10 patients (77%) were regarded as successful regarding pain and 9 (69 %) regarding mandibular function. For the temporalis muscle-fascia flap patients corresponding

figures were 14 (93%) and 13 (87%). Regarding maximum interincisal opening, 9 of 13 (69%) in the gap-osteotomy group and all patients (100%) in the temporalis muscle-fascia flap group were regarded successful. More pronounced occlusal changes postoperatively necessitating prosthetic or surgical treatment were noted in 5 patients, 2 in the gap-osteotomy only group and 3 in the temporalis muscle-fascia group. In one patient in the gap-osteotomy group, operated for a third time, a slight permanent palsy remained in the forehead.

Conclusion: Both gap-osteotomy only and gap-osteotomy with interposition with temporalis muscle-fascia flap are methods of great value for treatment of patients with advanced chronic arthritis and ankylosis of the TMJ, where the additional interposition of temporalis muscle-fascia seams to further increase the success rate.

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Effects of smoking on healing after endodontic treatment – a longitudinal prospective study

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Aim: To investigate the possible association of smoking and healing of periapical periodontitis after conventional endodontic treatment.

Material and Methods: Patients referred to the Department of Endodontics, Community Dentistry Lund, during the years 2000-2004 were consecutively examined by the same specialist in Endodontics. The total sample was 450 patients who were referred for treatment of 516 teeth. Inclusion criteria was that the patient had one or more teeth with apical periodontitis. Three hundred forty-four teeth in 303 patients, 169 women and 134 men, were included in the study. Current and former tobacco habits were recorded. Smoking of tobacco was analysed as the total amount used in kilograms during the lifetime of the individual. Total amount of tobacco smoked was calculated by multiplying the average amount of use (cigarettes/day) by the duration of use. One cigarette is equivalent to 1 g of tobacco. Periapical status was assessed with the periapical index (PAI) from Örstavik. Teeth with a PAI score of 1 or 2 was regarded as healed and no further examination was carried out. In teeth with

▷ persisting periapical lesion, the second examination was postponed 3 years.

Results: Two hundred-seventy patients, with a median age of 53 years (range 11-84), fulfilled the study, 47 patients (17.4 %) were current smokers with a mean consumption of 10.8 cigarettes/day (range 9-12) and 79 patients (29.3 %) were former smokers. Mean number of years with smoking habit was 29.7 years (range 26-34). In total 344 teeth were treated, 40 teeth were lost to follow-up (11.6 %). Healing after 1 year was assessed in 227 teeth and after the total study period after 4 years in 272 teeth. There was no difference between healing of apical periodontitis between different types of teeth $p=0.89$. The overall success rate was 89.5 %. After the total study period, healing was recorded in 152 (55.9%) teeth in patients with no current or smoking history, 43 (15.8%) of the healed teeth were recorded in current smokers and 77 (28.3 %) in former smokers. A significant increased risk of failed healing, was recorded in current and former smokers, OR 2.06 (95% CI 1.1-3.87) $p=0.036$. If the lifetime consumption was >125 kg, OR= 1.7 (95% CI 1.1 – 2.6) $p<0.018$ and if it was >250 kg the risk further increased to OR 6.51 (95% CI 2.17-19.52) $p<0.001$. Non-smokers had a statistically significant decreased risk, OR 0.5 (95% CI 0.26-0.91).

Conclusion: Smoking significantly impairs the healing after endodontic treatment in a dose-dependent way.

◎ ◎ ◎ 20

Protease activity in *Lactobacillus salivarius* and *Actinomyces naeslundii* in a model of root canal infection

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Aim: Conventional treatment, although usually effective, does not guarantee complete removal of bacteria from the root canal. If proteins and other macromolecules are available, bacteria remaining on dentine surfaces may be able to use them as nutrients, leading to growth and re-colonization of the root canal. The aim of this study was to investigate the expression of extracellular proteases in bacteria isolated from root canals in response to growth on type 1 collagen.

Material and Methods: Three bacterial species isolated from root canal biofilms; *Actinomyces naeslundii*, *Lactobacillus salivarius* and *Enterococcus faecalis* were grown as mono-species biofilms for up to 48 hours on collagen type-I coated ibidi μ -slide VI flow-cells. The growth pattern and morphology of the biofilms were visualized using BacLight Live/Dead staining followed by confocal scanning laser microscopy. Images were analyzed using the bioImage_L programme. The fluorescent substrate, FITC-casein was used to detect extracellular protease activity.

Results: *A. naeslundii*, *L. salivarius* and *E. faecalis*, showed different degrees of initial binding to the type 1 collagen-coated surface. All the species showed growth leading to biofilm formation over the 48-hour study period. After 24-48 hours, the degree of protease activity as shown by cleavage of the casein substrate differed between the bacterial species.

Conclusion: The three bacterial species used in this study showed varying degrees of adherence and growth on type 1 collagen-coated surfaces suggesting that they may differ in their capacity to form biofilms in root canals in vivo. Our data also suggest that these species may be able to exploit collagen and other proteins as a nutrient source in the root canal through the expression of extracellular protease activity.

◎ ◎ ◎ 21

Etiologic factors and clinical symptoms in patients with disc related disorders of the temporomandibular joint

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Aim: The aim of the study was to investigate whether there is a difference between patients with painful RC or CCL and control individuals with regard to generalized and local hypermobility (LJH) and a previous trauma.

Material and Methods: Patients diagnosed with either chronic CL (n=21) or painful reciprocal clicking (n=21) and matched healthy controls (n=20), were included in the study. The patients and controls were asked if they had sustained any previous trauma and

generalised, or local, (TMJ) hypermobility was registered according to defined criteria.

Results: The results showed a significant association between RC and GJH (OR=9.6; $p=0.0010$) as well as LJH (OR=38, $p=0.0001$). Also CCL was clearly associated with GJH (OR=7.5; $p=0.0030$) while its association with LJH was not significant (OR=9.5; $p=0.0582$). No significant association with a previous trauma was found.

Conclusion: The results indicate that GJH is an important etiologic factors for the development of RC and CCL of the TMJ.

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Influence of bacterial products on the viability of odontoblast-like cells

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Aim: In order to maintain a functional barrier, odontoblast-like cells beneath a deep caries lesion should ideally be able to respond to the presence of bacteria with the formation of reactionary dentin and activation of appropriate inflammatory responses. As a first step, we have studied the influence of extracellular products from bacteria found in a deep caries lesion, grown in biofilms, on the viability of odontoblast-like cells.

Material and Methods: A fresh clinical sample of microorganisms from a deep caries lesion leading to pulp exposure was collected. Conditioned medium was prepared from two strains of Lactobacilli and one anaerobic Streptococcus strain from the lesion as well as clinical isolates of Enterococcus faecalis and Lactobacillus salivarius by growing the bacteria in biofilms for 96 hours in Dulbeccos modified Eagle medium (DMEM) containing 1% foetal calf serum (FCS). A mouse odontoblast-like cell-line (MDPC-23) was grown for 24 hours in DMEM with 1% FCS, supplemented with penicillin, streptomycin and glutamine at 37°C. Cells were then exposed to the conditioned bacterial medium for 72 hours. 100µ/ml Lipoteichoic acid (LTA) and 100ng/ml lipopolysaccharide (LPS) were used as a reference and cells grown without the addition of conditioned medium served as controls.

Metabolic activity in the cells was assessed by adding 5mg/ml thiazolyl blue tetrazolium bromide solution (MTT) in DMEM for 50 minutes. After addition of 4mM hydrogen chloride in isopropanol containing 0.1% Nonidet P-40 to dissolve reduced MTT crystals, the absorbance at 570nm was read. Background absorbance at 690nm was subtracted and the experiments were performed four times on three separate occasions.

Results: Conditioned medium from biofilms of isolates from the deep caries lesion had no significant effect over control upon the viability, as shown by metabolic activity, of the odontoblast-like cells. The presence of conditioned medium from biofilms of the Gram positive bacteria, E. faecalis significantly reduced cell viability ($p < 0.05$) and LTA had a similar effect suggesting that this may be one substance mediating the effect. LPS, lipopolysaccharide from Gram negative bacteria did not influence viability of the odontoblast-like cells.

Conclusion: Our results show that while the viability of odontoblast-like cells was decreased by exposure to extracellular products from biofilm cells of E. faecalis, the cells tolerated extracellular products from the bacteria found in a deep caries lesion well, indicating that they may play a role in the functional barrier of the dentine-pulp complex.

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Formation of a hard tissue barrier after pulp cappings in humans. An updated systematic review

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Aim: To elucidate under which circumstances a hard tissue barrier form after dental pulp capping in humans by systematically identify new evidence and to incorporate this with a previously published systematic review (Olsson et al. 2006).

Material and Methods: The same method as in the former systematic review was used. Searches in PubMed (2005-01-01 to 2010-10-01) and in CENTRAL were performed using specific keywords followed by hand searches of reference lists from reviews and included articles. The level of evidence for each included article ▶

- ▷ was graded by the authors as high, moderate or low. The concluding evidence grade was rated as strong, moderately strong, limited or insufficient.

Results: The initial search in PubMed yielded 133 abstracts. 44 were selected of which 28 were original scientific articles. After interpretation, 20 articles were included and given a level of evidence. As expected, as this was an updated systematic review, hand search of reference lists yielded no additional original scientific articles. Preliminary grading of the articles shows that one article was given a high level of evidence, 5 moderate and 14 a low level of evidence. The overall methodological quality of the studies has improved since the original systematic review was published in 2006, but still the majority of included articles were rated as having a low level of evidence. Taken together with the formerly published systematic review, there is now evidence for the use of calcium hydroxide materials or Mineral Trioxide Aggregate (MTA) to result in the formation of hard tissue barriers to various extents and the use of dentine bonding agents to result in no hard tissue barriers. All experimental procedures were done in intact teeth, which limit the external validity as the inflamed pulps in teeth with carious pulp exposures may respond differently.

Conclusion: There seem to be some evidence for hard tissue barrier formation when using calcium hydroxide or MTA as pulp capping material on experimentally created pulp exposures in healthy human teeth. The use of different dentine bonding agents as pulp capping materials does not result in formation of a hard tissue barrier.

◎ ◎ ◎ 24

Treatment outcome in patients with peri-implantitis in a periodontal clinic - a retrospective study

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Aim: To investigate the treatment outcome of peri-implantitis in a specialist clinic of Periodontology and to identify background factors and risk indicators influencing the treatment success rate.

Material and Methods: The study was conducted as

a retrospective longitudinal study on a consecutive referral population at a specialist clinic of Periodontology. Subjects referred by general dentists for peri-implantitis treatment were collected from a computer database. The material included 382 implants with peri-implantitis in 150 patients with in total 784 implants examined by one periodontist. Anamnestic, clinical and radiographic variables were collected at baseline and at the re-evaluations from the records. Peri-implantitis was defined as presence of probing pocket depths >5 mm, bleeding at probing and presence of radiographic bone loss at implant sites. In all analyses, the statistical computational unit was at subject level. Results were considered statistically significant at $p < 0.05$.

Results: The mean age of the subjects at baseline was found to be 64 years (range 22-87). Eighty-three percent of the dentate subjects had the diagnosis local or general periodontitis. The mean number of implants was 6.1 (S.D. 3.5), while the mean number of implants with peri-implantitis was 3.1 (S.D. 2.3). The percentage of implants with peri-implantitis was significantly increased for earlier smokers and current smokers compared to non-smokers. The mean follow-up time was 26 months and the mean time between implant placement and the baseline examination was 6.2 (S.D. 4.8) years. The compliance was significantly lower for males, for smokers and earlier smokers. Periodontal flap surgery with osteoplasty was the most common type of therapy (47%) and regenerative surgery with bone substitute materials was chosen in 20% of the cases. The clinical re-evaluations of the treatments showed that 84% of the flap surgery treatments had been successful, while the corresponding percentage for regenerative surgery was significantly lower (75%). The success rate was significantly lower for individuals with the diagnosis general periodontitis, severe mean marginal bone loss around the implants, poor oral hygiene and low compliance. Presence of bone fill at the re-evaluation was recorded in 68% of the cases with regenerative surgery and was significantly lower in cases with flap surgery (15%).

Conclusion: The results of the present study indicated high success rates after surgical treatments of peri-implantitis during a mean follow-up period of about two years. The effectiveness of the therapy was impaired by general periodontitis, severe mean marginal bone loss around the implants, poor oral hygiene and low compliance.

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IL-6 expression in *P. gingivalis* and *E. coli* LPS-stimulated human periodontal ligament cells and human umbilical vein endothelial cells treated with L-NAME and 17 β -estradiol

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Aim: Periodontitis is an inflammatory disease affecting the supporting structures of the teeth causing alveolar bone destruction and ultimately tooth loss. The anaerobic Gram negative bacteria *Porphyromonas gingivalis* (*P. gingivalis*) is believed to be an important etiological factor in periodontitis. The bacterial endotoxins lipopolysaccharides (LPS) stimulate the resident cells to release proinflammatory cytokines and nitric oxide (NO). NO is a reactive gas with important signaling functions in mammalian cells such as control of vascular tone, stem cell proliferation and differentiation. Previous studies suggest a correlation between periodontitis and the female sex hormone estrogen, a hormone important in the regulation of bone metabolism.

In this study we investigate the IL-6 response in human umbilical vein endothelial cells (HUVEC) and periodontal ligament (PDL) cells stimulated with LPS from *P. gingivalis* and *E. coli*. We also investigate how the response was modulated by treatment with estrogen and the NOS antagonist L-NAME.

Material and Methods: PDL cells were obtained from teeth extracted on orthodontic indications. The PDL cells were cultured from the tooth surface using an explant culture technique. Commercially available HUVEC were used. The cell cultures were pre-treated with or without L-NAME and 17 β -estradiol (E_2) before adding commercially available pure LPS from *E. coli* and *P. gingivalis*. The cells were stimulated with LPS for 24 h. Cellular levels of IL-6 was measured using enzyme-linked immunosorbent assay (ELISA) and RT-PCR.

Results: Stimulating PDL-cells with *E. coli* LPS produced a thirtyfold increase in intracellular IL-6 concentration, but no effect was observed in response to LPS from *P. gingivalis*, both results were confirmed

on mRNA-level. Treating PDL cells with L-NAME decreased the IL-6 response by about 30%, while E_2 had no effect. In HUVEC no significant effects on IL-6 levels by LPS could be detected. L-NAME and E_2 had no effect on IL-6 production in HUVEC.

Conclusion: Our findings show that PDL cells react stronger to LPS from *E. coli* compared to *P. gingivalis* LPS. HUVEC didn't react to any LPS type. E_2 has no effect on IL-6 production in the investigated cells on the contrary, L-NAME produced a small decrease in IL-6 production in PDL cells.

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Adolescents with high periodontal risk in Public Dental Service

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Aim: To investigate the prevalence of adolescents with high periodontal risk in Public Dental Service in the County of Stockholm and to identify factors with influence on the degree of compliance and the treatment outcome. In addition, the prevalence of increased caries risk was studied for this group of adolescents.

Material and Methods: The investigation was conducted as a retrospective study on adolescents in 2007 at the Public Dental Service in Stockholm. In total, clinical examinations and risk evaluations according to caries- and periodontal risk were performed on 50347 adolescents in general dentistry at ages 13, 15 and 17. Individuals with an increased periodontal risk were included in the investigation. An increased periodontal risk was defined as presence of sites with periodontal pocket depths >6mm and loss of periodontal tissue support. An increased caries risk was registered if the following criteria were fulfilled: >1 caries lesions in the dentine and/or presence of an approximal restoration or >2 new and/or progressing approximal enamel caries lesions.

Results: In total, 120 males and 108 females were found to have high periodontal risk. The percentage of subjects with high periodontal risk was increased from 0.3% at age 13 to 0.8% at age 17. For 50% of the adol-

▷ escents at age 17 with high periodontal risk, the caries risk was evaluated to be high. However, for subjects with low periodontal risk at age 17, the caries risk was high for 27% of the cases. The diagnosis local aggressive periodontitis was valid for 15% of the subjects. The mean frequency of defaults from one or more treatments was 26% in general dentistry and 43% at the periodontal clinics. Smokers had a significantly lower compliance than non-smokers. In addition, the degree of compliance in subjects with several periodontal pockets >6 mm was significantly lower compared to adolescents with fewer periodontal pockets >6 mm. The success rate after periodontal treatment was significantly lower in cases when the subjects fulfilled the treatment but had at least two defaults from dental visits. In addition, the success rate was significantly lower for individuals with several periodontal pockets with probing depths 4-5 mm and >6 mm as well as for those with the diagnosis local aggressive periodontitis.

Conclusion: The compliance was significantly lower for adolescents with several deep periodontal pockets and for smokers. In addition, several deep periodontal pockets, defaults from treatments and the diagnosis aggressive periodontitis significantly decreased the treatment success rate.

◎ ◎ ◎ 27

Patients with periodontitis are diagnosed and treated differently - a questionnaire study.

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Aim: Several studies have shown that general practitioners diagnose and treat the same state of disease differently. This is also believed to be the case for general dental practitioners (GDP) concerning chronic periodontitis. The aim was to study GDPs' and dental hygienists' treatment strategies for patients with varying periodontal status.

Material and Methods: All GDPs and dental hygienists employed by the public dental service in Halland County were invited to participate in the questionnaire study. The sample consisted of 77 GDPs and 50 dental hygienists. Seven out of 127 caregivers did not return the questionnaire which gave a response rate of 94%.

The questionnaire consisted of four simulated patient cases with an identical answer form attached to each one. The four patient cases had different periodontal status, ranging from healthy to chronic periodontitis. The caregivers were asked to suggest a diagnosis, type of treatment and number of treatment sessions for each patient case. In the analysis of the results caregivers were divided into three groups for each patient case based on which diagnosis the patient case was given; healthy, gingivitis or periodontitis. These three groups of caregivers were statistically compared to each other regarding the treatment they suggested. The level of significance was set at $p < 0.05$.

Results: There was a variation in the given diagnosis in three of the four patient cases; same patient cases were diagnosed both as healthy, having gingivitis or having periodontitis by different caregivers. However, the fourth case, the one with the more severe periodontal status, was given the diagnosis periodontitis by all caregivers. Regardless of which diagnosis caregivers gave a patient case there were no significant differences in the suggested type of treatment. On the other hand there were significant differences regarding suggested number of treatment sessions. Caregivers that diagnosed a patient case as diseased suggested more treatment sessions in comparison to caregivers that diagnosed the same patient case as healthy.

Conclusion: Different caregivers give the same patient different diagnoses and the chosen diagnoses has an importance when caregivers form their treatment strategies. This implies that the same patient might be under- or overtreated in relation to their periodontal status.

◎ ◎ ◎ 28

Surgical treatment of peri-implantitis using a bone substitute with or without a resorbable membrane. 5-year clinical and radiographic follow-up

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Aim: The aim of the present prospective case-control study was to evaluate the clinical and radiographic long-term result following surgical treatment of peri-

implantitis using a bone graft with, or without a resorbable membrane.

Material and Methods: Subjects having implants with a diagnosis of peri-implantitis and suitable for bone graft procedures were assigned to either a surgical treatment with a bone substitute (Algipore, Friadent, Malmö, Sweden) alone (14 subjects with 26 implants) [group 1], or with the same bone graft and a resorbable membrane (Osseoquest, W.L. Gore & Associates, INC, Flagstaff, Arizona, USA) (12 subjects with 22 implants) [group 2]. During the 5 years follow-up, all subjects were kept on a strict maintenance program.

Results: 5-year follow up demonstrated clinical and radiographic improvements in both groups. Probing depths were reduced by 3.0 mm (S.D. ± 0.4) in group 1, and 1.8 mm (S.D. ± 0.3) in Group 2 ($p < 0.001$). Bone gain in both groups was significant ($p < 0.001$). At year 5, the average defect fill in group 1 was 1.1 mm (S.D. ± 1.3 mm), and in group 2 the fill was 1.6 mm (S.D. ± 1.3 mm) ($p = 0.15$). The decrease in BOP was greater in group 1 ($p < 0.001$). Baseline and year 5 plaque scores did not differ by study group. At baseline plaque index was 43% and was at 5 year 20%.

Conclusion: Both procedures result in stable and improved clinical conditions. Treatment with graft material alone provides greater probing pocket depth reduction.



Expected and experienced pain and discomfort after periodontal surgery

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Aim: In a previous study (Swed Dent J 2010;34:239), we found a significant positive correlation between postoperative pain and the time pain killers were taken after periodontal surgery. Pain expectation was believed lay behind this finding. The aim of this study was to relate the level of expected pain to the eventual level of experienced pain and discomfort.

Material and Methods: 30 periodontitis patients (aged 30 to 77 years, 14M/16F) in need for surgical treatment were included. Patients with extreme dental anxiety and patients in need of comprehensive pre-medication care were excluded. Before the surgery, patients

were asked to estimate post-operative pain and discomfort on a Visual Analogue Scale (VAS). Flap surgery was performed as required by the individual treatment plan. Use of analgetica was recommended and left to patients' own discretion. At suture removal, patients were asked to evaluate post-operative pain and discomfort on VAS. Both momentary pain and discomfort and retrospective evaluations of the worst experience between surgery and suture removal were recorded.

Results: The vast majority of the patients (93 %) expected post-operative pain and discomfort ($VAS > 0$). At suture removal, momentary pain and discomfort was reported by 63.3 % and 73.3 %, respectively. In retrospect, experience of worst pain and discomfort between surgery and suture removal were reported by 73.3 % and 80%, respectively. The levels of expected pain (median 29.5; quartiles 18.5 to 48.75) and discomfort (median 34.5; quartiles 14.5 to 65.5) were significantly ($p < 0.05$) higher than the VAS values given by the patients at suture removal. The worst retrospective pain (median 24.5; quartiles 0 to 49.25) and discomfort (median 18; quartiles 4.75 to 44) given at suture removal were higher than the respective values experienced at the day of suture removal (median 2; quartiles 0 to 6.25 and median 5.5; quartiles 0 to 12.75, respectively). All expected VAS values correlated significantly ($p < 0.05$) with the respective experienced ones. Significantly ($p < 0.05$) lower VAS values were expected by men, by older patients, by patients not taking painkillers later and by patients who had previous experience of periodontal surgery.

Conclusion: This study indicates that patients experienced significantly lower levels of pain and discomfort than they expected before surgery. The decision to take painkillers indicated higher postoperative pain expectation and experience. The dental team might through the results of this study feel confident to calm patients' concerns about periodontal surgery.

Dissecting human monocyte subset functionality in periodontal disease

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Aim: Periodontitis (PD) is a chronic inflammatory disease causing destruction of tooth supportive tissue. Although, the cause of PD is unclear evidence suggest that the chronic inflammation occurs as a result of deregulated innate immune responses to oral microbes. Innate immune cells, such as monocytes, express high levels of chemokine receptors, enabling their early recruitment into tissue, where they produce several different inflammatory mediators in response to microbial stimuli, depending on subset specificity. The aim of this study is to explore the migratory behavior of distinct monocytes subsets in periodontitis. We speculate that alterations in chemokine receptor expression and migratory behavior affect the composition of pro- and anti-inflammatory monocyte subsets inside the tissue, contributing to deregulated inflammation and the pathogenesis of PD.

Material and Methods: Peripheral whole blood monocytes from healthy donors were isolated using ficoll density gravity centrifugation, followed by magnetic bead selection using Human monocyte enrichment kit without CD16 depletion. The composition and characterization of monocytes expressing distinct chemokine receptors was identified using real time RT-PCR and multicolor flow cytometry.

Results: By using multicolor flow cytometry we identified three distinct subsets of human monocytes in peripheral blood from healthy controls. CD14+CD16-, CD14+CD16+ and CD14lowCD16+ subsets with distinct expression of the chemokine receptors, CCR1, CCR2, CCR5, CCR7, CCR9, CCR10 and CX3CR1, were identified. CCR1 and CCR2 is predominantly expressed by the CD14+ "classical" monocytes, while CX3CR1, CCR5, CCR9 and CCR10 is found mainly on the CD16+ "non-classical/pro-inflammatory" monocytes. The lymph node homing chemokine receptor, CCR7, is expressed on all monocyte subsets. Further-

more, RT-PCR analyses confirmed the monocyte expression of the chemokine receptors CCR1, CCR2, CCR5, CCR9, CCR10 and CX3CR1.

Conclusion: Human monocytes represent a heterogeneous family of cells, expressing distinct patterns of chemokine receptors. Further characterization of the functional properties of distinct human monocyte subsets in PD may identify mechanisms contributing to the deregulated inflammation and disease progression in PD, enabling the development of new strategies for immunomodulation.

This study has been supported by the Swedish Dental Society.

The effects of cathelicidin in periodontal ligament cells

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Aim: The antimicrobial peptide cathelicidin is expressed in periodontal tissue, and variations in cathelicidin levels have been associated with periodontal disease. The effects of cathelicidin on periodontal ligament cell (PDL cells) function have not been described before. Here we assess anti-inflammatory properties of cathelicidin and investigate the effects of cathelicidin on cell differentiation, cell proliferation and apoptosis in human PDL cells.

Material and Methods: PDL cells were obtained from teeth extracted for orthodontic reasons. Cytokine (IL-6) and chemokine (MCP-1) expression was determined by quantitative PCR, cell differentiation by alkaline phosphatase (ALP) activity, cell proliferation by counting cells in Bürker chamber, DNA-synthesis by incorporation of radiolabeled thymidine and apoptosis by cell morphology and activated Caspase 3 (Casp 3) quantities.

Results: Treatment with 0.1 and 1µM of cathelicidin totally reversed LPS-induced MCP-1 expression and suppressed LPS-induced IL-6 expression by 50-70%. Cathelicidin had no effect on ALP activity. Incubation with 8 µM cathelicidin strongly reduced cell number. DNA-synthesis was attenuated by about 90% in response to 8 µM cathelicidin, confirming its

anti-proliferative effect. Cell morphology was altered in an apoptosis-like fashion in cells treated with 8 μ M cathelicidin. Furthermore, the quantity of activated Casp 3 was increased in cells treated with 1 and 8 μ M of cathelicidin, suggesting apoptosis.

Conclusion: Cathelicidin strongly attenuates LPS-induced cytokine and chemokine expression in concentrations associated with periodontal health. In higher levels associated with chronic periodontal disease cathelicidin reduces cell proliferation through inhibition of DNA-synthesis and by promoting apoptosis in human PDL cells.

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Smoking cessation activities in dental clinics - a systematic literature review

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Aim: The aim of this study was to review current smoking cessation activities used at dental clinics and their effectiveness regarding number of individuals who cease smoking.

Material and Methods: A free text search was conducted for RCT (Randomized Controlled Trial) or CCT (Controlled Clinical Trial) studies comparing the outcome of smoking cessation in dental clinics.

Results: The search resulted in 40 abstracts; six RTC studies were included in the final analysis. Five of the six articles showed that smoking cessation advice gave a better result compared to the control groups. No difference between the test groups and the control group were found in one of the six studies.

Conclusion: The results show that smoking cessation advice at dental clinics can have good results, especially if the patients wish to cease smoking and/or get nicotine replacement therapy.

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Changes of the dentition following a 10-year use of a Mandibular Protruding Device

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Aim: This 10-year prospective study focus on changes of the dentition following the use of a Mandibular Protruding Device (MPD) in the treatment of Obstructive Sleep Apnea (OSA)/snoring.

Material and Methods: At baseline 77 subjects participated, (50 males and 13 females, mean age 53.5, range 38-69 years). At the 10-year follow-up all subjects, except 3 that were deceased, were invited to participate. Alginate impressions and fabrication of dental casts as well as jaw registration index in intercuspal position were made at baseline and at the follow-up. The analysis focused on the frontal relation, Angle classification, intercanine and intermolar arch width changes, and lateral open bite. The systematic single measurement error was evaluated.

Results: Sixty-three subjects responded to the invitation and their dental casts were analyzed, 43 still used the device and 20 who ceased their use of the MPD within 8 years. The MPD users showed significant changes in almost all analyzed variables, decrease of overjet (-1.8mm), overbite (-1.5mm), intercanine width in the maxilla (-0.4mm) and increase of the perpendicular distance between molars and incisors of the mandible (+0.3mm). No significant changes were seen in the intercanine width in mandible nor in the perpendicular distance between molars and incisors of the maxilla. MPD-ceased users retained their initial values except for a decrease of the overbite (-0.6mm). In contrast to the MPD-ceased users the MPD users showed an increased number of mesio-occlusion and lateral open bites. The consistency in measurements showed no systematic measurement errors - the ICC ranged between 0.93 - 0.99 (an ICC > 0.75 indicates excellent reliability).

Conclusion: Long-term nocturnal use of an MPD may cause changes of the dentition especially in decreasing the overjet and overbite. A general feature was an anterior drift of the mandibular teeth. This might

▷ have negative consequences for Class III patients in aggravating their mandibular prognatism. The small alterations of the dentition seen in the MPD-ceased users may indicate that the MPD-related changes are reversible.

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Soft drink consumption related to life style and oral health in Swedish adolescents

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Aim: The aim of this study was to investigate the relation between soft drink consumption, oral health and some life style factors in Swedish adolescents.

Material and Methods: 392 individuals completed the study (13-14 years, n=195; 18-19 years, n=197). A clinical examination including cariological/periodontal status and severity of dental erosion was performed followed by an interview about drinking habits and a questionnaire concerning life style factors, e.g. oral hygiene, dietary consumption, physical activity and TV/computer habits.

The yearly consumption of soft drinks was estimated per individual, and the material was divided into a high and a low consumption group, corresponding to the highest and the lowest ~25th percentile for each age group (13-14 years n=58High and n=60Low; 18-19 years n=57High and n=57Low. Differences between the groups were tested by the Mann-Whitney U-test.

Results: In the 13-14 year high- and low consumption group the reported soft drink intake was 72 and 8 L/year respectively. Corresponding figures for the 18-19 year group was 167 and 9 L/year. In both the high consumption groups there were significantly more boys. The 13-14 year high consumption group reported significantly more frequent intake of candy, chips/cheese doodles, syrup (light), juice/fruit drinks and sweet milk drinks but less frequent intake of soured milk compared to the low consumption group. They also reported a significantly lower frequency of tooth brushing, sports activities and intake of school lunch, but more hours spent in front of the TV/computer. Significantly more children in the high consumption group had parents borne outside Sweden. Among the

clinical variables, dental erosion/cupping was significantly more common.

The 18-19 year high consumption group reported significantly more frequent intake of chips/cheese doodles, fruit drinks/cordial, coffee with sugar, juice/fruit drinks and sweet milk drinks, while intake of fresh/dried fruit, soured milk/yoghurt and breakfast was less frequently reported. The reported frequency of tooth brushing and sports activities was significantly lower, while hours spent in front of the TV/computer were higher. DFT/DFS, GBI, dental erosion/cupping and BMI were significantly higher in the high consumption group.

Conclusion: High consumption of soft drinks among both younger and older adolescents was related to worse oral health and an unhealthier lifestyle compared to those with a low consumption. To promote a healthier behavior among adolescents, their choice of life style needs further investigations and collaboration between different types of health workers is needed.

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Frontal agenesis of upper lateral incisors treated with implants – a retrospective follow-up study

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Aim: To evaluate the long-term effects of implant treatment in the upper incisor region and the survival rate of the implants after at least 5 years.

Materials and Methods: The sample consisted of 36 patients (17 males, 19 females) with congenital missing upper lateral incisors. The mean age of the patients at the follow-up examination was 27.3 ± 7.9 years. All the patients were treated between years 2001 and 2004. Totally 54 implants (mean age 7.3 years) and implant-supported crowns were examined. Established clinical criteria were used to assess the implant-supported crowns (California Dental Association index; CDA) and the surrounding soft tissue adaptation. Standardized intra-oral photographs (n=54 implants) were taken to evaluate whether the implants had come into infraposition compared to photographs taken at baseline (n=25 implants). The height of the papillae

and the filling up of the interproximal room in connection to the implant-supported crowns were also analysed.

Results: The adaptation of the soft tissue around the implant-supported crowns was similar to adjacent natural teeth. There was a difference in vertical height between 19/25 of the implants and the neighbouring teeth compared with baseline. No implants were lost and no implant-supported crowns had been fractured or replaced. One implant had a fistula. Two implants did not have interproximal papillae. Seven papillae filled up <1/2 of the interproximal room, 28>1/2, and 71 papillae filled up the whole interproximal room and were corresponding well to the adjacent dental papillae. The CDA rating for marginal integrity, anatomic shape, surface and colour were “excellent”.

Conclusion: The implant survival rate in this study was 100%. Implant-supported crowns showed high values according to the CDA-index. Soft tissue adaptation and filling of the papillae had an acceptable level compared to neighbouring teeth. Some of the implants had come into infraposition.

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A cephalometric analysis in patients with obstructive sleep apnea and snoring, treated with a Mandibular Protruding Device – a 10-year follow-up

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Aim: The aim of this prospective cephalometric study was to evaluate the influence of a Mandibular Protruding Device (MPD) following 10-years nocturnal use in patients with obstructive sleep apnea (OSA)/snoring.

Material and Methods: At the 10-year follow-up a total of 65 patients out of initial 77 patients were available and subjected to the cephalometric evaluation, 45 MPD-users and 20 MPD-ceased users. Cephalograms taken at baseline in an upright position, with an analogue technique, were digitized for comparison with digital cephalograms from the 10-year follow-up. An analysis of the consistency in the cephalometric readings showed no systematic errors. The cephalo-

metric analyses focused on the position of the incisors, the hyoid bone, and routine skeletal measurements.

Results: The MPD users, showed the following mean differences (standard deviation) from baseline to the 10-year follow-up: overjet (-1.5mm (1.9); $P<0.001$) and overbite (-0.7mm (1.4); $P=0.002$) were reduced. The upper incisors (ILs/SN) were retroclined (-4.2degrees (4.0); $P<0.001$) and the lower incisors (ILi/ML) were proclined (+3.2degrees (5.0); $P<0.001$). The mandibular protrusion (SNB) was slightly reduced (-0.6degrees (1.4); $P=0.01$). The mandibular length (CdPg) increased (+5.1mm (6.8); $P<0.001$) and the linear distance between the hyoid and mandibular plane (hyML) increased (+3.3mm (2.9); $P<0.001$). The MPD-ceased users retained their initial cephalometric values on all measures except for CdPg and hyML, which increased (+6.1mm (6.0); $P<0.001$) and (+3.8mm (3.7); $P=0.001$) respectively.

Conclusion: Nocturnal use of an MPD over a 10-year period caused alterations in bimaxillary incisor inclination, a mandibular posterior rotation, and the overjet as well as the overbite decreased. No such changes were seen in the MPD-ceased users.

In both groups the position of the hyoid bone was lowered and the mandibular length increased. The clinical significance of the skeletal changes remains still to be determined.

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BMI status in Swedish children and young adults in relation to caries prevalence

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Aim: The aim of the present study was to investigate the relationship between body weight status and caries prevalence in an unselected population followed from pre-school years to young adulthood.

Material and Methods: The present investigation was designed as a longitudinal analysis of the association between overweight/obesity and dental caries in one population at 3, 6, 15 and 20 years of age.

Results: The result shows that adolescents (15 years) and young adults (20 years) who are overweight/obese had a statistically significantly higher caries ▶

prevalence than normal-weight young people. At 6 years of age, the odds (OR) of having caries among obese children are 2.5 times higher than the odds for caries among six-year-old children of normal weight ($p=0.04$). At 3 years of age, no association between overweight/obesity and caries was found.

Conclusion: Overweight and obese adolescents and young adults had more caries than normal-weight individuals. The present study emphasises the need for multidisciplinary approaches to change the lifestyle factors causing both overweight/obesity and dental caries.

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Spontaneous resorption of impacted mesiodentes

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Aim: To radiographically investigate the frequency of resorptions and possible pathologies of mesiodentes left in situ.

Material and Methods: 44 individuals where mesiodentes have been left in situ have been radiographically followed. The material is collected from three areas in Sweden; Stockholm, Gothenburg and Jönköping. The follow-up intraoral radiographs were taken with either digital or analogue technique and were compared with earlier analogue radiographs. The radiographs were examined in collaboration with a specialist in radiology. The study has been approved by an ethical committee.

Results: 44 individuals 18-38 years of age with a total of 49 mesiodentes left in situ have been radiographically examined. 20 of these 49 impacted mesiodentes showed different levels of resorption - from surface resorption to nearly complete resorption. The stage of resorption seems not to be correlated to chrono-

logic age. One of the patients showed pathology in form of a gingival irritation located to papilla incisiva, where a mesiodens was positioned close to margo.

Conclusion: Impacted mesiodentes may be resorbed over time

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Veau-Wardill-Kilner versus minimal incision technique repair of isolated clefts of the hard and soft palate – a cephalometric study at five and ten years

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Aim: To compare the Veau-Wardill-Kilner (VWK) technique with the minimal incision (MI) technique repair of isolated clefts of the hard and soft palate regarding cephalometric outcome at five and ten years (y) of age.

Material and Methods: A consecutive series of 145 Caucasian children born with isolated cleft palate between 1980 and 1996. Individuals with other craniofacial malformations, apart from Pierre Robin Sequence, were excluded. The patients were treated surgically using VWK (N=59) or MI (N=86) palatoplasty at a mean age of 13 months, and divided further into two subgroups: clefts within the soft palate only and a notch less than 3 mm in the posterior border of the hard palate (small cleft, N=64) and clefts within the hard and soft palate (big cleft, N=81). **Methods:** A retrospective evaluation at five (mean age 5.5 y) and at ten (mean age 10.3 y) years of age was performed using lateral cephalograms. Eleven skeletal and one soft tissue measurements were evaluated. Two-way analysis of variance (ANOVA), three-way ANOVA with repeated measurements on one factor and a mixed model analysis were performed.

Results: Only minor differences in cephalometric morphology were found between the VWK technique groups and the MI technique groups, as well as among small and big cleft length (shorter mandibular length in the MI big cleft group at 5 y, decrease ▶

▷ of SNA angle in the small cleft groups from 5 to 10 y, an increase of facial convexity in the big cleft groups and in the VWK groups from 5 to 10 y).

Conclusion: The craniofacial cephalometric morphology at five and ten years of age in patients with isolated cleft palate did not differ between the two surgical techniques (VWK, MI) or extension of the cleft.



A long-term follow-up of objective treatment need in young adults, treated with functional appliance. A retrospective study

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Aim: To evaluate the success rate of Class II malocclusion treatment with functional appliances 6-7 years after treatment.

Subjects and Methods: The patient records of all listed young adults between 18-20 years (n=1054) treated in a general practice in Eslöv, in southern Sweden were reviewed, for the purpose of finding patients treated with removable functional appliances (Andresen- and van Beek activators). From 61 subjects that previously had been treated with these appliances fifty-four patients, (34 boys and 20 girls) accepted to participate in the study. The test group was matched, in terms of sex and age, with an orthodontically untreated group of 35 boys and 21 girls. All participants were examined clinically and study casts were taken to evaluate the occlusion, lip closure, gingival impingement, and forced bite. Weighted PAR (wPAR) was calculated.

Successful treatment was defined if at least three of the following criteria were met:

- Normal sagittal molar relation ($\pm 1/2$ cusp)
- Overjet was less than 5 mm or had been reduced by at least 50 %
- No gingival impingement
- Competent lip closure.

If retreatment with fixed appliances was needed or if the treatment had been interrupted prematurely, because of lack of cooperation or undesired treat-

ment result, the treatment was considered as unsuccessful.

Results: Twenty patients (37.0 %) succeeded with the functional appliance treatment. Twenty-four patients (44.4 %) interrupted the treatment with the functional appliance prematurely, mainly due to lack of cooperation. Fifteen patients (27.8 %) received treatment with fixed appliance in addition to the functional appliance. Very few patients showed gingival impingement and forced bite in both treated and control group. In the functional appliance group, 35.9% had incompetent lip closure compared with 13.3 % in the fixed appliance group and 3.6 % in the control group. Significantly more patients in the functional appliance group (35.9%) had had incompetent lip closure compared with the fixed appliance group (13.78%) and the control group (3.6%). The patient group treated with functional appliance only, had the significantly highest wPAR (mean=18.19). Including only those patients that fulfilled the functional appliance treatment wPAR declined to 13.78. The patient group that was retreated or had received additional treatment with fixed appliance showed a mean of 8.67 in wPAR. The control group showed a mean wPAR of 7.43.

Conclusion: Treatments with functional appliances, in a general practice shows that the failure rate is rather high mainly due to cooperation problems. It is therefore of importance, already before starting treatment, to estimate the child's cooperation ability and to avoid treatment with removable appliances, if the child or parents are reluctant about such treatment.



Dental implant supported prosthetic constructions – a clinical study after an observation period up to 6 years

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Aim: To (i) assess the implant prosthesis long-term results up to 6 years post occlusal loading and (ii) to evaluate the risk factors associated with the complications and failure.

Material and Methods: 120 patients received im-

plants in the years 2004-2006. They were examined 4 to 6 years after implant placement. The examination consisted of (i) questionnaire focusing on self-reported general health, smoking habits, gender, age, awareness of parafunctional activity and usage of occlusal appliance, (ii) registration of occlusal abrasion, (iii) examination of the implant prosthesis for presence of veneer abrasion, screw loosening, abutment fracture, loss of cementation, porcelain fractures, (iv) registration of occlusion type by inspecting the first molar and canine relationships, and (v) type of restoration of the opposing dentitions. Bruxism was diagnosed based on patients' self-reported dental history and clinical examination of wear facets.

Results: The success of implant prosthesis in this study was 94.7% while survival was 97.4%. Veneer fracture and abrasion were often seen with screw loosening and abutment fracture. Technical complications were associated with metal-ceramic on the opposing dentition and bruxism.

Conclusion: In this study implant prosthesis demonstrated satisfactory prognoses after an observation period of up to 6 years.

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Self-reported TMD-symptoms eight years after appliance therapy

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Aim: Long-term follow-up studies of patients treated for temporomandibular disorders (TMD) pain are sparse in the literature. The aim of this study was to evaluate after 8 years the treatment outcome of patients with temporomandibular joint (TMJ) pain and/or myofascial pain.

Material and Methods: 120 patients were initially randomly assigned to two treatment modalities: an occlusal appliance or a control appliance covering only the palate. A questionnaire was sent to 118 eligible patients after 8 years. Ninety patients (76%) returned the questionnaire. Outcome measures were assessment of pain intensity, frequency of pain, physical and emotional functioning, overall improvement of pain and headache.

Results: At follow-up the worst pain had decreased by > 30% in 64 out of the 90 patients. Pain frequency also decreased significantly. A better physical functioning was reported by a majority of all patients, 57/90. 59 out of the 90 patients had a moderate to severe depression, while the value for non-specific physical symptoms was 61 patients out of 90. 68 patients (76%) reported overall improvement of their TMD pain. 61 patients felt that their headache had overall improved. As far as treatment modality, 57 patients have received another treatment in addition to the initial appliance, most often another occlusal appliance.

Conclusion: Eight years after appliance therapy a majority of patients reported an improvement of their TMD pain and headache.

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Bruxism and prosthetic treatment: a critical review

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Aim: Based on the findings from available research on bruxism and prosthetic treatment published in the dental literature, an attempt was made to draw conclusions about the existence of a possible relationship between the two, and its clinical relevance.

Material and Methods: MEDLINE/PubMed searches were conducted using the terms 'bruxism' and 'prosthetic treatment', as well as combinations of these and related terms. The few studies judged to be relevant were critically reviewed, in addition to papers found during an additional manual search of reference lists within selected articles.

Results: Bruxism is a common parafunctional habit, occurring both during sleep and wakefulness. Usually it causes few serious effects, but can do so in some patients. The etiology is multifactorial. There is no known treatment to stop bruxism, including prosthetic treatment. The role of bruxism in the process of tooth wear is unclear, but it is not consi-

dered a major cause. As informed by the present critical review, the relationship between bruxism and prosthetic treatment is one that relates mainly to the effect of the former on the latter.

Conclusion: Bruxism may be included among the risk factors, and is associated with increased mechanical and/or technical complications in prosthodontic rehabilitation, although it seems not to affect implant survival. When prosthetic intervention is indicated in a patient with bruxism, efforts should be made to reduce the effects of likely heavy occlusal loading on all the components that contribute to prosthetic structural integrity. Failure to do so may indicate earlier failure than is the norm.

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Clinical signs indicative of temporomandibular disorders in adults: changes over time and associated factors – a preliminary report

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Aim: The study aims to investigate (1) possible changes in prevalence of clinical signs indicative of temporomandibular disorders (TMD) in an adult population over time, and (2) possible relations between TMD signs and background factors in the same population.

Material and Methods: Independent and randomly selected samples of around 100 individuals in the age groups of 20-, 30-, 40-, 50-, 60- and 70-years participated in cross-sectional investigations on oral health carried out in Jönköping, Sweden, in 1983, 1993, and 2003. The participation rate was 77% in 1983, 75% in 1993 and 68% in 2003. A total of 1,693 individuals comprised the study material. Signs of TMD were recorded and the Clinical Dysfunction Index (Di) according to Helkimo was calculated. Relations between the separate signs and the independent variables: time of investigation, age group, gender, reported bruxism and self-perceived healthiness were studied in univariate and multiple regression models.

Results: Impaired jaw movement capacity and temporomandibular joint (TMJ) palpation pain were more frequent in 2003 compared to earlier recor-

dings. Impaired jaw movement capacity was associated to age >40 years. TMJ palpation pain was associated to female gender. Pain on jaw movement, TMJ palpation pain and jaw muscle palpation pain were related to reported bruxism. Most of the TMD signs were related to self-perceived health impairment. Higher Di was related to female gender, reported bruxism and self-perceived health impairment.

Conclusion: The preliminary results suggest that the prevalence of some TMD signs in adults has increased during the period 1983-2003. Impaired jaw movement capacity is associated to advancing age. More severe TMD signs are associated to female gender, reported bruxism and self-perceived health impairment.

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TMD pain after whiplash trauma - a systematic review

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Aim: Several studies have reported Temporomandibular Disorder (TMD) pain after whiplash trauma, but knowledge about incidence, prevalence, and treatment effect from different interventions is limited. The aim of this systematic review was to assess (i) the prevalence and incidence of TMD pain after whiplash trauma, and (ii) the effect on TMD pain from different interventions.

Material and Methods: A systematic literature search of the PubMed, Cochrane Library, and Bandolier databases was conducted from 1 January 1966 to 1 March 2011. Two investigators evaluated the methodological quality of each identified study using scoring modified from MacFarlane (1991). The systematic search identified 118 articles. After an initial screening of abstracts, 45 articles were reviewed in full text.

Results: Eight studies on incidence/prevalence of TMD pain and “whiplash”, and four studies on in-

terventions in TMD pain and “whiplash” met the inclusion criteria. The reported median incidence of TMD pain after whiplash trauma was 10% (range 4% to 34%) and the median prevalence 23% (range 2% to 52%). There were large variations in study design, outcome measures, and study populations. A range of interventions such as jaw exercises, occlusal appliances, medication, behavioral therapy, and physiotherapy were reported in the intervention studies. For patients with a combination of TMD pain and neck pain after whiplash trauma, treatment modalities normally used for TMD had limited effect.

Conclusion: Due to the disparity in study designs, outcome measures, and study quality, it is difficult to draw firm conclusions. There is some evidence that incidence and prevalence of TMD pain increase in patients with neck pain after whiplash trauma. The few intervention studies found in the search indicated limited treatment effect in patients with combined TMD pain and neck pain after whiplash trauma. There is a need for more specific studies of the interplay between the pain generators in the neck, TMD pain and interventions.

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Essix retainer versus bonded cuspid-to-cuspid retainer for stabilization after orthodontic treatment – a preliminary report from a randomized controlled trial

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Aim: The aim of this trial was to evaluate and compare stability in the mandibular arch 6 months after retention with an Essix retainer compared to retention with a bonded cuspid-to-cuspid retainer (CTC). Patients’ perceptions of the two methods were also evaluated with a questionnaire.

Material and Methods: In total, 52 adolescent patients (26 girls and 26 boys) were recruited and randomized into 2 groups; Essix retainer (group A) and CTC (group B). Forty-four patients have so far completed the study and thus group A comprised 23 patients (mean age 17,1) and group B 21 patients (mean age 17,8). Little’s Irregularity Index (LII) was measured at the debond appointment (T1) and after 6 months (T2). At the follow-up visit after six-month all pa-

tients assessed a questionnaire in order to evaluate their experience of retention with an Essix retainer and a CTC respectively.

Results: Differences in Irregularity index during the observation period (T1-T2) within each group was 0.39 mm for group A, which was statistically significant ($p=.015$), and 0.15 mm for group B, which was not statistically significant. There were no significant differences in LII between groups during the observation period of 6 months. According to the questionnaires both groups accepted the retention well (Md=94 and Md= 99 respectively) and with no significant difference. On the question if the patients had noticed any irregularity in the mandibular arch and if this bothered them both groups scored low on the visual analogue scale (VAS). Median (Md) values for group A was 8.0 and 2.0 for group B and with no significant difference between groups.

Conclusion: In a short-term perspective both retention methods are successful in retaining the orthodontic treatment results from a clinical point of view. Both Essix retainer and CTC are well accepted by the patients.

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Langerhans cells and T cells in leukoplakias – a retrospective study

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Aim: Activation of the immune system is crucial in host response to tumour cells. The aim of this retrospective study was to compare presence and distribution of Langerhans cells (LCs) and T cells in oral leukoplakias (LPL) that transform into squamous cell carcinomas (SCC) with LPL that do not develop into SCC.

Material and Methods: Tissue specimens from patients with LPL biopsied and a histopathological diagnosis of hyperkeratosis with dysplasia at were retrieved from our archives (LPL/LPL; n=15). Also, specimens biopsied at least twice with a histopatho-

logical diagnosis of hyperkeratosis with dysplasia at the first occasion and a histopathological diagnosis of SCC at a later occasion were collected (LPL/SCC; n=13). Immunohistochemistry was performed using monoclonal antibodies against CD1a+ (LCs), CD3+ T cells Ki67+ cells. Digitalized images of sections were obtained and quantitative analysis of number of positive cells/mm² were done. Statistical analysis: Mann-Whitney U-test.

Results: LPL/LPL compared to LPL/SCC: Epithelium: LCs: median values: 91/53; p < 0.05. T cells: 129/135; p > 0.05. Ki67+ cells: 508/352; p > 0.05. Connective tissue: LCs: 59/50; p = 0.05. T cells: 574/697; p > 0.05.

Conclusion: Number of LCs is significantly decreased in LPL that transform into SCC compared to LPL that do not transform into SCC. This implies that impaired immunosurveillance may be of importance in the malignant transformation process. No significant differences could be detected between the groups in CD3 and Ki67 expressing cells. Further investigations are presently undertaken.

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Sucking habits in children and effects on the mixed and permanent dentition; a systematic review

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Aim: This study aimed to perform a systematic review, concerning the literature of sucking habits and the effect on the mixed and permanent dentition.

Material and Methods: A systematic review was carried out in the database PubMed, using MeSH, Medical Subject Headings. Articles were included in accordance with specific selection criteria, reviewed and quality assessed. The reference lists of the articles were also examined in order to include additional articles.

Results: The initial search resulted in 188 articles, of which ten finally were selected for analysis in full text. The ten included articles were focusing on different sucking habits and malocclusions, furthermore they had different study designs and sample sizes which made it difficult to compare them. The articles were also variable in quality, no article had high quality and only two articles had medium quality.

Conclusion: This study indicates that the scientific basis for the effect of sucking habits on mixed and permanent dentition is deficient.

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Is there a “best method” for complete denture impressions? A systematic/critical literature review

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Aim: Many procedures used in prosthodontics lack support of good evidence. It has been suggested that methods and materials for complete denture impressions belong to that group. The aims were therefor to systematically/critically review the literature on impressions for complete dentures to obtain information about clinically useful materials and methods, and try to find a procedure with the best clinical outcome for complete dentures.

Material and Methods: PubMed was searched for studies on impression procedures used in the clinical fabrication of complete dentures. The search focused on best available evidence for the clinical outcome.

Results: PubMed listed 1163 titles for the combination complete denture and impression. Of these only 4 were randomized controlled trials. No review of complete denture impressions was found in the Cochrane library. A 2-stage procedure for complete denture impressions is totally predominant in textbooks, teaching and specialist practice in spite of lack of convincing evidence of its superiority. No studies supporting the use of border molding, post dam, functional and mucostatic impressions were identified. Two studies showed that a simple 1-step method, alginate in a stock tray, offers as good clinical results as more complicated, expensive and time-consuming 2-stage material–technique combinations.

Conclusion: There was no strong scientific support for the common opinion that different clinical situations require different combinations of materials and techniques for complete denture impressions. Two studies using a 1-step procedure with alginate in stock trays demonstrated as good clinical outcome as traditional 2-step impression procedures for fabrication of complete dentures.

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