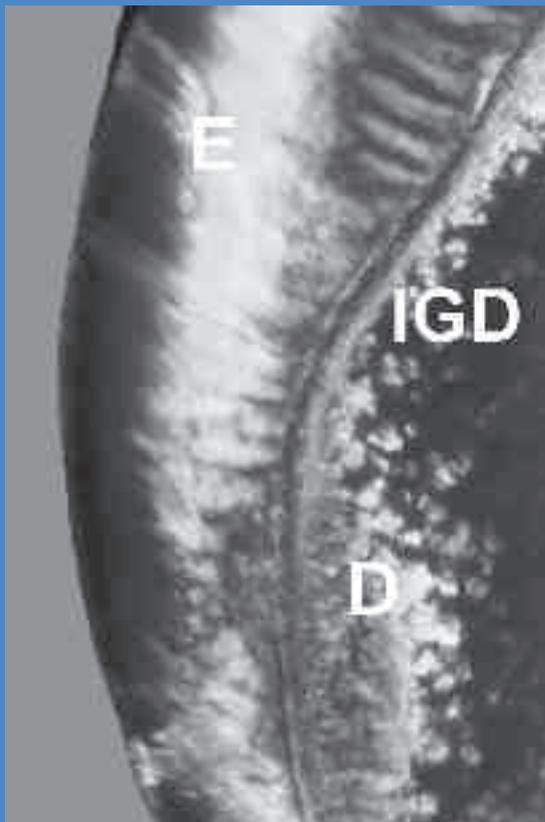


# Swedish Dental Journal

Scientific Journal of The Swedish Dental Association



Morphology and chemical composition of dentin  
in permanent first molars with the diagnose MIH  
page 155

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No. **4/07**  
Vol.31 Pages 155-208

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## CONTENTS

Morphology and chemical composition  
of dentin in permanent first molars  
with the diagnose MIH

Heijs, Dietz, Norén, Blanksma, Jälevik

155

A randomized double-blind  
comparative study of Biolight® light  
therapy following surgical extraction  
of impacted lower third molars

Kashani, Kanagaraja, Kahnberg

165

The HIDEP model  
– a straightforward dental health care  
model for prevention-based practice  
management

Sandberg, Fors

171

Abstracts of free communications and  
posters presented at the 44th Annual  
Congress of the Swedish Dental  
Society, Gothenburg,  
November 8-10, 2007

181

Contents of Swedish Dental Journal  
Volume 31, 2007

Cover page 3

# Swedish Dental Journal

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

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# Morphology and chemical composition of dentin in permanent first molars with the diagnose MIH

SUZANNE C B HEIJS<sup>1</sup>, WOLFRAM DIETZ<sup>2</sup>, JÖRGEN G NORÉN<sup>3</sup>, NYNKE G BLANKSMA<sup>4</sup>, BIRGITTA JÄLEVIK<sup>5</sup>

## Abstract

© The purpose of this investigation was to study the morphology and distribution of some inorganic elements in dentin in first permanent molars from children with Molar-Incisor Hypomineralization (MIH). Sixty four tooth sections from thirty two children were examined in polarized light. Fifteen representative sections were selected for SEM/XRMA analysis; 5 were used for SEM analysis and 10 for XRMA analysis. No morphological changes in the dentin were revealed in polarized light microscopy (PLM). However, in all but two sections interglobular dentin was found. The SEM analyzes confirmed the findings of the PLM with no structural changes to be found in the dentin. The XRMA results showed a difference in the concentration of elements between dentin below normal and dentin below carious or hypomineralized enamel. Elements related to organic matter appeared with higher values in dentin below hypomineralized and carious enamel. The morphological and chemical findings in dentin below hypomineralized enamel imply that the odontoblasts are not affected in cases of MIH, but may be affected by hypocalcemia, reflected by the presence of interglobular dentin.

## Key words

*Enamel, hypomineralization, polarized light microscopy, SEM, XRMA*

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## Morfologi och kemisk sammansättning av dentin i första permanenta molarer med diagnosen MIH

SUZANNE C B HEIJS, WOLFRAM DIETZ, JÖRGEN G NORÉN, NYNKE G BLANKSMA, BIRGITTA JÄLEVIK

### Sammanfattning

⊙ Avsikten med studien var att undersöka morfologin och fördelningen av några oorganiska element i dentinet hos första permanenta molarer med diagnosen Molar-Incisor Hypomineralization MIH. Sextiofyra ourkalkade snitt från 32 barn undersöktes i polarisations mikroskop (PLM). Femton representativa preparat utvaldes för kemiska och morfologiska analyser i skanningelektron-mikroskop (SEM). Inga morfologiska förändringar kunde ses i dentinet i PLM förutom rikligt med interglobulardentin i 2 preparat. SEM-analysen bekräftade PLM fynden att inga strukturella skillnader förelåg mellan dentin under normal emalj respektive under hypomineraliserad emalj. Den kemiska analysen visade en skillnad i den oorganiska sammansättningen i dentin under normal, kariös och hypomineraliserad emalj. Element så som C och N hade högre värden i dentin under hypomineraliserad och kariös emalj jämfört med dentin under normal emalj. De morfologiska och kemiska fynden pekar på att odontoblasterna inte är påverkade vid MIH.

## Introduction

Defects in enamel formation are common and can be related to hereditary, systemic or local factors (1). Examples of systemic origin are amelogenesis imperfecta which is a hereditary disorder, only affecting enamel, overexposure to fluorides during tooth mineralization is known to cause defects in the enamel (29, 7). Trauma and infections are local factors which can cause hypomineralization as well as hypoplasias in the enamel. However, in many cases the etiology is unknown and thus these disturbances are called idiopathic.

Idiopathic hypomineralization of enamel of incisors and permanent first molars has been described in the dental literature since the late seventies in Sweden (16). Different names have been used for this particular kind of enamel hypomineralization: such as non-fluoride hypomineralization or cheesemolars as well as several other names (28). In 2001 *Weerheijm et al.* suggested the term Molar Incisor Hypomineralization (MIH), and defined it as hypomineralization of systemic origin of one to four permanent first molars frequently associated with affected incisors (29).

Clinically the enamel in MIH may be soft and with severe loss of substance, the color varies from white yellow to brownish with a sharp demarcation between the affected and sound enamel (28, 29). Increased sensitivity of affected teeth is often noted by the clinician, even with intact enamel an increased sensitivity is apparent and tooth brushing can create toothache (8, 25, 29).

Few studies are available on the prevalence of hypomineralization of incisors and permanent first molars. In Sweden, Finland, Germany and the Netherlands the prevalence have been reported to vary between 5.6 to 19.3 % (8, 10, 17, 26). In addition *Weerheijm et al.* concluded that pediatric dentists in Europe are aware of MIH and the majority considers it to be a major clinical problem (27).

The etiology of MIH is not yet fully understood, a number of possible causes are suggested: for instance environmental conditions, common childhood diseases, long-term breastfeeding and respiratory tract problems (13, 28). However, these factors have not thoroughly been elucidated. Histo-morphological and biochemical mapping is important to gain further knowledge in order to find possible etiological factors (13). Until now no studies have been performed on dentin in teeth with MIH.

## Aim

The purpose of this investigation was to study the morphology and distribution of some inorganic elements in dentin in first permanent molars from children with MIH, by means of polarized light microscopy and scanning electron microscopy.

## Material and methods

### *Tooth material*

The tooth material derived from a previous study of the morphology and chemical composition of some inorganic elements of the enamel of hypomineralized permanent first molars (11, 12). For the convenience of the reader a short description of the findings will be given here. From the previous described studies, undecalcified sections from seventy-one teeth representing thirty-two children became available for the histological study of dentin.

### *Polarized light microscopy*

All sections were examined in polarized light, dry-in-air, in an Olympus polarizing microscope. The sections were examined for morphological changes in the dentin below hypomineralized enamel and normal enamel, presence of reparative dentin, pulp stones and inter globular dentin. Further, the presence of restorations and caries were registered, as well as partly or total loss of enamel.

### *Scanning electron microscopy (SEM) and X-ray microanalysis (XRMA)*

Five sections representing teeth with normal, hypomineralized and carious enamel were chosen for the SEM analysis. The sections for SEM were etched 45 seconds with 30 % phosphoric acid, carefully rinsed with distilled water, mounted on sample holders for the microscope, sputter coated with gold, and investigated in a Philips SEM 515 at 15kV. All sections were thoroughly examined with a magnification of 1000x and 3000x. Images from dentin below normal, hypomineralized and caries affected enamel were taken.

Ten sections representing teeth with normal, hypomineralized and carious enamel were used for the XRMA analyses. The sections were etched 45 seconds with 30 % phosphoric acid, carefully rinsed with distilled water, mounted on sample holders for the microscope, sputter coated with carbon and analyzed in a Philips SEM 515; EDAX DX4 using an ECON-detector. For all measurements the X-rays were detected by a small window (6.1x4.3 µm). Additional SEM survey images were taken from the undecalcified sections and immediately after a XRMA

line scan was carried out. The line scans were made at 5, 10, 20 and 50  $\mu\text{m}$  from the dentino-enamel junction below normal, hypomineralized and caries affected enamel. The relative amounts of the measured elements were calculated with a computerized program (Point Electronic DISS 2). In XRMA the concentration of C, N, Ca, P and O were measured in weight percentages. In each section the average value was calculated from the measurements below comparable parts

## Results

### *Polarized light microscopy*

Of the seventy-one sections, the dentin in 7 sections was too disintegrated by caries to be used for morphological studies. Thus, sixty-four sections representing thirty-two patients became available for this study.

No major structural changes could be found in the dentin, even though the birefringence varied more in the dentine below hypomineralized enamel compared with dentin below normal enamel.

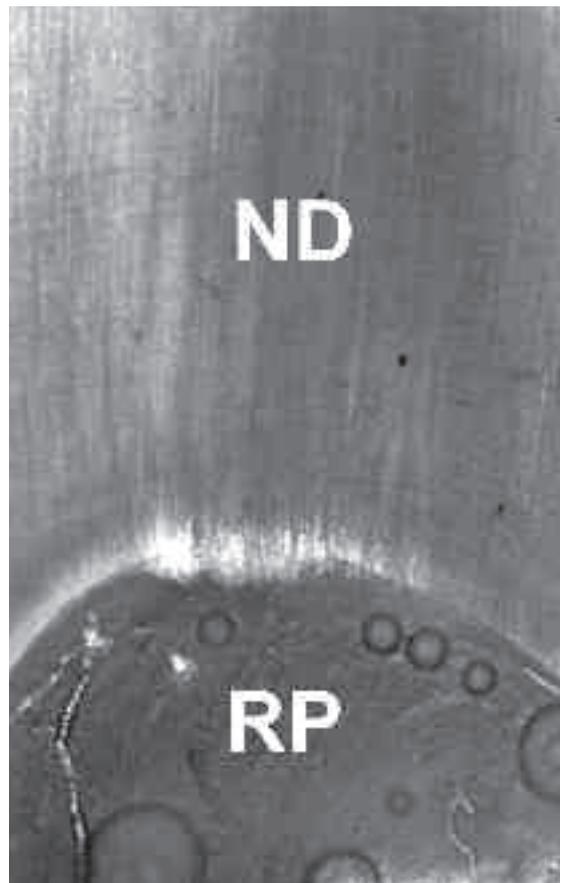
In 38 of the teeth restorations were found. Below the restorations or disintegrated enamel carious dentin was seen and in these areas the dentin appeared to have a wave-like pattern (Fig. 1). This pattern was seen below hypomineralized enamel only in combination with a restoration or disintegrated enamel.

In 33 sections reparative dentin in the pulp chamber was noted (Fig. 2a) and in 23 cases it could be related to the presence of caries. In only three cases reparative dentin could be related to hypomineralized enamel. Pulp stones were found in 4 sections from 4 different patients (Fig. 3a).

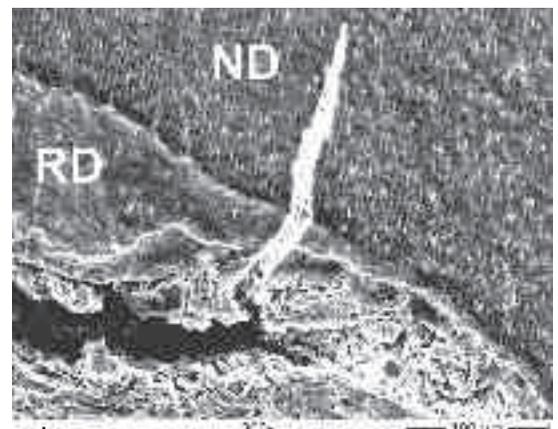
In 62 of the 64 sections a band of interglobular dentin (Fig. 4) was found in the circumpulpal dentin just below the mantle dentin, in some cases ex-



© **Figure 1.** Wave like pattern in carious dentin in an un-demineralized section of a first molar, seen dry in air in polarized light (EDJ=Enamel-Dentin-Junction; Mag. 40x).

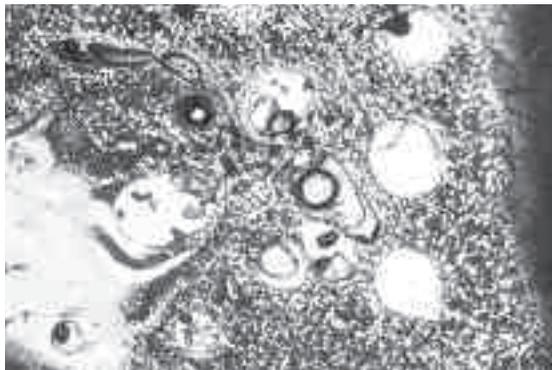


2 a



2 b

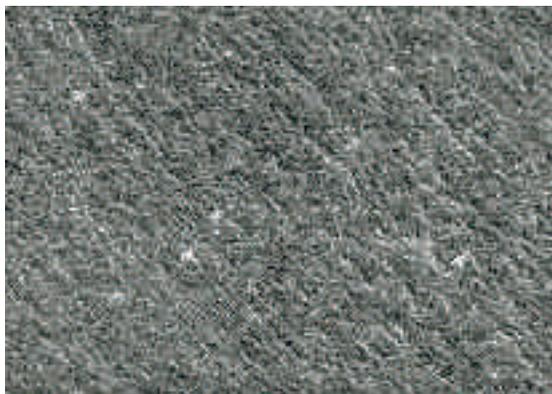
© **Figure 2.** a) Reparative dentin (RD) below normal dentin (ND) in an un-demineralized section of a first molar, seen dry in air in polarized light (Mag. 40x). b) Reparative dentin (RD) below normal dentin (ND) in an un-demineralized section of a first molar examined in SEM (Mag. 300x).



3 a



3 b



3 c

© **Figure 3.** a) Pulp stones in dentin in an un-demineralized section of a first molar, seen dry in air in polarized light (Mag. 40x).  
 b) Pulp stones in dentin in an un-demineralized section of a first molar, examined in SEM (Mag. 90x).  
 c) Pulp stones in dentin in an un-demineralized section of a first molar, examined in SEM (Mag. 3,000x).



© **Figure 4.** Interglobular dentin in an un-demineralized section of a first molar, seen dry in air in polarized light (Mag. 40x).

tending into the root dentin. In most sections the interglobular dentins was found in one or both of the lateral parts of the crown but in some also occlusally.

#### SEM analyses

From the SEM analyses no structural differences between the dentin below normal enamel and the dentin below hypomineralized enamel could be discerned (Fig. 5). In two sections there appeared to be more open tubules in the dentin below hypomineralized enamel than in dentin below normal enamel. In two sections the cut and etched surface of the dentin below hypomineralized enamel was rougher than the dentin below normal enamel, however, in caries dominated sections the dentin had an even rougher surface. When comparing the dentin below hypomineralized enamel with the dentin below caries; the dentin below carious parts appeared to be more disintegrated than the dentin below hypomineralized enamel.



© **Figure 5.** Dentin in an un-demineralized section of a first permanent molar below normal enamel (*Left*), hypomineralized enamel (*Middle*) and carious enamel (*Right*) (Mag. 1,000x)

In two sections reparative dentin was examined and it was found to be thicker than could be expected for the age of the child when the tooth was extracted. The reparative dentin showed partly a normal dentin structure (Fig. 2b). In SEM the pulp stones showed a fairly uniform appearance with little dentinal structure (Fig. 3b, c).

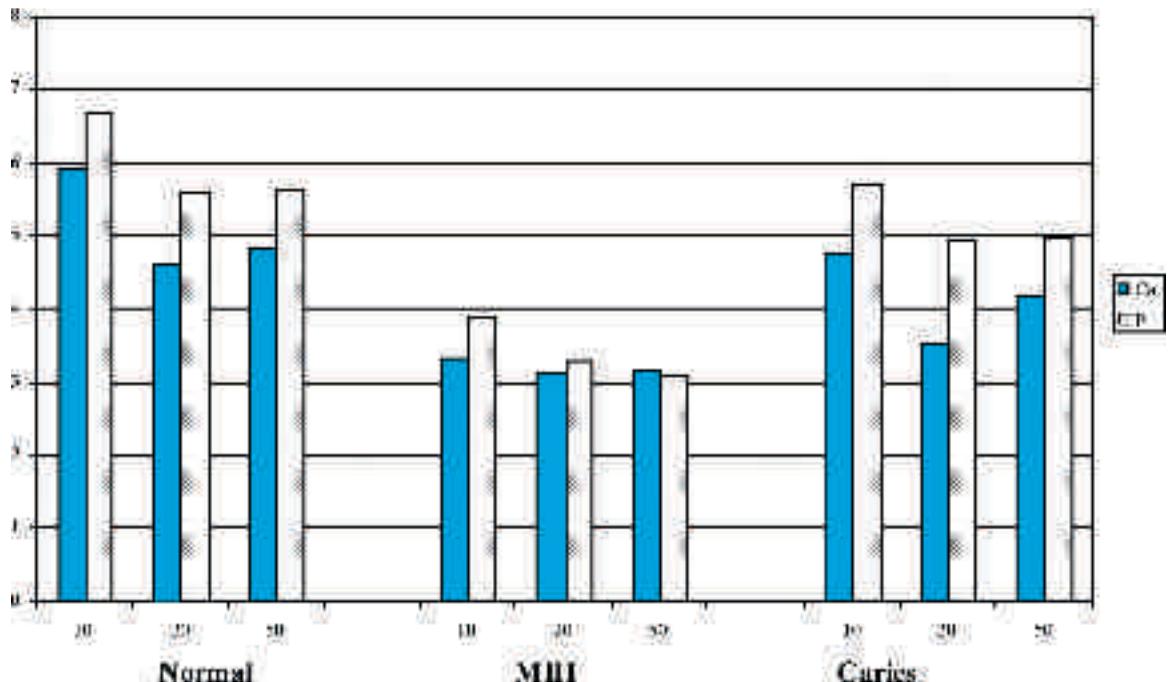
#### XRMA analyses

A total of 90 measurements were performed in the dentin and the results are presented as mean values of these. In general the measurements located in the first 5  $\mu\text{m}$  of the dentin, below the enamel-dentin

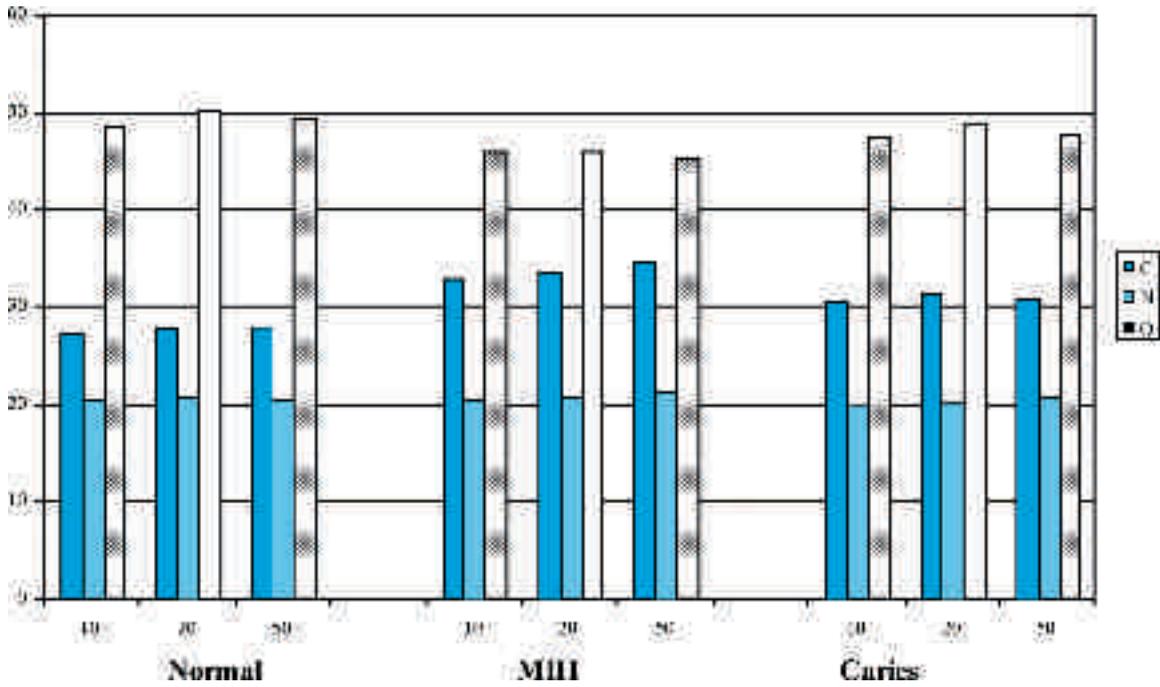
junction (EDJ) were highly irregular. A probable reason is the difficulties to achieve an exact position for the measurements, located only in the dentin. Therefore, only the measurements on the 10, 20 and 50  $\mu\text{m}$  levels below the EDJ will be presented.

#### Measurements of Ca, O and P

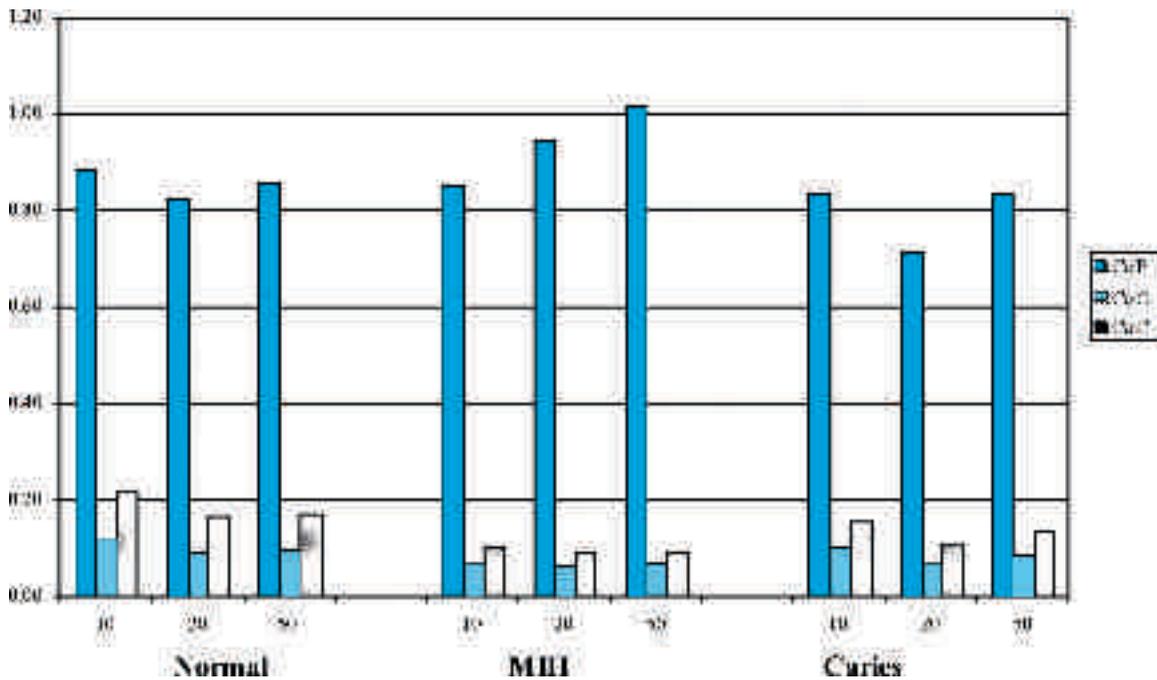
For Ca, O and P the levels in dentin below normal enamel were higher compared with values in dentin below hypomineralized and carious enamel. For dentin below carious enamel the values were higher than values in dentin below hypomineralized enamel (Fig. 6, Fig. 7).



© **Figure 6.** Relative values in weight % for Ca and P in dentin below normal (Normal), hypomineralized (MIH) and carious enamel (Caries) 10  $\mu\text{m}$ , 20  $\mu\text{m}$  and 50  $\mu\text{m}$  below the EDJ.



© Figure 7. Relative values in weight % for C, N and O in dentin below normal (Normal), hypomineralized (MIH) and carious enamel (Caries) 10 μm, 20 μm and 50 μm below the EDJ.



© Figure 8. Relative values in weight % for the ratios Ca/P, Ca/O and Ca/C in dentin below normal (Normal), hypomineralized (MIH) and carious enamel (Caries) 10 μm, 20 μm and 50 μm below the EDJ.

#### Measurements of C and N

The level of C was highest for dentin below hypomineralized enamel and lowest for dentin below normal enamel. For dentin below carious enamel the values were between those for dentin below normal and hypomineralized enamel (Fig. 7).

N showed a somewhat different pattern, and values for dentin below hypomineralized enamel being the highest. Measurements of N in dentin below carious enamel showed the lowest values (Fig. 7).

The Ca/P ratios of dentin below normal enamel were higher than for dentin below carious enamel. The Ca/P ratios for dentin below hypomineralized enamel were in principle identical to those of normal enamel (Fig. 8). When the Ca/C ratio was analyzed, dentin below hypomineralized enamel had the lowest values, dentin below normal enamel the highest and the ratio for dentin below carious enamel had a value between these two (Fig. 8).

#### Discussion

This study has shown that there are few morphological changes in the dentin below hypomineralized or carious enamel compared with what was found below normal enamel. Since no evident structural changes were found in the dentin, with the exception for interglobular dentin, these findings indicate that only the ameloblasts were affected but not the odontoblasts. Further, the chemical analyzes revealed some differences between dentin below normal and dentin below carious or hypomineralized enamel.

The SEM findings confirmed the results from the polarization microscopy, since no structural changes in the dentin were found by the SEM analyzes. However, dentine that had been exposed to caries exhibited some changes with disintegration of the tubules, which may be attributed to be an effect of the caries attack. This implies that mainly the ameloblasts somehow are affected in teeth with MIH.

Previous studies of hypomineralized enamel in MIH-molars (11, 20) have shown that the enamel is highly porous, thus there is an increased possibility for diffusion of e.g. acid and other chemical agents through the enamel. The finding of reparative dentin in MIH molars, may thus be a reaction of this diffusion. This assumption is strengthened since by formation of reparative dentin is seen as a reaction to bacterial metabolic products from the carious process (24).

The increased sensitivity sensed by children with MIH teeth (8, 25, 29) may, therefore, be an effect of external stimuli diffusing through the porous ena-

mel, affecting the pulp. It is well known that a local inflammation caused by acids or other chemical stimuli can induce pain (1, 24). Since children, shortly after eruption of MIH molars, complain over an increased sensitivity of the teeth one explanation might also be that, since the dentinal tubules are wide fluid, movements can elicit a pain response (1).

The presence of interglobular dentin has been reported as a response to vitamin D deficiency (18) and hypocalcaemia (9). Small amounts of interglobular dentin can be found in most teeth even in the root area. To some extent the distribution pattern can be related to different tooth types (23). However, the exact mechanism behind interglobular dentin formation is still unknown (23). However, in a study of rat molars it was demonstrated that interglobular dentin is formed during the early stage of dentin formation and that there is an association with the enamel maturation (14). Since MIH is chronological to its character the findings of interglobular dentin in MIH teeth coincides with its location. It is not known in what stage the ameloblasts are affected in teeth with MIH. The connection between hypomineralized enamel and hypocalcemia has been shown in numerous studies, even if hypocalcemia *per se* is not the primary etiological factor. Therefore, it is reasonable to believe that interglobular dentin is a dentin response to whatever affected the enamel in MIH.

Pulp stones are a common finding in teeth with a reported prevalence of 10% and 22% (5, 22). Pulp stones occur more often in first and second molars (5, 22) one study found that pulp stones occur significantly more often in first than in second permanent molars (22). There is no reason to believe that the occurrence of pulp stones can be attributed to MIH.

The XRMA measurements revealed that the chemical properties of dentin below hypomineralized and carious enamel showed the same patterns in relation to dentin below normal enamel. It is evident that there is proportionally less organic matter in dentin below normal enamel. However, the main difference between dentin below hypomineralized and carious enamel is the lower Ca/C ration found in dentin below hypomineralized enamel, indicating an even higher content of organic matter. The proportionally higher organic content in dentin below carious enamel is likely to be a response to acid from the caries attack. Since the hypomineralized enamel is highly porous it cannot be excluded the possibilities for effects of acid. Nevertheless, the Ca/C ratio

indicates a basically higher organic content in dentin below hypomineralized enamel, which might be an effect of a hypocalcemic state.

Dioxins in mother's milk and prolonged breast-feeding have been proposed to be a possible etiological factor of mineralization defects (2, 3, 4), however, not supported by other studies (13, 17). Nevertheless, several studies have investigated the effects of dioxins on tooth development in rats (6, 15, 19, 21) and concluded that dioxins affect tooth development in rats, both ameloblasts and odontoblasts, resulting in arrested development and delayed eruption of third molars (21) or even blocking of the development of third molars (15). The frequency of the defects depends on the dose and the morphological consequences are related to tooth type and stage of tooth development (19). The morphological and chemical findings of the present study suggest that mainly the ameloblasts are affected which is contradictory to the findings of the above mentioned studies. However, dioxins, or any other environmental potentially hazardous agents, can not be ruled out.

It can be concluded that there are few morphological changes in the dentin below hypomineralized enamel, but a high frequency of interglobular dentin. The chemical differences in the dentin were limited, but a higher level of elements related to organic matter was noted in dentin below both carious and hypomineralized enamel. Further, the highly porous enamel in teeth with MIH may transport acid or other agents from the oral cavity thus affecting both the dentin and the pulp.

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# A randomized double-blind comparative study of Biolight® light therapy following surgical extraction of impacted lower third molars

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## Abstract

☉ Monochromatic light has been used in many studies and indicated that phototherapy might be effective in the treatment of pain relief. The aim of this investigation was to evaluate the efficacy of monochromatic light phototherapy on patients who had undergone impacted third molar surgery.

Sixty adult patients were included in the study. The patients were divided into 2 groups; the Biolight® therapy group and the placebo therapy group. All the subjects received phototherapy 6 minutes preoperative and 10 minutes postoperative. They were examined 3 and 7 days after surgery to evaluate postoperative pain and wound healing. One patient was excluded from the study due to extraction of the third molar in maxilla. All the patients received a questionnaire to answer regarding pain and the number of pain killers consumed. The results from this study showed that Phototherapy using monochromatic light Biolight® therapy had no significant differences compared to the placebo group.

## Key words

*Impacted third molar, Biolight® therapy, pain*

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## Effekt av Biolight® terapi efter visdomstandkirurgi

HOSSEIN KASHANI, SANJIV KANAGARAJA, KARL-ERIK KAHNBERG

### Sammanfattning

☉ Syftet med undersökningen var att jämföra behandlingseffekten av monokromatisk fototerapi Biolight® jämfört med placebo gruppen, efter visdomstand kirurgi med avseende på objektiva och subjektiva postoperativa besvär. Slumpmässigt valdes 60 vuxna patienter mellan 18 och 61 (medelvärde $\pm$ SD 30.71 $\pm$ 8.0, män 58% och kvinnor 42%) som hade remitterats till Sahlgrenska akademien, avdelning för käkkirurgi, Göteborg. Samtliga patienter opererades för en visdomstand i underkäken utom en som hade opererats för en visdomstand i överkäken. Denna patient exkluderades från studien. En slumpvis dubbel blind design valdes och patienterna delades i 2 grupper, Biolight® grupp och placebo grupp.

Alla deltagare fick extra-oral ljusterapi behandling (Biolight® Care Device, Biolight® International AB, Stockholm, Sweden) i 6 minuter, 20-30 minuter före och 10 minuter efter operativa ingreppet. Patienterna fick ett frågeformulär med frågan om hur många tabletter man hade konsumerat samt skatta hur mycket värk man hade post operativt enligt VAS.

Alla patienter undersöktes dag 3 och 7 postoperativt för att bedöma postoperativ smärta och läkningen.

Studien visade att fototerapi med monokromatisk ljus Biolight® hade inte någon effekt på postoperativa besvären jämfört med placebo gruppen.

## Introduction

Surgical extraction of impacted lower third molars frequently results in swelling, pain and trismus. The major problems usually appear in the first 3 days postoperatively. Attempts to find better and more effective treatments were the major reason for this study. Pulsed monochromatic light (Biolight® therapy) is now used clinically for pain relief and wound healing (1, 10, 13). The Biolight® therapy is a non-invasive, non-drug medical technology based on the biological effects of pulsating monochromatic light (i.e. electromagnetic energy in the visible or near-visible spectrum). Applying a combination, specific to each indication of light to specific areas of the body, performs the therapy. A single treatment, depending on the indication, lasts between 3 and 30 minutes. The exact mechanisms of how monochromatic light affects tissue are still unknown.

Low-level laser therapy has been shown to reduce pain and swelling in patients with rheumatoid arthritis (6) and to improve healing in recently extracted tooth sockets of rats (15). *Bezuur et al.*, 1988 (4) showed that this kind of light therapy might have a positive effect on increased biochemical metabolism and healing of rabbit mandibular bone callus.

The method has successfully been used in treating inflammatory conditions and muscle exhaustion, alleviating pain and speeding up the healing of wounds. In a previous study (12), it was shown that patients with skin ulcers treated with Biolight® were observed to have a 49% higher ulcer healing rate and 50% shorter healing time compared to controls. In another study (7), it was noted that Monochromatic pulsating light may have an effect on pressure ulcer healing. In an animal study (5), the authors investigated the effect of treatment by Biolight® on healthy pigs and no morphological changes were found in the groups.

The primary objective of this study was to compare differences in perceived pain using the Visual Analog Scale (VAS) 0-10 (3, 11) between the Biolight® treated and placebo treated groups. A clinically significant difference of 30% between the two treatment groups was aimed for.

The secondary target of the study was to demonstrate the difference to using the painkiller, Ibuprofen (Ibuprofen) 600 mg.

## Material and method

Sixty patients who were referred to the department of Oral & Maxillofacial Surgery at the University of Gothenburg to undergo lower third molar surgery

under local anesthesia were chosen and randomized for this study. Orthopantomographic radiographs were used to assess the similarity of depth and angulation of impacted teeth. One patient was excluded from the study due to operation of the third molar in the upper jaw. The subjects had no relevant medical history. Their ages ranged between 18 and 61 with mean±SD 30.71±8.0 (male 58% and female 42%). Data from the remaining 59 patients were used in the statistical analysis.

To be eligible the patients were to have proper indications for extraction of the tooth, be in otherwise good oral health and both willing and capable of fulfilling the study requirements. In addition to the department's standard contra-indications for surgery exclusion criteria were, photosensitivity or other sensitivity to electromagnetic radiation. The investigators left both verbal and written information explaining the duration of the study and signed a consent form prior to inclusion.

The patients were divided into two groups, the Biolight® therapy group (31 subjects) who received Biolight® therapy and the placebo therapy group (28 subjects). All subjects received extra-oral treatment with a light-emitting device for six minutes, 20-30 minutes prior to surgery and 10 minutes postoperatively according to the instructions from the manufacturer. The study was performed as a randomized double blind study. The patients received a questionnaire regarding pain and the number of analgesic tablets consumed. The Biolight® method is based on the biological effects of electromagnetic energy in the form of monochromatic, primarily infrared light. The light was administered using a special device, (the Biolight Care Device, Biolight® International AB, Stockholm, Sweden). The Biolight equipment is non-invasive and non-thermal based on the effect of pulsed monochromatic light in the visible or near-visible spectrum. A probe contained 30 diodes which could emit infrared light at 956 and also 80 diodes which could emit red light at 637 nm. The placebo light or monochromatic phototherapy was given as extra oral treatment. Infrared light with an irradiance of 55 W/m<sup>2</sup> was given first and then red light with an irradiance of 21 W/m<sup>2</sup>. Using a duty cycle of 80%, the infrared and red light were pulsed at the following frequencies: infrared- 287 Hz, 31.2 Hz, 9900 Hz, 8 Hz, 15,6 Hz and 780 Hz. Red light- 8 Hz, 31.2 Hz, 9900 Hz and 8.6 Hz. The equipment for phototherapy and placebo was identical in appearance and both alternatives emitted a red light. No heating was seen from either treatment.

© **Table 1.** Characteristics of patients. No significant difference was observed between groups.

Variables	Total (n=total)	Biolith® (n=31)	Placebo (n=28)
Female %	42	38	46
Male %	58	63	54
Age (mean/SD/range)	30.71 ± / 18-61	31.12 ±8 / 18-61	30.25/±7 / 19-47
• Female	28.7 / ±6 /18-61	28.2 / ±7 / 18-39	29.2 / ±5 / 20-38
• Male	31.6 / ±10 / 18-61	32.5 / ±12 / 18-61	30.6 / ±9 / 19-47

Finally the patients were then informed about post-surgical complications and they received analgesic Ibuprofen® (Ibuprofen) 600 mg according to standard ordination. Two surgeons performed all the surgery (HK, SK).

To evaluate the postoperative complications, a questionnaire was used. Patients were followed up 3 days and one week postoperatively and in the event of complications, until full recovery. Patients were also examined to evaluate pain and wound healing.

#### Statistical analysis

The non-parametric test the Mann-Whitney U test-, was relevant to use for the statistical analysis. The

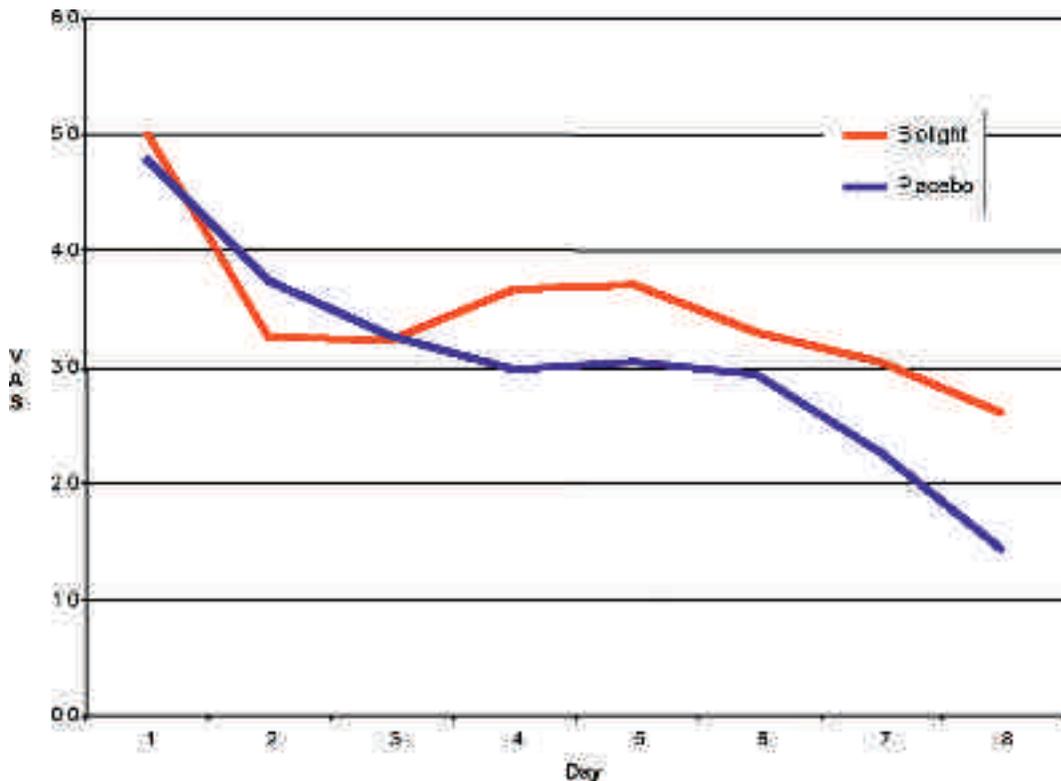
level of significance was set at 5% for comparison of data.

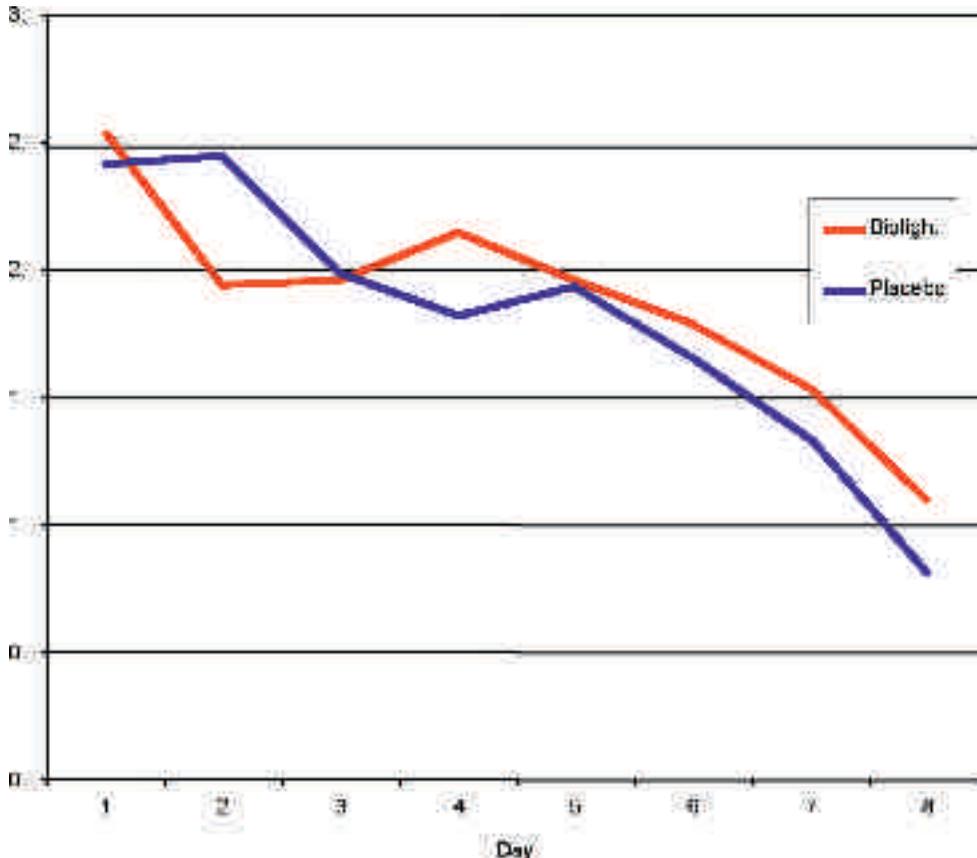
#### Results

Sixty patients were randomized for treatment, with the exception of one patient, who was withdrawn due to removal of the third molar in the upper jaw.

There were no statistically significant differences in the frequency of complications between the groups. The treatment groups were similar at baseline, with no statistical differences in mean age, sex, surgical characteristics, or baseline pain intensity (Table 1). Four patients in the Biolight®

© **Figure 1.** VAS mean value for the primary targets, (pain relieving-VAS) Mann-Whitney U-test.





© Figure 2. Mean value for using amount of tablets postoperatively in Biolight and placebo group.

group suffered postoperative infections (alveolar osteitis) compared to three in the control group.

### Efficacy Analysis

#### Pain relief

Based on categorical PR scores (VAS scale 0-10), The mean value for the VAS scale was 5 in both groups postoperatively which decreased during the following days. After three days the mean value was about three for both groups. The Biolight® group had less pain on day 1 (operations day) and 2 postoperatively compared to the placebo group. The differences were not statistically significant (Fig 1). In the following days the placebo group had less pain compared to the Biolight® group. However, none of the differences were statistically significant. There were more variations after 4 days postoperatively in favour of the placebo group (Fig 1). Again these differences were not statistically significant. Pain decreased in both groups 2 days after surgery.

#### Amount of analgesic

Based on the amount of painkiller taken postoperatively, there were no statistically significant differences between the groups one day postoperatively. The Biolight® group consumed less pain killer compared to the placebo group.

No differences were found 4 days after surgery. Up to 20% less analgesic was used during days 1 and 2 postoperatively in the Biolight® group (Fig 2). Patients were allowed to take up to 4 tablets per 24 hours. Ibuprofen® (Ibuprofen) 600 mg according to standard ordination was given to the patients. The mean value for using tablets was 2.5 tablets during day 1 and 2 tablets during day 2 postoperatively in the Biolight® group and 2.5 tablets during the first 2 days in the placebo group postoperatively. After day 4 no differences were found between the groups. The mean values were less than 1.5 tablet per day in both groups after day 6 (Fig 2).

## Discussion

A previous study (11) has shown that laser irradiation on cultured human gingival fibroblasts has an effect on soft tissue with a reduction of the inflammatory process. *Takas et al.* (14) have recently published a study to evaluate pain relief after scaling and rootplaning treatment of patients with periodontal disease who have been treated with monochromatic phototherapy. No pain relief could be obtained after this treatment compared to a placebo. This result is in accordance with our study. Third molar surgery involves insult to both soft and hard tissue, and to our knowledge, this is the first study addressing effects of monochromatic light on both tissue types.

The subjects in this study received analgesic Ibuprofen<sup>®</sup> (Ibuprofen) 600 mg according to standard ordination. Ibuprofen has been investigated in many studies (8, 9) and shown good efficiency on pain control. *Lysell & Anzén* (1992) compared Ibuprofen<sup>®</sup> (ibuprofen) Citodon<sup>®</sup> and (paracetamol/codeine) in a single-blind multi-centre trial after third molar surgery. Ibuprofen<sup>®</sup> proved to be a better pain reliever and Citodon<sup>®</sup> induced significantly more side-effects than Ibuprofen<sup>®</sup>.

It is also important to note the fact that 4 patients in the Biolight<sup>®</sup> group suffered postoperative infections compared to 3 in the control group. The differences were not statistically significant in the present material. We recommend that this issue be addressed in future studies with a nominal number of patients. To our knowledge no side effects have been documented following monochromatic light therapy until now. The Biolight<sup>®</sup> device is approved for use in the European Union (CE). This study shows no tendencies to reduced postoperative discomfort in patients who underwent Biolight<sup>®</sup> therapy compared to the control group. However, further studies are required to definitely establish differences in symptom reduction post-operatively.

## Conclusion

Phototherapy, using monochromatic light had no effect on pain relief compared to placebo light.

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# The HIDEP model – a straightforward dental health care model for prevention-based practice management

HANS C H SANDBERG, UNO G H FORS

## Abstract

© With the ambition of continuously improving the effectiveness of oral health care, the concept of minimal invasive dentistry has become an issue within modern dentistry. The ultimate goal of this concept is to preserve dental tissues (teeth and their attachment). To preserve oral tissue, effective methods for management and resource allocation are needed. Involving the patient within the dental team as a member and not as a customer might also increase the effectiveness. To achieve this, a dedicated tool for managing the actions of all parties involved towards the desired goals is needed. This paper describes the development and use of a special management tool, the HIDEP model (Health Improvement in Dental Practice). The model is used to measure, steer and evaluate the actions within a dental clinic involving patients as well as professionals.

## Key words

*Dental, health, informatics, management, prevention*

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## Den nivågrupperade modellen – riskgruppering för bättre tandhälsa

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### Sammanfattning

⊙ I slutet av 1980-talet ställde vi, i vår tandvårdsmottagning oss frågan: ”- Blir våra patienter friskare?” Att ge ett svar, patient för patient med de index och mått vi har tillgång till vållar inga större problem men att kunna se mottagningens helhetsresultat, var betydligt svårare. Vi saknade ett verktyg. Eftersom den viktigaste tandvården utförs av patienten själv önskade vi ett verktyg som även innebar en ökad patientdelaktighet. Målet, friska vävnader skulle vara tydligt. Vi inledde arbetet med att kontakta cariologer och parodontologer i ambitionen att få fram en lättfattlig sammanfattning av en enskild patients tandhälsotillstånd. Antalet tänder och antalet intakta tänder var lätt att mäta och kommunicera, men alltför grovt. I RAMVUX, ett ramförslag för vuxentandvård som socialstyrelsen hade utarbetat 1988, graderades sjukdomarna karies och parodontit i fyra grupper beroende på hur kraftiga/omfattande symtomen var. Vi saknade dock en mer proaktiv inriktning varför vi adderade fem kariologiska och fem parodontala riskgrupper. Detta gav grunden för det kodsysteem som Den Nivågrupperade Modellen (HIDEP Model) bygger på. Koden består dels av patientens antal intakta tänder och total antalet tänder, dels den aktuella kariologiska respektive parodontala situationen. Sjuk eller Frisk? Om sjuk hur sjuk, om frisk vilken risk finns att bli sjuk. För grupperingen användes vedertagna mått och riskvärderingar.

I och med att samtliga patienter erhåller en sammanfattande beteckning som grovt beskriver tandhälsotillståndet, utgör en sammanställning av deras koder mottagningens hälsoprofil. En hälsoprofil som kan vara basen för en övergripande vårdplanering. Det vill säga hur ska vi anpassa våra resurser för att på bästa sätt möta våra patienters behov, avseende friska vävnader. Modellens konstruktion innebär att patienten integreras i mottagnings arbete på ett helt annat sätt än vad som tidigare var fallet. För att ytterligare stärka samsyn och delaktighet i team och bland patienter har såväl strukturerade behandlingsplaner som stödbehandlingsplaner relaterade till de olika kariologiska och parodontala grupperna upprättats. Även informationsblad baserade på patientens aktuella behov som betonar vikten av patientens egna insatser har utvecklats. Då modellen genererar en mängd data konstruerades tidigt datorstödet DentiGroup. Genom åren har modellen visat sig fungera väl inom områden som management, marknadsföring och kvalitetsutveckling.

## Introduction

In Sweden we are, within health care, facing an increasing discrepancy between needs and resources. In dental health care we have, on one hand, young adults with a good dental health situation, and on the other hand an ageing population keeping their own teeth, most often heavily restored [7, 21]. These restorations demand repair, new lesions develop, attachment loss advances and - furthermore - for those who are missing teeth, the introduction of implants has now led to a situation where dental health care and preventative treatment has become a lifelong commitment.

As the needs increase more than the available resources, questions about cost-effectiveness and management strategies arise. In other words, the focus should be on what is achieved in terms of health, instead of what is performed in terms of number of restorations. In Sweden, where the government is using tax money to subsidise dental health care, there is a clear interest in seeing what effect these subsidiaries have on the oral health situation. For dental practitioners, it becomes important to be able to answer the questions, "Has the tax payers' money been used in the most efficient way?" and "Has the oral health of our patients improved?"

To answer such questions for the individual patient, there are a number of existing and well respected indices that are used. However, studying the overall outcome of a clinic and using the result for managing tasks becomes more complex.

Hence, the role of the dentist changes nowadays according to changing demands. The team leader of a clinic in this new environment has to set not only economical goals but should also define health-related goals. To continuously improve, it might also be important to involve the patient to a higher degree than before, by giving them responsibility for their own dental health, as the most important preventive health care is performed at home. This might be facilitated if the view of the patient as a customer is altered. To see the patient as a member of the team instead might open up new perspectives.

When setting goals and structures aimed towards achieving the desired goals, a way of measuring is needed. Such measures should be able to be understood by all parties involved.

At the end of the 1980s we, in our dental clinic, started to develop our work from traditional reparative dentistry towards a more preventive and resource-efficient oral health-oriented clinic. Because of this, we had an urge to find a tool that could be

used for evaluation of the outcomes of the clinic in terms of oral health improvement. A tool that also could be used for health care management involving both professionals and patients. Our work ended up with the development of the first version of the HIDEP model [16, 17, 18,19].

## The development of the HIDEP model

The development of the HIDEP model started with a search for a management tool that:

- was interpretable for both health care providers as well as patients to be used for effective management
- could take into account the clinical experience of the health care providers and at the same time be as objective as possible, based on tangible data
- already established examination methods and indices would be used
- could aggregate the health situation of all the different patients to form an overview of the clientele, in order to evaluate and continuously improve the actions towards good oral health within the specific clinic

A clinically applicable management tool needs to be based on certain measures. As the fundament of dental health care should be saving sound tissues, this goal had to be the focus when defining the measures.

The most straightforward measurement as well as a tangible quality indicator is the total number of teeth per patient; however, this cannot be the only indicator. An intact tooth (a tooth with neither restorations nor cavities) might be seen as a tooth of a better quality than a tooth that has lost enamel/dentine; and a tooth that has no loss of attachment is in a better situation than a tooth that has lost more or less of its supporting tissues: this was considered as a second important measure. Moreover, the two diseases, caries and periodontitis, are by far the most common causes of oral tissue loss, and therefore it was decided to condense the oral health status of a patient to, on one hand, the total number of teeth and number of intact teeth and, on the other hand, a summary of the cariological respectively periodontal condition of the patient's teeth.

The literature was searched and specialists in the fields of periodontology and cariology were consulted. At this time, the end of the 1980s, a number of well-known and respected Swedish specialists proposed a system called RAMVUX [20]. It was based upon a four grade scale describing severity/activity

of the diseases caries and periodontitis. Concerning the caries disease, "1" corresponded to an activity of 1-2 new manifest lesions per year. A "2" indicated 3-4 new manifest lesions; "3" more than 4 new lesions; and "4" extremely high activity with cavities outside predilection sites.

Concerning the periodontal aspect, "1" corresponded to gingivitis without any loss of attachment; "2" gingivitis with an ongoing periodontitis with a horizontal loss of attachment less than 1/3 of the root length; and "3" corresponded to an ongoing periodontitis with a horizontal loss of more than a 1/3 of the root length. Finally a "4" corresponded to a severe periodontitis showing vertical pockets, furcation involvements etc.

### The HIDEP coding system

It was thought that RAMVUX was a step in the right direction to be used in general dental practise; however, RAMVUX lacked a proactive approach. Why wait until the damage was already a fact before acting? To better suit a proactive strategy for prevention, five cariological and five periodontal risk groups were added. These became: Very low risk of attracting disease, Low risk, Clear risk, High risk, up to Very high risk of attracting disease.

To distinguish the different risk and disease levels from each other and also caries groups from periodontal groups, a denomination system was developed. Patients with signs/symptoms of the caries disease (manifest lesions) were assigned one of the C1, C2, C3 and C4 codes. For the periodontal part, the codes became P1, P2, P3, and P4 respectively (Fig. 1).

For patients at risk but without signs of symptoms of active disease, the cariological risk-groups were expressed as CoS, C1S, C2S, C3S or C4S. The periodontal risk groups were denominated as PoS, P1S, P2S, P3S and P4S respectively. "S" stands for Support, which means that patients at risk need Support,

Disease	Degree of symptoms				Treatment	
	1	2	3	4		
Health	0S	1S	2S	3S	4S	Maintenance

Risk of attracting disease

© **Figure 1.** The base of the HIDEP model with four groups, 1, 2, 3, and 4, describing severity of symptoms, and five groups, 0S, 1S, 2S, 3S and 4S, describing risk of attracting disease

port/maintenance to avoid symptoms of disease.

To define an appropriate HIDEP code for a patient, the issue becomes to judge if the patient is healthy or if she/he has signs of ongoing disease. If healthy, the issue is to determine a corresponding risk group (0S 1S 2S 3S or 4S). For the patients who show symptoms of active disease, the task becomes to determine how severe the symptoms are (1, 2, 3 or 4).

These groups, in combination with the number of intact teeth and total number of teeth, formed the HIDEP code for a specific patient.

### Examples:

24/30 C1S P3. This HIDEP codes gives the summary of a patient with all their teeth except for two, probably third molars. Six teeth are restored. C1S corresponds to a patient with no manifest carious lesions, being at low risk of developing such. P3 means that this patient has an active periodontitis with a horizontal loss of attachment of more than 1/3 of the root length.

2/15 C2 P2S. This code describes a patient with fifteen teeth left, which probably show extensive restorations as only two teeth are intact, most probably lower incisors. C2 means that the patient has developed 3-4 new manifest lesions since last year, which have to be restored. There is a necessity not only to restore the damaged teeth but also to perform a risk assessment concerning risks of attracting new lesions. This will lead to a C\_S group indicating an adequate support treatment and home care with an intensity dependent upon how high the risk level is. From the point of view of periodontitis, this patient shows no signs of active disease but has a horizontal loss of attachment of less than one third. This is probably an elderly patient with mainly cariological problems.

Every dental examination consists of collecting numerous data, from sex, age and general health conditions to the specific situation in the mouth and surrounding tissues. The patient also presents soft, non-measurable data, which has to be taken into consideration. When all these data, hard and soft, are compiled, it will end up as a summary in the head of the clinician: a summary from which the clinician decides the actions concerning the specific patient needs. The HIDEP code forms a tangible expression of this summary.

### The clinical applicability of the HIDEP codes

As all patients received a HIDEP code that formed

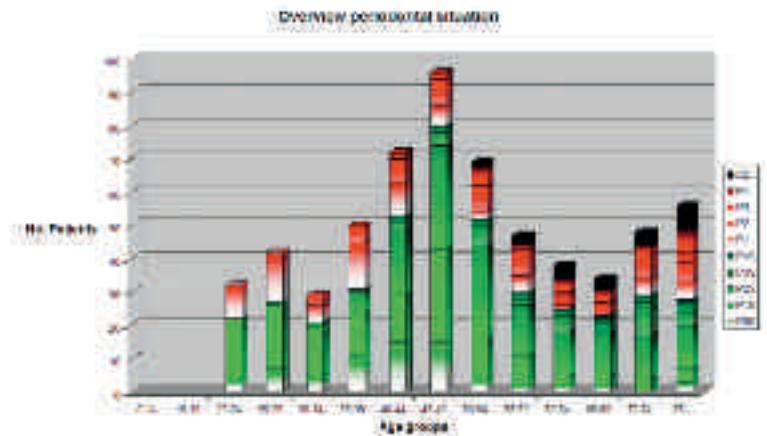
a summary of their dental health status, it became possible to compile these data to obtain an overview of all patients attached to the clinic. This overview forms the health profile of the specific clinic; an overview which includes evaluation of performed treatments, risk analyses and health care management, as well as acting as a base for task delegation to team and patients (Fig. 2.).

To the different cariological disease groups (C1, C2, C3 and C4) as well as periodontal disease groups (P1, P2, P3 and P4), structured treatment plans were defined. These treatment plans were adapted to the needs of the individual patient as indicated by the HIDEP groups as well as to the existing resources of the clinic. Treatment plans also indicated what has to be done, by whom and when. These written plans should not be seen as a limit, but instead as the backbone of the clinic: a backbone which it is possible to bend in order to keep balance. As we are treating human individuals, exceptions and adaptations have to be made, but without structure no one knows when an exception is made. Concerning the different risk groups (CoS-C4S and PoS-P4S), the frequency of recall as well as content of the support treatment were defined.

Furthermore, written information leaflets targeting the specific problems each patient might have were developed, describing in short what the problem was and how to solve it. The information leaflets clearly defined what the health care provider could offer and what demands there were upon the patient, concerning behavioural changes and home care. Examples of such plans and information leaflets can be seen in Fig. 3.

The work according to the model created huge amounts of data. In order to be efficient, a software system called DentiGroup™ was developed and initially released in 1992. In 1994 it became commercially available [6].

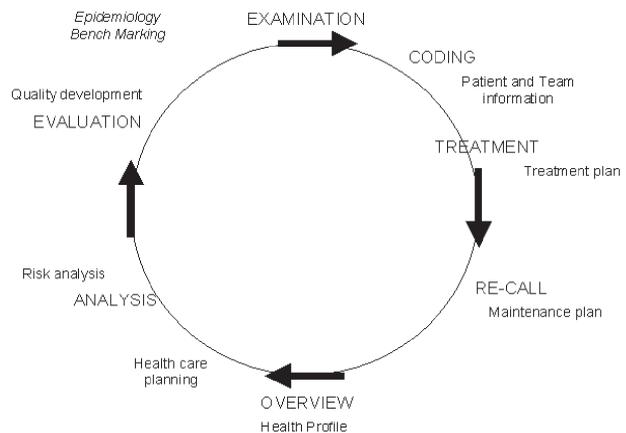
Within a dental practice, there is a dynamic change of patients. New patients enter and others leave, which leads to a need for following up the development of the oral health among the patients, but due to the limited resources of a normal dental clinic, traditional epidemiological studies can not be performed. However, the output from the DentiGroup software can give some indications of the development of the oral health at a specific clinic over time. For example, during the period 1995-2005, the overall results of the clinic where 750 patients were tracked, indicated that 97 % of the teeth and 96 % of the intact teeth remained over the ten-year period. 94 %



© Figure 2. The bar diagram shows an overview concerning the periodontal situation of the practice in 1995. The different bars represent different age groups. The height of the bars shows the number of patients in each age group. The red sections show patients with various degrees of active periodontitis (P1, P2, P3, P4). The green areas show different risk levels of attracting disease/or recurrence (PoS, P1S, P2S, P3S, P4S). The black areas correspond to patients with no natural teeth.

of these patients did remain in the same category of attachment level, despite an average age of 57 years of the patients at the start of the period.

The HIDEP model has, through the years, shown some advantages. In dental clinics that use the HIDEP model it has been increasingly integrated into the work and is often used to support several steps in the management of the clinic. (Fig. 4.).



© Figure 4. Describing the different steps in a dental practice where the HIDEP model could offer support.



*1 Patient level*

The HIDEP model facilitates the involvement of the patient within the team as a member instead of being a customer. HIDEP groups are based on easily understandable criteria, in fact so easy that the patient themselves, after some assistance, can define an adequate HIDEP code. In other words, the patient can define the STARTING line: "Where am I on the bar corresponding to my age group of the health profile diagram?" The health care provider could define a GOAL. How the GOAL is reached is described by the structured treatment plans. Where are the uphill and where are the downhill? How should the race best be planned? What can we do and what should the patient do? When patients realise the actual situation and possible end result, questions often occur like: "What shall I do?", "How long will it take?" and "How much will it cost?" All these questions could be answered directly as there are structured treatment schemes linked to the different HIDEP groups.

The patient information leaflets consist of one page sheets focusing only on the actual problems that the specific patient presents. In the information leaflet it is clearly stated what the patient should do and what the health care providers could offer: how the work is divided, and how the tasks are delegated.

*2 Health care provider*

Defined parameters and criteria lead to a view in common among professional health care providers. The screening examination mainly serves as a tool to sort out the healthy patients. For those showing high risk or symptoms of disease, a more thorough examination is offered: an examination oriented towards the specific disease, for example in the case of signs of periodontitis, plaque index, bleeding index, six surface pocket measurement, attachment level etc., and concerning the caries disease, dietary questionnaire, plaque index, saliva diagnostics, use of fluorides etc. The whole dental team has the same view upon what treatment could be appropriate and, concerning patients at risk, how frequent the recall intervals should be. The best frequency of all is according to the concept of "JIT": to see the patient Just In Time; to have a recall vision of seeing the patient a day before irreversible tissue loss occurs. One month earlier is a waste of resources; a day after is counterproductive. The communication within the team is facilitated by using the HIDEP codes describing the summary of each patient's health status. What, when, by whom and how often are described

in the structures.

The defined criteria and structured treatment plans make it easier to make decisions more objective. It is not the actual mood that determines what to do; it is stated in writing instead. According to the progress of science, the treatment plans should be updated. This also applies to the different parameters and criteria used concerning risk assessment.

As a leader it is important to have devoted followers; it becomes much easier to have the patients as followers when the health care providers have a united view. This will not only give a good impression but also it will give an effective organisation. Both information leaflets as well as treatment plans display the common view of the team.

*3 Clinical level*

When all HIDEP codes are compiled, for example with the DentiGroup software, they form the clinic's health profile. This health profile forms the basis from which analysis could start. This analysis could answer questions like:

- What is the actual situation, and what are the obstacles concerning reaching our vision of saving tissues?
- How should the competences of the professional health care team best be used?
- How should effective task delegation be administered?
- Have we succeeded in our ambition to improve the oral health among our patients?
- Could we be more effective; could we reach further with same input?
- Have the methods used shown good results? Could we improve the methods or do better methods exist?
- If we have succeeded in our ambition, why not communicate this to all team members, their friends and surrounding society?

The health profile is formed in the same way as the closing of the economical accounts, the basis on which evaluation and planning for the years to come can be made.

*4 Marketing*

One of the modern marketing techniques is called relation marketing. The focus is not to Satisfy the Customers, instead to create Devoted Team Members. This method of marketing is well fitted for the health care sector, dealing with those diseases involving a behavioural aspect, where the contributions from the patients are most necessary. Periodontitis

and caries are good examples but also other health disorders like obesity, heart-coronary diseases, diabetes and other behaviour-influenced diseases.

Marketing is a vast area but if it is seen as a method to sell a product, in our case good oral health, the HIDEP model is an effective and straightforward marketing tool, from the involvement of the patients in the model to the possibility of marketing the results achieved by the team.

#### 5 Authorities

It becomes more and more obvious that not only patients but also authorities as well as third party payers demand more information from dental clinics. The reason for this is questions about efficiency, from the oral health care of a specific patient to the dimensions of the education of dental health care providers.

It is not cost-effective to perform a complete gingival index or six surface pocket probing on all patients. It is neither necessary nor interesting on a national level. However, a congregation of data that forms a rough summary of the oral health status of the population could be an advantage. If reports of statistics concerning oral health could be extracted directly from daily work, much could be won. Today there is nothing of the sort among the adult population on a national level in Sweden.

#### Discussion

*Why create a new index?*

We haven't created any new index; instead the HIDEP coding system has to be seen just as a summary of a patient's oral health status. Concerning the periodontal part, we are in fact using a Swedish index called FPU (Simplified Periodontal Examination) [5] that corresponds to PSR [4,12]. From modern digital recording systems, DMFS could also be extracted and used.

If CPI, [1] DMF, PI plaque index, GI Gingival Index, [11, 15] or other accepted indices are in use in a dental clinic, they could all serve as a basis for the summary that the HIDEP codes present. This also applies to different risk assessment methods [2, 8, 9, 10, 14]. The main idea is to have a summary defining the dental health status of a patient in a way that it is easy to understand and useful for motivation. If healthy, what is the risk of attracting disease? If diseased, how severe are the symptoms?

*There are already indices giving an overall view of a dental clinic.*

Yes, indeed, but most often they present so-called

composite indices such as Oral Health Index OHX [3]. However, these are often difficult to analyse. On which of the included issues should we focus to improve? The HIDEP coding system makes it easier to define the problem in a specific clinic; is it caries or periodontitis, is it within specific age groups, gender etc?

*The HIDEP risk assessment is based upon what?*

As science continuously struggles with these questions, we do not see that it is our task to define parameters; instead we are trying to be up-to-date with what science continuously presents. We see a construct with a five-step scale from Very Low to Very High as clinically useful, despite the different risk indicators/factors that might occur in the future.

*There are a lot of groups: nine periodontal and nine cariological.*

Yes, it gives more than 80 possibilities in combination; this, together with the number of teeth and number of intact teeth, gives a lot of possibilities to define the clientele of a dental clinic. In this way, it becomes easier to give an individualised summary of a specific patient. As one of the aims of the model is to be used for management issues, there are several advantages. For example, a patient at risk needs support/maintenance treatment: as we have five risk levels these could be roughly combined with different recall intervals. Also, the health profiles give more precise information than they would if there were just three groups, for example: Healthy - Slight symptoms - Severe symptoms.

*It seems that attachment level stands for the most important part of defining periodontal risk: is that wise?*

Yes, we think it is. According to the science of today, loss of attachment is still the most obvious sign that a patient is prone to periodontitis. So far there has been no more cost-effective way to identify patients prone to periodontitis. Because of this, an early identification of attachment loss is most important. By including the attachment level in the HIDEP codes, it facilitates the evaluation of preventing loss of tissue in a clinic. One has to take into account the age of the patient. For example, the HIDEP group P2S describes a patient who shows a non-active horizontal attachment loss of less than one third of the root length. If this patient is 65 years old the risk is very low that this patient would lose his teeth even if the disease became active. On the other hand, if the patient was only 22 years old, the risk would be considerable. Because of this reason, young patients

showing a loss of attachment are offered a more intense case corresponding to a higher risk level, in this case P<sub>3</sub>S.

*There are much better expert systems than the HIDEP model*

Yes, indeed, like OHIS (Oral Health Information Suite) [13] and Cariogram [8], for example. We are not competing; instead, we welcome such systems. The HIDEP model has, as one of its major aims, to give every patient in a clinic a code in order to evaluate the results of the entire practice. Specialised expert systems are aimed at giving support in those cases where the clinicians need special support, not in the easier cases that form about 80% of normal clientele in a dental practice.

### Conclusions

Nowadays, it is not a lack of information that is the problem; on the contrary, we have an overflow of information. From all this information we have to condense and extract knowledge. What knowledge should be extracted depends upon the goals we have. Within dentistry the most basic goal is to prevent loss of tissues; the most important part of this work is performed by the patients themselves. We, as professionals, could only establish the dental situation in the mouths and the mental conditions of the patients in order to let them take the daily responsibility for their own oral health treatment. We see the HIDEP model as an effective management tool based upon the concept of saving tissues to be used within dental clinics with the ambition of continuously improving oral health among their patients.

### Acknowledgements

This study was supported by the Karolinska Institutet, Zahnärztekammer Nordrhein, Praktikertjänst AB and Svenska Tandläkarnes inköpsförenings stiftelse för forskning och studier.

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# Abstracts

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<b>Subjects</b>	<b>Nos</b>
Community Dentistry, Special Oral Care.....	1-8
Cariology, Endodontics .....	9-16
Periodontology.....	17-27
Orthodontics, Paediatric Dentistry.....	28-37
Stomatognathic Physiology .....	38-51



Professor Jan Lindhe, Gothenburg received 2006 the International Prize of the Swedish Dental Society for outstanding scientific contributions in periodontology. At the annual congress 2007 he presented his Prize Lecture.



### Oral status and treatment needs among elderly within municipal long term care 2002 - 2004.

R Isaksson

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**Aim:** The aim of this study was to follow the assessments and the possible changes in oral status and treatment needs in a population of persons enrolled in municipal long term care (LTC). The protocols from this period were examined, focusing on changes during the studied period in a group consisting of the persons, included the first and the third year.

**Material and Methods:** Subjects The study was carried out in a county in the south west of Sweden. The study was longitudinal. The study group was those subjects within LTC, in nursing homes (NH) and in municipal home care (HC), who were examined by dental hygienists in their visiting oral health examinations during the year 2002. The study group was followed during another two years; protocols from the first and the third year (2004) were included in this study. Examination procedure The examinations were blunt, as the tools used were mainly a dental mirror and a halogen lamp. Individual prophylactic advice followed the examination, when needed.

**Results:** Totally 1170, i.e. 48.4%, of those 2416 persons, examined 2002 were deceased two years after the initial examination. Only 914 were available for assessment with full data at follow up. Regarding dentition, totally 36.6% of all those examined in 2002 had 10 or more teeth; two years later, 39.8% had 10 or more teeth. The result of the assessed variables, i.e. modified plaque index (PI), mucosal index (MI), and mucosal friction index (MFI), revealed a significant impairment as to MI and MFI in the cohort, from 2002 to 2004. On the other hand, also in the cohort, 47% of those examined had a persistent good or acceptable oral hygiene and 77% were registered with persistent acceptable mucosal conditions. In 2002, the assessed number of examined persons in the cohort with need >60 minutes to be seen by the dentist was 59, i.e. 8%, this figure being 74, i.e. 10%, two years later. The corresponding figures for the dental hygienist were 153; i.e. 18%, and 172; i.e. 20%, respectively.

**Conclusion:** In sum, the study shows the importance of maintaining regular cooperation between the nursing and the dental profession within elderly care, to maintain/obtain an acceptable oral status in the elderly within LTC. The fragility of the elderly within LTC, indicated by a high mortality figure, further makes it important to primarily stress the need for oral prophylaxis in order to avoid extensive dental treatment, and, especially, emergency need.



### Oral health in patients with Crohn's Disease.

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**Aim:** The aim of the present study was to investigate perceived oral health of patients with Crohn's disease (CD) in comparison with a control group without CD.

**Material and Methods:** The study population comprised 1943 patients with CD recruited from the National Patients Organisation of Inflammatory Bowel Disease and 1000 randomly selected controls. All participants got a questionnaire containing questions concerning socio-economic variables, education, civil status, income and dental care habits, oral health and tobacco use.

**Results:** Patients with CD perceived their oral health as significantly worse than controls, OR 9.1, after adjusting for age and smoking. The patients also reported significantly more need for dental treatment than the controls, OR 6.12 after adjusting for age and smoking. After compensation for age and smoking the patients with CD reported significantly more mouth related problems than controls, OR 3.1, -e.g. significantly more caries. The patients reported significantly more gingival bleeding compared to the controls, OR 2.2, after adjusting for age and smoking. There were significantly more smokers in the patient group.

**Conclusion:** Our results shown that patients with CD perceived worse oral health and have more need for dental treatment compared to a control group.



### Mucosal surface interactions as inducers of acid tolerance in oral micro-organisms - development of methodology for studies

J R Davies

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**Aim:** Recruitment of micro-organisms to the tooth surface occurs mainly from biofilms on the oral mucosal surfaces. We propose that micro-organisms undergo adaptation in mucosal biofilms which affects their subsequent ability to colonize tooth surfaces and cause disease at these sites. This work focuses on development of methodology with which to study how interactions with cell-surface proteins and conditioning films on oral mucosa influence the physiological adaptation of oral streptococci with emphasis on properties relevant to caries e.g. induction of acid tolerance. Our overall goal is to identify new strategies for preventing caries which focus on changing bacterial virulence properties rather than eliminating specific bacteria.

**Material and Methods:** A number of techniques are required as a methodological basis for this work: (i) a model where interactions between bacteria and oral epithelial cells and the effects of conditioning film proteins (saliva and mucins) can be studied in situ (ii) fresh streptococcal isolates from oral mucosa, since reference bacterial strains have often undergone significant changes since their isolation (iii) reliable assays to determine bacteria numbers, metabolic status and degree of acid tolerance (iv) proteomics approaches for identification of proteins involved in epithelial/bacterial interactions.

**Results:** A model of the oral mucosa where immortalized oral keratinocytes are grown in a flow cell has been developed. To obtain fresh isolates of oral streptococci, bacteria were harvested from the buccal mucosa and the predominant species identified as *S. oralis*, *S. mitis*, *S. salivarius* and *S. gordonii*. Using a combination of fluorescent staining and confocal microscopy, we have shown that both *S. oralis* and *S. gordonii* interact with keratinocyte cell surfaces and that binding of *S. oralis* is enhanced in the presence of a conditioning film. To identify key proteins involved in binding, cell-surface proteins have been

isolated from keratinocytes after biotinylation and separated using 2D-electrophoresis. To demonstrate acid tolerance in streptococci, a microscopic method where bacteria surviving after exposure to low pH are visualized by fluorescent staining has been developed.

**Conclusion:** We have established and tested a good methodological basis for this work and studies are now being undertaken to identify key molecules involved in binding bacteria to the oral mucosa as well as to investigate phenotypic changes in bacteria due to these interactions. In the longer term this work will aid our understanding the role of the oral mucosa in influencing the development of virulent phenotypes such as acid tolerance in oral streptococci.



### Dental implants in cerebral palsy

B Bergendal

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**Aim:** Dental implant treatment has been successfully carried out for 25 years with excellent long-term clinical results. But very little is known about outcomes and side-effects in individuals with rare disorders, mental disabilities, and chronic diseases - only two patients with cerebral palsy (CP) have been reported in the literature. These reports indicate that implants can be successfully placed and maintained, on condition that the patient adheres to a strict maintenance care programme and the patient's caretaker has been informed about the importance of good oral hygiene. The aim of this pilot study was to retrospectively evaluate experiences of oral rehabilitation with single tooth implants in individuals with cerebral palsy (CP) in Sweden.

**Material and Methods:** A questionnaire on treatment with single tooth implants in persons with CP was sent to 12 specialists in prosthetic dentistry. The questions aimed to collect information on reason for tooth loss, need for general anaesthesia and sedation, compromises compared to ordinary treatment, and complications, especially loss of implants.

**Results:** All 12 specialists answered the questionn-



▷ aire. Treatment had been performed at five centres in 11 individuals with CP and missing front teeth: 6 females and 5 males, born between 1966 and 1988. Nine (82%) had CP and a learning disability. Anterior tooth loss in 10 patients was due to trauma – often falling out of the wheel chair - and in one patient to tooth agenesis. Usually surgery, and sometimes all treatment, was performed under general anaesthesia or sedation. Nineteen implants were placed, 16 in the maxilla and 3 in the mandible. One was lost shortly after placement and reinstalled after one year. All implants and single tooth replacements were in service at the time of the inquiry.

**Conclusion:** This pilot study found promising treatment outcomes with frontal single tooth implants in individuals with CP. The dominating reason for loss of front teeth was trauma because of falls. Treatment indications were social and aesthetic and treatment was often strongly desired by the family. The ethical dilemma in treating persons who have no say of their own is one of the challenges of treatment planning in this group of individuals. Need for maintenance care and the long term results of treatment with dental implants in patients with CP ought to be further investigated.

◎ ◎ ◎ 5

**Salivary secretion after fractionated or single dose total body irradiation**

K Garming Legert, O Ringdén, M Remberger, G Dahllöf

Departments of Oral and Maxillofacial Surgery, Pediatric Dentistry, Institute of Odontology, Karolinska Institute and Center for Allogeneic Stem Cell Transplantation, Karolinska University Hospital, Huddinge, Stockholm, Sweden

**Aim:** Allogeneic stem cell transplantation (SCT) is an accepted treatment for patients with haematological malignancies. Modification of total body irradiation in fractionated schedules (fTBI) has enabled an escalation in total radiation dose. fTBI has been associated with less tissue toxicity compared to single-dose TBI. The aim of this study was to investigate if dose fractionation of TBI will result in less salivary dysfunction after SCT.

**Material and Methods:** Between January 1994 and

December 2005, 80 consecutive children below 12 years of age received allogeneic SCT. Sixty patients, old enough to cooperate to salivary sampling and who survived more than 1 year were available for follow-up. The children, diagnosed mostly with acute lymphoblastic leukaemia, either received cyclophosphamide (CY) in combination with 10 Gy of single-dose TBI (n=31) or CY in combination with fractionated TBI (3 Gy x 4; n= 29) on 2 days. Unstimulated saliva was collected during 10 minutes and paraffin-stimulated saliva was collected during 5 minutes.

**Results:** At baseline there were no differences in age, unstimulated or stimulated salivary secretion rate between the two groups. At the one-year follow up children treated with fractionated TBI had an unstimulated salivary secretion rate of 0.3±0.2 ml/min, a 14% reduction compared to baseline, the TBI-group had 0.1±0.1 ml/min, a 65% reduction (p<0.001). Regarding the stimulated salivary secretion rate children treated with fractionated TBI had a secretion rate of 0.9±0.5 ml/min, a 10% reduction compared to baseline, the TBI-group had 0.5±0.3 ml/min, a 55% reduction (p<0.01). The incidence of chronic graft-versus-host was similar in the two groups.

**Conclusion:** Fractionated TBI resulted in a significantly better salivary secretion rate one year after stem cell transplantation compared to single dose TBI, despite a higher total dose.

◎ ◎ ◎ 6

**Electropalatography**

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**Aim:** During the last years the Orthodontic Laboratory in Jönköping has specialised in intra-oral stimulation devices in close cooperation with the team of speech pathologists and dentists in the region. Manufacturing electropalatography(EPG)plates for the treatment of articulation disorders has not been available in Sweden. The aim was to make EPG-plates more accessible for the users.

**Material and Methods:** Dental technician John

Broughton, in Newbury, England was contacted and two dental technicians from Jönköping spent a week there of practical learning and training. Back in Sweden a test unit for the plates was built by an electrical engineer. Silver contact plates and copper electrodes for the plates are supplied by WASPs Electronic & Electromechanical Engineers in England.

**Results:** The training and set-up has been successful and after six months six EPG-plates have been made. Sixty-two small silver contacts are placed on the lingual surface of the hard palate connected with ultra-thin copper electrodes that are bundled together, 31 on each side. The bundles are protected by a thin silicone hose. The cast has been well extended behind the rear molars where the electrode bundles are placed. The electrodes have to be isolated from one another adding to the time-consuming work process. A plate takes approximately 16-18 hours to construct. Collaboration with other speech pathologists outside of the region has also been established.

**Conclusion:** The dental technician plays an important role in the oral motor teamwork involving individual intra-oral devices. EPG-plates are expensive and complicated to build. Having the production close to patients and teams increases the efficacy. Thus, new possibilities to use the method arise.



### **An advanced dental hygiene educational model for nursing home staff with an evidence-based approach for prevention of general health complications related to oral health status in elderly**

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**Aim:** To construct a framework for a dental hygiene educational model for nursing home staff, by integrating an advanced dental hygiene teaching strategy to an evidence-based literature database.

**Material and Methods:** An advanced dental hygiene

educational model for nursing home staff was constructed. A dental hygienist held lectures for small groups of nursing home staff (4-8 persons), with visual models, and hands-on training. An evidence-based literature database containing systematic reviews of clinical trials on the impact of oral health on systemic health in elderly was designed, initially focusing on the impact of oral health on respiratory tract infections and pneumonia. Search filters were constructed and literature searches were conducted in the Medline database. Reference lists of obtained publications were scrutinised. Publications fulfilling the inclusion criteria were selected for inclusion in the database.

**Results:** Initially, 178 potentially relevant publications were located in the database literature searches. The search filters had low accuracy, thus a large number of publications had to be located by hand-searching. Sixteen publications fulfilled the criteria for inclusion in the database. A framework for an educational model for dental hygiene education for nursing home staff was constructed, based on hands-on training, and lectures based on clinical evidence from systematically reviewed research.

**Conclusion:** This evidence-based educational model may prove useful for further improvement of oral care, and oral health status in elderly people in nursing homes, by increasing technical skills and motivation among the nursing home staff, integrating scientific evidence with technical skills among the nursing home staff, and by improving patient values.



### **Effect of environmental factors on quality of images displayed on two types of LCD monitors**

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**Aim:** To study the influence of different environmental conditions on image quality for two types of LCD monitors.

**Material and Methods:** Low-contrast objects in si-



▶ mulated CDRAD images were displayed on a standard colour LCD Dell 1907 Fpt monitor (Dell TM Round Rock, Texas USA) and on a VL191D Barten LCD monitor with grey-scale curves calibrated according to DICOM 14 (Olorin AB, Göteborg, Sweden). The walls behind the monitors were covered with 5 different colours: black, red, grey, white and green. Furthermore, both monitors, and each one of the coloured walls, were placed in a dental office with a yellow light colour temperature as well as in an office with a blue light colour temperature. The yellow and the blue lights were of similar illuminance. 12 subject, 6 women and 6 men between 26 and 45 years, examined the simulated CDRAD images. 6 subjects were dental clinicians with experience to interpret radiographic images while 6 subjects had no experience of radiographic images. After a thorough instruction of how to interpret the simulated CDRAD images, the observers registered the number of low-contrast objects they were able to detect in the images.

**Results:** No differences were found in low-contrast performance when the low-contrast objects in the simulated CDRAD images were displayed against different wall colours or in different environmental light colour temperatures. The DICOM 14 calibrated Barten LCD monitor yielded a significantly better low-contrast performance than the standard colour LCD monitor, irrespective of background wall colour or environmental light colour temperature.

**Conclusion:** The grey scale calibrated monitor provided a better image quality regarding low-contrast objects than the standard colour monitor. The environmental light colour temperature as well as the background wall colour had no impact on the display image quality.

◎ ◎ ◎ 9

### Bacterial consortia in dentine caries

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**Aim:** The aim was to investigate the acid tolerant microflora in established dentine caries lesions using

solid pH-selective media.

**Material and Methods:** Primary dentine caries lesions in 5 patients were sampled with a rose-bur at 3 levels: superficially, in the centre and the bottom of the lesion. Samples were incubated on neutral and pH-selective (pH 4.0, 4.5, 5.0, 5.5) agar. Numbers of colony-forming units (CFUs) were determined and colonies characterized morphologically and with enzymatic- and sugar fermentation tests.

**Results:** The total numbers of bacteria recovered from the pH-neutral agars did not decrease with lesion depth, whereas CFU recovery from low pH agars decreased with increasing agar acidity. The composition of the aciduric microflora varied both between subjects and between sample sites within the lesions. Gram-positive cocci were most abundant, but with lower pH and deeper sampling sites, the numbers of lactobacilli and other Gram-positive rods increased.

**Conclusion:** The results clearly indicate that many different microorganisms can be recovered on pH 5.5 agars and thus survive low pH environments. pH 5.5 is quite sufficient to moderately demineralize dentine, and aciduric microorganisms should thus have the potential to contribute to the dentine caries process. Solid pH agars are a useful tool in studying aciduric bacterial consortia.

◎ ◎ ◎ 10

### Spit and mail – could a salivary test be as simple?

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**Aim:** The main purpose was to compare the salivary test results from salivas stored and collected under different conditions, in order to simplify a salivary test. Salivary tests are often considered too complex and time consuming for use in the daily clinic.

**Material and Methods:** Ten persons participated in the pilot study. Day 1: An ordinary salivary test was performed i.e.: a Dentocult SM Strip mutans test was done according to the manual and 5-10 ml

whole paraffin-stimulated saliva was collected while time taken was noted. For estimation of Lactobacilli a Dentocult LB was used and Dentobuff Strip for the buffer capacity (Orion Diagnostica). The whole paraffin-stimulated saliva sample was then divided in to two: one part was stored in  $-20^{\circ}\text{C}$  and one part was stored in room temperature for 48 hours. A chewing gum-stimulated saliva test was also performed, as chewing gum might be easier to accept for small children. Day 3: The frozen saliva was thawed. The frozen stored and the room temperature stored salivas were then cultivated in the same way - using Strip mutans test, Dentocult LB and Dentobuff test. Day 3-7: The saliva results were analysed according to the manufacture's manual.

**Results:** For all ten subjects the Strip mutans, Lactobacilli and buffer capacity scores showed no differences between the different stored salivas. However, the chewing gum-stimulated saliva showed a one step decrease in Strip mutans score, though the Lactobacilli and the buffer capacity was stable. For nine subjects chewing gum stimulation resulted in a double fold secretion rate.

**Conclusion:** The results indicate that a "spit and mail" method may be reliable, though it needs to be further evaluated in a larger group when the salivas should be sent by mail!

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### Caries risk assessment in adults with dental restorations using Cariogram Model

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**Aim:** 1- Evaluate the caries risk in adult patients with several dental restorations using Cariogram. 2- to correlate Cariogram outcome, expressed as "percent chance of avoiding caries", with initial lesions DiS, DS as a predictor and number of restored surfaces as FS.

**Material and Methods:** Total of 175 individuals, between 17 to 56, years of age were randomly selected. All individuals were interviewed about their oral health, dietary habits and use of fluoride. Individuals were examined for caries clinically and radiographi-

cally. Saliva analyses, including mutans streptococci, lactobacilli, buffer capacity, and secretion flow rate, were obtained using a chair-side test

**Results:** The mean of the number of teeth, Di+mMFS, DiS and FS was 26, 53.8, 19.3 and 22.6, respectively. Individuals were divided according to Cariogram outcome into 4 caries risk groups; 0-20% (n=66), 21-40% (n=43), 41-60% (n=50), 61-100% (n=16). ANOVA test showed statistical significance between the groups with regard to DiS ( $p<0.01$ ), Di+mS, and FS ( $p<0.001$ ).

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### Evaluation of three fluoride treatments of initial root carious lesions

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**Aim:** The objective of this study was to evaluate the efficacy of three fluoride treatments to arrest initial root carious lesions

**Material and Methods:** Fourty patients participated in an open, randomised study. Of the 60 root carious lesions included, 20 were randomised for treatment with the chemo-mechanical technique Carisolv® and the fluoride varnish Duraphat (2.23% F), 20 with Duraphat only and 20 with a stannous fluoride solution (8%). The lesions were treated at baseline and after 3 and 6 months. A clinical evaluation and microbiological sampling was carried out at these three occasions and after one year.

**Results:** All but 4 lesions went to arrested caries during the one-year follow-up period, 18 in the Carisolv-Duraphat group and 19 respectively in the Duraphat and stannous fluoride group. There was a minor reduction in size, around 0.2 mm in height and 0.1 mm in width, of the lesions and a moderate change in colour from a lighter to a darker appearance during the period. There were no obvious differences found between the groups. The mean percentage of mutans streptococci in plaque from all lesions was around 4% at baseline and decreased to around 2% during the year. The decrease was, ho-



▶ however, not statistically significant and no significant differences were found between the groups.

**Conclusion:** Almost all of the initial root carious lesions in this study became arrested during the one-year period irrespective of fluoride treatment used

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### Uptake and release of fluoride impregnated chewing-sticks (Miswaks) in vitro and in vivo

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**Aim:** To investigate the uptake and release of fluoride (F)- impregnated chewing sticks (Miswaks) both in vitro and in vivo

**Material and Methods:** In Vitro, the first series, (10x4x3) 3-cm long pieces were impregnated in 1, 2, 3 and 4% NaF solutions for 3 hr, 1 day and 3 days (10 pieces/test). In the second and third series, 20+20=40 Miswaks pieces (10/test) were impregnated in 3% NaF for one day and 3 days; the outer cover was separated from inner spongy part and analysed separately In vivo, 9 healthy adult patients used three F products during 2 min with cross-over design: 1) a Miswak impregnated in 3% NaF for 1 day, 2) a Miswak impregnated in 3% NaF for 3 days, and 3) 1 gram of F toothpaste (containing 1450 ppm as NaF) on a tooth brush

**Results:** In 1st series, there was a clear dose-response effect with respect to both impregnation time and concentration of the F solution used. In 2nd and 3rd series, F was released from both parts, but somewhat more from the cover than from the inner part; a plateau was reached at around 30 min in both parts

**Conclusion:** NaF impregnated Miswaks showed a quick release of F in vitro as well as in vivo and may be as interesting vehicle for home care use in prevention of dental caries in those countries where they are used regularly.

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### Methods and materials in endodontic practice - a survey among Swedish dentists

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**Aim:** To investigate the present-day situation concerning materials and methods used in endodontic treatment by Swedish dentists and to compare the results with similar studies performed 10 and 20 years ago. The aim was also to find possible reasons to the discrepancy in success rate comparing students at the faculty with general practitioners.

**Material and Methods:** A postal questionnaire with 27 multiple choice questions was sent to 287 dentists in Sweden. General information about the dentists was requested as well as questions concerning methods and materials used in endodontic treatment and the frequency of different treatment methods.

**Results:** The response rate was 85%. The dentists performed endodontic treatment frequently. Root canal treatment was performed more frequently than pulpectomy. Root canal preparation was commonly done using a combination of manual and rotary instruments. The use of rotary instruments had increased compared with earlier studies. As canal irrigant sodium hypochlorite in a low concentration (0.5%) was used by a majority (73%). Calcium hydroxide paste was used as interappointment dressing by almost all. A few used camphorated phenol or iodine-potassium iodide even if the use of camphorated phenol had reduced considerably over a 20 year period. Nearly all of the clinicians used gutta-percha as root filling material. The majority (66%) combined gutta-percha with sealer while 43% combined it with rosin chloroform (HG). The use of sealer had increased. One visit endodontics was uncommon. Rubber dam was not used as a routine during emergency treatments by the majority of the dentists (70%), the use increased during the continued treatment but still 30% did not use rubber dam routinely. The use of rubber dam appears to be unchanged during the last two decades.

**Conclusion:** Compared with the results from earlier studies it was found that; the use of rotary instruments had increased considerably and root filling

technique using sealer had increased. Concerning the difference in success rate between treatments performed by students at the faculty and general practitioners several explanations are possible; one aspect that was obvious in this study was the reduced use of rubber dam among the general practitioners.

### 15

#### Long-term follow-up of root-filled teeth

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**Aim:** To investigate the long-term result after root canal therapy performed at an endodontic specialist clinic.

**Material and Methods:** Forty-nine necrotic infected incisors and premolars with radiographic signs of apical periodontitis were endodontically treated. All teeth were ultrasonicated during the root canal preparation procedure. When a negative bacteriological root canal sample was noticed the canals were obturated with gutta-percha in the rosin chloroform technique. Annual clinical and radiographic controls were performed for five years. A final follow-up examination was made after 20 years.

**Results:** Forty-six teeth could be examined for five years or until complete healing was verified. All teeth were free from symptoms and the radiographic examination showed a success rate of 91%. Three of the four failures underwent apical surgery. Meticulous histological examination of the biopsies showed an intraradicular infection in one case, an extraradicular infection in the second and a scar tissue healing in the third. At the 20 year follow-up 25 of the 46 teeth could be examined. Five teeth were extracted (none of endodontic reason). Other reasons of the dropping off were death of patients (11) unknown address (4) and one patient denied to come. All 25 teeth were free from symptoms and showed the radiographic criteria of complete healing. In four teeth an initial root filling excess had been resorbed during the 20 year period. In five teeth the root filling seemed to be 1-2 mm shorter 20 years later.

**Conclusion:** This study shows that endodontic treat-

ment of infected necrotic teeth performed with high aseptic technique will result in a high success rate. The long-term outcome after root canal treatment, where complete healing has taken place, is stable.

### 16

#### Non-specific chronic orofacial pain. A qualitative study of the patients' attitude to every-day life.

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**Aim:** The aim of this study was to analyse the attitude of the non-specific chronic orofacial pain patients to every-day life.

**Material and Methods:** Fourteen patients (11 female, 3 male) 21-77 years of age, were strategically selected among those referred to the Orofacial Pain Unit at the Faculty of Odontology, Malmö University, Malmö, Sweden. All selected patients agreed to participate. Data were obtained through thematic in-depth interviews, which exposed the context of the orofacial pain condition. The two interviews with each patient were audio taped and transcribed verbatim. The text material was analysed using a qualitative research strategy based on phenomenology.

**Results:** The preliminary results indicated that the patients expressed self-loathing, had difficulties in managing conflicts, especially concerning human relations and they often expressed fear, mainly directed to objects difficult to grasp. The consequences of the fear were avoidance and feelings of shame and guilt. More than half of the patients spontaneously also mentioned situations they were content with in every-day life.

**Conclusion:** The patients in this study showed limited ability to constructively handle certain difficulties in every-day life although a majority of the patients also brought up areas related to personal satisfaction.





### Time and spatially resolved detection of cells and gene expression in human implant-tissue interfaces using real-time PCR

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**Aim:** The aim of the present study is to examine the possibility to determine gene expression at implant surfaces during the early healing period by means of real-time polymerase-chain-response (real-time PCR).

**Material and Methods:** The project is addressing inflammation, bone formation, resorption and remodeling by means of selected genes. 16 partially edentulous patients participating in a prospective randomized controlled trial on immediate and delayed loading of dental implants were consecutively enrolled in this pilot study. Two days after one-stage implant placement, the test group of eight patients received fixed implant supported bridges (immediate loading), while in the control group of eight patients the implants were not loaded until three months after surgery (delayed loading). Crevicular fluid was collected using filter strips at two implants and one healthy tooth from each patient 2 days, 2 weeks, 4 weeks and 12 weeks after surgery. RNA attached to the strips was extracted, purified and converted to cDNA. Quantitative PCR assays for IL-1b, TNF- $\alpha$ , Osteocalcin, Alkaline Phosphatase, Cathepsin K, TRAP and 18S ribosomal RNA were designed and validated. Relative gene expression levels of these markers were calculated.

Parallel to these analyses clinical measurements were performed during the study period, including Resonance Frequency Analysis (RFA).

**Results:** A good correlation of healing parameters was found, such as ALP and osteocalcin gene expression with implant stability as measured by RFA. In failing implants, elevated gene expression levels of IL-1b and TNF- $\alpha$  correlated with decreased RFA values.

**Conclusion:** The analysis of clinical oral implants has hitherto been dependent on clinical evaluation and radiological examination. The presented technique is a promising non-invasive research tool in order to gain deeper understanding of the cellular and molecular events during implant healing.

**Acknowledgement:** The support from the VINNOVA financed program "Biomedical Development in Western Sweden" (BMV), the Swedish Research Council (grant K2006-73X-09495-16-3), and Nobel Biocare AB is acknowledged.



### Prevalence of Porphyromonas gingivalis, Mycoplasma pneumoniae and Chlamydia pneumoniae in the oral cavity in patients with coronary heart disease

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**Aim:** To study the prevalence of Porphyromonas gingivalis (Pg.), Mycoplasma pneumoniae and Chlamydia pneumoniae in a group of patients with coronary heart disease, and to correlate the prevalence to periodontal status.

**Material and Methods:** The study group consisted of 90 consecutive patients, 22 women and 68 men, aged 42-74 with stable or unstable angina pectoris. The patients were examined in the time period 2003-2007 by coronar angiography at the Cardiac Clinic, University Hospital of Linköping. The periodontal conditions were examined clinically (Lindhe & Nyman 1975) and by panoramic radiographs, at the Centre for Oral Rehabilitation, Linköping, Sweden. Patients were scored into periodontal disease experience groups according to Hugoson and Jordan (1982). Group 1 and 2 represent subjects with no boneloss, group 3 subjects with boneloss not exceeding 1/3 of the root length (moderate periodontitis) and group 4 and 5 boneloss exceeding 1/3 or 2/3 of the root length respectively (severe periodontitis). The presence / non presence of microbial DNA for Porphyromonas gingivalis, Mycoplasma pneumoni-

ae, Chlamydia pneumoniae was determined by PCR (Polymerase Chain Reaction) on subject level. Samples were taken from subgingival exudates in the four deepest periodontal pockets and from epithelial cells at the tongue, in the bucca and soft palate mucosa.

**Results:** The median number of teeth was 24 (1-32), the PLI % 36 (3-66), and the GI% 39 (9-80). In average the prevalence of periodontal pockets 5 mm or deeper with bleeding on probing was n= 4 (0-41). Pg. was found in 24 subjects (27%) in the total sample and in 36% of the subjects with severe periodontitis (group 4 or 5). None of the subjects of group 1 scored positive for Pg. In group 2; 5 subjects were positive for Pg, in group 3; 12 subjects, in group 4; 5 subjects and in group 5; 2 subjects. In the beginning of the study a number of patients were analysed by PCR for Mycoplasma pneumoniae and Chlamydia pneumoniae but we could not detect these microorganisms in any of the patients.

**Conclusion:** In this sample of patients with coronary heart disease, the prevalence of Porphyromonas gingivalis was related to the severity of periodontal disease. Preliminary, there is no indication for presence of Mycoplasma pneumoniae and/or Chlamydia pneumoniae.

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### LPS specifically enhances production of MCP-1 and IL-6 in human periodontal ligament cells

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**Aim:** The aim of the present study was to investigate the effects of LPS on the production of chemokines and cytokines in periodontal ligament cells (PDL cells) and if LPS affects functional characteristics of the cells, such as alkaline phosphatase (ALP) activity, collagen and DNA-synthesis. We also assessed if estrogen modulated the LPS-induced responses.

**Material and Methods:** Explants were obtained from the middle third of root surface from teeth extracted for orthodontic reasons. Cells were allowed

to migrate from explants and were used in passages 3-4. Aortic tissue was obtained from NMRI mice. Production of monocyte chemoattractant protein-1 (MCP-1), IL-6 and C-reactive protein (CRP) were assessed using ELISA. Transcriptional activity of macrophage inflammatory protein-2 (MIP-2) gene was examined using real-time RT-PCR. ALP activity was measured using a substrate solution and read colorimetrically. Collagen and DNA-synthesis were measured using the radiolabeled isotopes proline and thymidine, respectively. The measurements were corrected to the total amount of protein according to the Lowry method.

**Results:** LPS enhanced the production of MCP-1 and IL-6 in PDL cells in a time and dose dependent manner, but had no effect on CRP production. The effects of LPS in PDL cells were not reversed by estrogen. LPS did not affect ALP activity, collagen and DNA-synthesis in PDL cells. LPS enhanced the transcriptional activity of MIP-2 in smooth muscle cells (SMCs). LPS induced MIP-2 was attenuated by a physiological concentration of estrogen (100nM).

**Conclusion:** LPS enhances the production of MCP-1 and IL-6 in PDL cells in a specific manner. LPS induced MCP-1 production in PDL-cells suggests an important role of PDL cells in recruiting leucocytes to the periodontal ligament. Down-regulation of MIP-2 gene by estrogen suggests that estrogen exerts an anti-inflammatory effect via this mechanism.

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### The influence of periodontal treatment on interleukins in blood

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**Aim:** The purpose was to investigate if interleukins and cytokines, which is associated with a risk for atherosclerosis, in patients with periodontitis are different compared to an healthy group and to investigate if these risk markers could be changed by periodontal treatment.

**Material and Methods:** A total of 69 patients (37 men) between 38-73 years of age, mean



▶ 53,6 with severe periodontitis and 48 healthy controls (23 men) between 39-69 years of age, mean 53,0 were investigated. A fasting venous blood sample was taken and plasma was analysed for different interleukins and cytokines which are associated with atherosclerosis development such as TNF $\gamma$ , IL 1 $\gamma$ , IL-4, IL-5, IL-8, IL-10, IL-18 and IFN $\gamma$  at baseline. Among the patients 3 additional blood samples was taken during periodontal treatment 3, 6 and 12 months after initial treatment and baseline.

**Results:** IL-4 levels were lower in-patients (19,6 vs. 52,9,  $p < 0.025$ ) and also IL-8 levels were lower ( $p < 0.025$ ) as well as IL-10 (4,13 vs. 5,87,  $p < 0.05$ ). The IL-18 levels were higher ( $p < 0,005$ ) compared to the controls, whereas IFN $\gamma$ , IL-5 and IL-6 did not show any difference. Regarding changes after periodontal treatment, limited changes were seen, IL-18 and IFN $\gamma$  decreased significantly ( $p < 0.001$ ), the other cytokine levels did not change.

**Conclusion:** This study indicates that patients with periodontitis have lower levels of anti-inflammatory cytokines compared to the controls. The pro-inflammatory cytokines are, however, the same between the groups. Periodontal treatment seems to have limited influence on the cytokine levels. However, some cytokines such as IFN $\gamma$  and IL-18 are influenced in a positive way. These new findings strengthens the association between periodontitis and cardiovascular diseases.

◎ ◎ ◎ 21

### Oral health status of patients with Inflammatory Bowel Disease

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**Aim:** To determine the prevalence of periodontal disease, the decayed, missing and filled teeth (DMFT) index and oral manifestations of inflammatory bowel disease (IBD) in Crohn's disease (CD) and ulcerative colitis (UC) patients.

**Material and Methods:** Ninety nine CD patients (39.0 SD  $\pm$  12.9 years), 80 UC patients (43.3 SD  $\pm$  13.2) and 74 healthy controls (40.3 SD  $\pm$  12.9) were examined. Periodontitis was estimated as at least 4

sites with clinical attachment loss (CAL)  $\geq$  3mm. The periodontal examination included probing pocket depth (PPD), CAL, bleeding on probing (BOP) and presence of plaque. The dental conditions were evaluated by DMFT index. The intra oral examination for assessing mucosal lesions was performed by visual inspection and digital palpation.

**Results:** Significantly more periodontitis was observed in UC (95.0%,  $p = 0.004$ ) and CD (91.9%,  $p < 0.001$ ) than in controls (79.7%). UC showed significantly more CAL (1.3 mm,  $p = 0.004$ ) and number of sites with CAL  $\geq$  3mm (22.8%,  $p = 0.007$ ) than controls (1.2mm and 11.7%, respectively). UC patients showed higher CAL ( $p = 0.005$ ) and higher number of sites with CAL  $\geq$  3mm ( $p = 0.006$ ) than CD (0.9 and 13.2%, respectively). The DMFT index was significantly higher in UC (16.4,  $p = 0.020$ ) and CD (15.1,  $p = 0.016$ ) patients compared to controls (12.5). UC patients had significantly less teeth (22.0,  $p = 0.002$ ) than controls (25.0). There were no significant differences in the prevalence of oral lesions between the groups. Altogether, we diagnosed 20 candidiasis lesions (CD n=8, UC n=8, controls n=4), 3 ulcerous aphtous (CD n=2, UC n=1) and 5 lichen planus lesions (CD n=1, UC n=3, controls n=1).

**Conclusion:** CD and UC patients had a higher prevalence of periodontitis and DMFT index than controls. The periodontal destruction differed between these groups and was most pronounced in UC patients.

◎ ◎ ◎ 22

### Implant treatment of patients with edentulous jaws. A 20 year follow-up

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**Aim:** The aim was to investigate the outcome of implant treatment with fixed prostheses in edentulous jaws after 20 years.

**Material and Methods:** The patient material was a group of patients treated in the early 80's. The original patient group comprised the first 48 consecutive patients treated with implant-supported prostheses

at Umå University. All patients were edentulous in one or two jaws. The patients had a mean age at the implant insertion of 54.3 years. At the planning of this study twenty years after treatment, 19 of the 48 patients were found to be deceased. Of the 29 patients still alive, 21 patients with altogether 23 implant-supported bridges could be examined clinically and radiographically. All patients were treated ad modum Brånemark with a 2-stage surgical procedure. The implants had a turned surface. Abutment connections were performed three to four months after fixture insertion in the mandible and after a minimum of six months in the maxilla. The prostheses were fabricated with a framework of gold alloy and acrylic artificial teeth.

**Results:** The 21 patients (with 23 implant-supported prostheses) examined, had at the treatment got 123 implants ( 27 in the upper jaw and 96 in the lower jaw), inserted. Only one of these implants had been lost ( about two years after loading) giving a survival rate of 99.2% Very small changes occurred in the marginal bone level. Between the 1-year and 20-year examinations, the mean bone loss was 0.53 mm and the mean bone level at the final examination was 2.33 mm below the reference point

**Conclusion:** This follow-up over two decades of implant-supported prostheses demonstrates a very good prognosis for the treatment performed. The frequencies of peri-implantitis , implant failures or other complications were very small and the original treatment concept with a 2-stage surgery an a turned surface of the implants will obviously give very good results.

◎ ◎ ◎ 23

### **Natix used as Osteoconductive material for sinus floor augmentation. Three years follow up. Case report**

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**Aim:** Porous titanium granules (Natix, Tigran Technologies, Sweden) used as non-resorbable osteoconductive bone substitute, in sinus floor augmentation.

**Material and Methods:** A 73 year old woman needed a sinus floor augmentation in the left sinus to get a

dental implant in the region of 24 and 25. The residual bone height was 2-4 mm. Grafting and installation of the dental implant was done in the same session. In the sinus lift procedure the window of the lateral bone wall was left attached to the sinus mucosa. Before the two fixtures, Microthred, 11 and 13 mm in length and 4.0 mm in diameter (Astra Tech AB, Mölndal, Sweden) were installed, the fixture sites were prepared and the titanium granules packed into the sinus. The fixtures got a good stability when they were installed into the titanium granules. Five months after the fixture operation, the abutment operation was performed and three weeks later the prosthodontic work was in place.

**Results:** The patient has been followed in three years after the abutment operation. The clinical and X-ray examination show a very good result with a healthy gingival margin and a stable marginal bone level.

**Conclusion:** Titanium granules seem to function as augmentation material in sinus floor.

◎ ◎ ◎ 24

### **Osteotome sinus floor elevation and simultaneous placement of implants**

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**Aim:** The bone support for implants in the posterior part of the maxilla is often poor. This condition may be treated with augmentation of the maxillary sinus floor. The most common technique used is to elevate the sinus floor by inserting a bone graft through a window opened in the lateral antral wall, although less invasive techniques with osteotomes have been used since 1994. **Purpose:** The aim of this study was to evaluate the clinical and radiographic outcome of implants placed in the posterior maxilla with the osteotome sinus floor elevation (OSFE) technique without grafting.

**Material and Methods:** The study population comprised 36 consecutive patients in whom 53 implants were inserted with the OSFE technique. The indication for sinus floor elevation was that the bone height below the maxillary sinus was considered to be 10 mm or less.

▶ **Results:** The mean height of the alveolar process in the intended implant sites was 6.3±0.3mm and the mean elevation of the sinus floor was 4.4 ± 0.2 mm. At the 1-year follow-up two implants had been lost, both in edentulous patients. The remaining 51 implants inserted were in function giving a one-year cumulative survival rate of 96 %. Implants used in single tooth replacements and in partially edentulous cases had a 100% survival rate. The mean marginal bone level at the time of loading of the implants was 0.1±0.04 mm below the reference point. One year later the corresponding value was 0.5±0.06 mm. The mean bone loss between the two examinations was 0.4±0.05 mm.

**Conclusion:** Conclusions: The osteotome sinus floor elevation technique (OSFE), without bone-grafts, was found to produce predictable results in the treatment of 36 patients with restricted bone volume in the posterior part of the maxilla.

◎ ◎ ◎ 25

### Submerged healing following treatment of peri-implantitis using a bone substitute and a resorbable membrane

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**Aim:** The aim was to study a regenerative surgical treatment modality for peri-implantitis using a bone substitute, resorbable membrane and submerged healing.

**Material and Methods:** Twelve patients, having a minimum of one osseointegrated implant with peri-implantitis, with a progressive loss of ≥3 threads (1.8 mm) following the first year of healing were involved in the study. After surgical exposure of the defect, granulomatous tissue was removed and the implant surface was treated using 3% hydrogen peroxide. The bone defects were filled with a bone graft substitute (Algapore), a resorbable membrane (Ossequest) was placed over the grafted defect and a cover screw was connected to the fixture. The implant was then covered by the flaps and submerged healing was allowed for 6 months. After 6 months the abutment was reconnected to the suprastructure.

**Results:** 1- year follow up demonstrated clinical and radiographic improvements. 87% of the implants did not bleed on probing. Probing depth was reduced by 4.2 mm, probing attachment gain was 1.4 mm and mucosal recession was -2.8 mm. A mean defect fill of 2.3 mm was obtained. 81% of the implants had a defect fill of ≥1.2 mm.

**Conclusion:** Treatment of peri-implantitis defects using a bone substitute combined with a resorbable membrane and submerged healing, results in defect fill and clinical healthier situations.

◎ ◎ ◎ 26

### Strong antibacterial effect of Miswak against oral microorganisms associated with periodontitis and caries

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**Aim:** In many parts of the world the chewing stick (miswak) is used for oral hygiene. As well as a mechanical removal of plaque, an antibacterial effect has been postulated, but tests of miswak extract from *salvadora persica* (Arak) have disclosed only low to moderate antibacterial effects. This may be attributable to the extraction process. Our aim was to test, in vitro, the antibacterial effect of miswak pieces without extraction, on bacteria implicated in the aetiology of periodontitis and caries.

**Material and Methods:** Miswak pieces were standardized by weight and size, and then tested against *Streptococcus mutans*, *Lactobacillus acidophilus*, *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, and, as a reference, *Haemophilus influenzae*. The miswak pieces were tested in two ways, embedded in the agar plate or suspended in the air above the agar plate. Smaller miswak pieces were used to test the dose effect.

**Results:** The inhibitory effect was most pronounced on *A. actinomycetemcomitans*, *P. gingivalis*, and *H. influenzae*, less on *S. mutans*, and least on *L. acidophilus*. The median inhibition zone of 0.14g embedded miswak for *A. actinomycetemcomitans* was 10.9 cm, *P. gingivalis* 14.0 cm, *H. influenzae* 9.3 cm, *S. mutans* 3.2 cm, and for *L. acidophilus* 1.4 cm.

Suspended 0.14g miswak had comparable or stronger effects than miswak embedded in agar. The test with smaller miswak pieces showed a dose response effect.

**Conclusion:** Miswak embedded in agar or suspended in the air above the agar plate had strong antibacterial effects, greater against Gram negative than Gram positive bacteria. The antibacterial effect of suspended miswak pieces suggests the presence of volatile active antibacterial compounds.

◎ ◎ ◎ 27

### Periodontal and cariological status of adults of Karachi, Pakistan

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**Aim:** The aim of the study was to survey the oral health status, cariological and periodontal of an adult urban population in Pakistan.

**Material and Methods:** Those who answered the questionnaire (994) in our earlier study, every tenth person was given an invitation to come for clinical and radiological examination. Total were 110 persons, 57 men and 53 women, were examined.

**Results:** The participants had an average 25 teeth. Plaque, bleeding on probing, calculus and gingival recession was prevalent in this population. Men had significant more bone loss compared to women, odds ratio 3.4 ( $p < 0.002$ ). Older age group had more bone loss as compared to the younger age group, odds ratio 10.8. Individuals using toothbrush had a tendency to bleed less on probing, and less bone loss as compared to the finger users ( $p < 0.15$  and  $p < 0.02$ ). The number of caries lesions was low ( $2.1 \pm 2.7$ ). Females had more decay than men, odds ratio 7.75. Chalia users had more decayed teeth ( $2.6 \pm 3.3$ ) than pan users ( $1.5 \pm 1.9$ ). Participants cleaning their teeth daily had fewer fillings as compared to occasional cleaners ( $0.6 \pm 1.2$  vs  $1.5 \pm 2.1$ ). Individuals using toothbrush had more decay as compared to finger users ( $2.3 \pm 2.9$  vs  $1.9 \pm 1.4$ ). However, our results did not reach significance.

**Conclusion:** The findings show that this population

does not require major restorative treatment, preventive work like scaling, minor fillings, propagation of oral hygiene habits and education regarding dental health would improve oral health considerably in this population.

◎ ◎ ◎ 28

### Short-term effect of Surgically Assisted Maxillary Expansion (SARME) on nasal respiration and nasal airway size. Subjective and objective measurements

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**Aim:** To evaluate how SARME effect the minimum nasal cross-sectional area (MCS) 3 month after surgery and if there are any correlations between an improved nasal breathing and an alteration in MCS.

**Material and Methods:** The sample consisted of a consecutive and prospective material of 29 individuals, 15 men and 14 women (mean age, 19.4 years SD 4,5) treated with a SARME in accordance to Glassman et al., 1985. Indication for treatment was maxillary transverse discrepancy. The subjects were submitted to acoustic rhinometry (Rhinoscan) to determine the minimum cross sectional area in the anterior part of the nose (0,0-2,2 cm) and in the posterior part of the nose ( 2,2-5,4 cm ) before and 3 month after surgery. To asses nasal congestion before and after surgery, a validated ENT-questionnaire was given to the patients.

**Results:** There was a in the whole sample ( $n=29$ ) a significant larger MCS post surgery ( $P < 0.05$ ) both anteriorly and posteriorly, but no significant difference concerning nasal congestion before and after. The expansions were significantly more pronounced in the posterior part of the nasal airway ( $P < 0.05$ ) than in the anterior part. However, those who subjectively exhibited nasal congestion before surgery ( $n=14$ ) showed after surgery a significant improved subjective nasal breathing ( $n=11$ ,  $p < 0.05$ ). We found

▷ also in this group a significant correlation between the pre and post MCS in the anterior part of the nasal airway ( $p < 0.001$ ), which was not obvious in the posterior part. There were likewise in this group a significant larger expansion in the posterior part of the nasal airway ( $p = 0.005$ ). Individuals who post surgery showed subjectively improved nasal breathing ( $n = 11$ ) were individuals with initial significant more narrow MCS ( $p < 0.005$ ) in the anterior part of the nasal airway and the post surgery expansions were very moderate.

**Conclusion:** The SARME increase the nasal minimum cross sectional area (MCS), both anteriorly and posteriorly

There is after SARME a significant correlation between subjectively improved nasal breathing and an initial narrow cross sectional area in the anterior part of the nasal airway.

◎ ◎ ◎ 29

### Clinical evaluation of a pre-manufactured activator.

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**Aim:** The aim of this study is to evaluate clinical instructions, effect on overjet, overbite and patients' adaptability to a pre-manufactured activator before starting a longitudinal multicenter study comparing conventional activator with a prefabricated one.

**Material and Methods:** In three Public Dental Clinics in Halland County Council, 12 patients (7-10 years) with an overjet  $> 6$  mm were consecutively selected for treatment with a pre-manufactured activator (LM-aktivator). Other malocclusions were excluded. They were registered using extra- and intraoral digital images, casts and clinical registrations including measurements of overbite and overjet. At each visit the patients were interviewed regarding problems caused by the appliance. The evaluation period was 12 months.

**Results:** The reduction of overjet and overbite, for all of the 12 patients was approximately 59% and 53%, respectively. For the 3 best patients with normal signs of cooperation a mean reduction in

overjet and overbite was 76 % and 75% respectively. Poor cooperation was observed in three patients due to soreness (one patient) and breathing problems (two patients), which resulted in a slightly longer treatment time than the group with good cooperation.

**Conclusion:** The results from this study on the pre-manufactured activator showed a reduction of the overjet and the overbite. No drop-outs indicate a good adaptability to the appliance. The activator was tolerated well by the patients and the majority of the patients stated that it was comfortable to use it.

◎ ◎ ◎ 30

### Oral health in individuals with Homocystinuria

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**Aim:** The aim of this study was to do, as far as we know, the first comprehensive study of the oral health in individuals with the diagnosis of homozygote cystathionine beta synthase (CBS) deficient homocystinuria, a rare disorder of amino acid metabolism, affecting connective tissue. It was also aimed to evaluate if the oral observations reported in medical case reports of high narrow palate, mandibular prognathia, crowding and early eruption of the teeth, could be referred to individuals suffering from this kind of severe homocystinuria, in Sweden.

**Material and Methods:** All departments of medicine, internal medicine, eye and rehabilitation in every hospital in Sweden were contacted, which resulted in 15 individuals, participating in the study. 14 individuals participated in both clinical oral examination and dental records from the general dentist in charge, and one individual participated only with anamnestic data and dental records required from the general dentist.

**Results:** Registrations made, showed great heterogeneity according to oral findings and oral health, which are described in this study. Compared to oral observations reported in previous case reports, a high narrow palate was found in only one of the individuals, and no one suffered from mandibular

prognatia. Space deficiency more than 4mm was present in 7 of 12, and early eruption was noted in 4 of 6, individuals. However, short roots were found, when the root crown ratio of maxillary central incisors in 11 of 12 subjects were compared to reference values used. The finding of low root crown ratio has not been previously reported.

**Conclusion:** It seems as if there is a discrepancy in oral findings in individuals suffering from severe homocystinuria in this study, when compared to oral observations reported in medical case reports. The finding of short roots in this study, has not been previously reported. Further questions to be answered and examined are if the affected connective tissue - with excessive free sulfhydryl and amino groups of homocysteine in the extracellular matrix, in these individuals, has a role in the finding of low root crown ratio, and maybe the increased crowding in the dental arches. According to our findings in this study, though, when referred to clinical work, it is strongly advisable that root length should be carefully analyzed before orthodontic, prosthodontic, periodontal and endodontic treatment in patients with homozygote CBS deficient homocystinuria.

31

**Long-term treatment outcomes for ectopic maxillary canines, to evaluate root resorption.**

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**Aim:** To monitor the fate of the maxillary incisors with root resorptions in patients treated in Jönköping, Sweden, up to 28 years ago, for severely ectopic maxillary canines.

**Material and Methods:** The records of 39 patients were found: 35 could be contacted and 25 agreed to participate in the study. Thus the material comprised a total of 37 incisors in the 25 subjects. The post-treatment follow-up times ranged from 13 to 28 years. Clinical examination was followed by intraoral radiographs and CT. The degree of resorption was collated with the clinical characteristics of the incisor. Resorptive lesions were described in detail and

the intraoral radiographs were compared with those taken immediately post-treatment.

**Results:** In all, 22 incisors with root resorption were identified. In 17, the lesions were unchanged. Resorption had improved in 2 cases and aggravated slightly in two. In one case, the resorption had progressed to the pulp, necessitating endodontic treatment. Two subjects had lost 3 incisors post-treatment. Most of the resorptive sites showed enhanced definition of the periodontal ligament and improved trabeculation of the lamina dura, indicating inactive sites. Incisors with resorption exhibited no clinically distinguishable characteristics.

**Conclusion:** Although based on a limited material, the results suggest that incisor root resorption induced by an ectopic maxillary canine does not tend to progress post-treatment and should not threaten the long-term viability of the affected incisors. Teeth with root resorption show no clinically relevant symptoms at follow-up.

32

**Duration of orthodontic treatment involving orthognatic surgery**

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**Aim:** The purpose of this study was 1) to analyse factors influencing the duration of treatment time and 2) to examine if there is any relationship between the duration of orthodontic treatment and type of malocclusion, sex, number of ordinary/acute visits in a sample of patients who have had combined orthodontic/orthognatic surgery. This was in order to give orthognatic surgery patients realistic expectations about the treatment time and consequently enhance their satisfaction with the treatment.

**Material and Methods:** This is a retrospective study based on the orthodontic records of patients treated with orthognatic surgery in the period between year 2000 and 2005 at the surgery clinic (Department of Dentofacial orthopedics). The study includes 207 of

▶ 233 patients (107 females and 100 males) in the age of 15,8-56,9 years (median 24,2 years) at the time for surgery. Fifty-nine patients had their orthodontic treatment at the surgery clinic and 148 patients at six public orthodontic clinics. Twenty-six patients were excluded because they had syndrome diagnosis.

**Results:** The mean value for duration of presurgical orthodontic was 19,2 months (range 2,4-68,4), for postsurgical orthodontic 4,6 months (range 0-18,8) and for total orthodontic 27,8 months (range 5,9-79,1). Duration of preoperative (16,7 months) and total orthodontic treatment (25 months) was significantly shorter at the surgery clinic. However the postsurgical orthodontic treatment was significantly longer at the surgery clinic (4,1 months). There was no statistically significant difference neither between duration of the treatment and sex/malocclusion or between the number of ordinary/acute visits and malocclusion/sex. The surgery clinic had significantly fewer ordinary visits than the others but there was no significant difference in number of acute visits.

**Conclusion:** We found that the total treatment time was significantly reduced when the orthodontic was performed at the surgery clinic.

◎ ◎ ◎ 33

### The Neonatal Line - in an ultra structural view

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**Aim:** At birth, all primary teeth are in progress of mineralization. A distinctive, incremental line in the enamel and dentin is seen which corresponds to the time of birth, termed; The Neonatal Line (NNL). The aim of this study was to analyze the ultra structure of the neonatal line.

**Material and Methods:** The lower right mandibular teeth were removed from infants who had died at different ages after birth. The tooth germs were then stored in cold neutral formalin until processed into ground sections. The teeth were orientated and embedded in methylmethacrylate and serially sec-

tioned longitudinally in a bucco-lingual direction with a Leitz low speed saw microtome, to a thickness of about 120 µm. After a histological examination in polarized light, the sections were prepared for scanning electron microscopy (SEM). The sections were etched for 30 seconds with 30 % phosphoric acid and carefully rinsed with de-ionized water. For the SEM analysis, the sections were sputter-coated with either carbon or gold by vapor deposition. The sections were examined in a Philips SEM 515 and 3-D images were made. The SEM examination was carried out in a field emission scanning electron microscope (Gemini IMB, LEO 1530, Germany).

**Results:** In the SEM, the NNL was clearly observable in lower magnifications (40x), however, becoming more difficult to distinguish in higher magnifications. Analyzed data showed a change in diameter between the enamel prisms located pre- and post-natally to the neonatal line. A change in growth direction of the prisms was found in the region of the NNL. In the 3-D images at 400 times magnification the neonatal line was readily observable and visible as an indentation in the enamel with a noticeable depth and width.

**Conclusion:** The neonatal line is visible due to a change of direction of growth and a change of the diameter of the prisms. The NNL was seen as a marked indentation in the 3-D pictures.

◎ ◎ ◎ 34

### How can our GA patients cope with dentistry in the future?

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**Aim:** To study the handling and treatment of child patients treated under general anesthesia (GA) at two Specialist Clinics for Pediatric Dentistry within Region Skåne, Sweden. · To study the compliance of the patients and their families concerning recalls, dental examination and cooperation in the dental office during the first two years after treatment under GA. · To study follow-up, risk evaluation and treatment need during two years after GA. · To estimate

possible further needs of treatment or consultation at a Specialist Clinic for Pediatric Dentistry.

**Material and Methods:** Data were assembled concerning 289 healthy children, aged 4-14 years, treated under GA 2002 and 2003 in the Specialist clinics for Pediatric Dentistry in Lund and Helsingborg within Region Skåne. Criteria for inclusion in the study were "behaviour management problems and/or dental anxiety", "pathological conditions in jaws and teeth" and "high caries activity and/or extensive treatment needs". Data from the specialist clinic were name of remittent and clinic, date of referral, date of treatment, number of teeth filled and extracted and occurrence of postoperative pain. From the remittent, data were assembled considering prophylaxis before and follow-up after GA, compliance concerning visits to the regular dentist, cooperation at examination and prophylaxis visits, further treatment needs, cooperation to the treatment needed and future caries risk evaluation. At the visit two years after GA, the regular dentist was asked to evaluate the further needs of specialist care for each patient. Data were processed and statistical analysis performed.

**Results:** The patients were divided into two groups, 4-6 years old and 7-14 years of age. Data from the two clinics were processed together. 43% of the total amount of children had a non-scandinavian ethnicity. In the younger group, this share was 58%. The treatments were comprehensive with a mean value of 5.9 for extracted teeth and 4.2 for filled teeth in the younger group and 4.9 and 3.6 respectively in the older group. Postoperative pain was registered in 4 patients. Data from the 2 year examination were obtained for in all 230 children. 93% cooperated to examination and prophylaxis. 87 (38%) needed treatment, 21 did not cooperate to the operative treatment needed. There was no difference between agegroups. The future need for specialist care was recorded for 230 patients. 70% were not supposed to need such care, 18% were supposed to need specialist care and for 12% no opinion was available.

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## About Anton

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**Aim:** Hypohidrotic ectodermal dysplasia (HED) is a rare disorder that involves symptoms from teeth, hair, nails, and sweat glands. The severity of the symptoms vary, but can for many families be a source of daily worries and complications. The unsatisfactory heat regulation due to lack of sweat glands may cause abnormally elevated body temperatures as a reaction to warm weather, physical exercise, or mild infections. This can be especially severe in infants. Therefore early diagnosis is important, but it is, however not often made until the first tooth erupt - or doesn't erupt. The dentist should refer the patient to a medical specialist in order to confirm the correct diagnosis. This project was aimed to increase knowledge about HED among dental and medical professionals, school and day-care personnel as well as affected families.

**Material and Methods:** A family with a 2-year-old boy diagnosed with hypohidrotic ectodermal dysplasia was filmed and the parents interviewed.

**Results:** The interviews and film have been edited and put together to a 10 minute long documentary about getting the diagnosis, strategies for coping, and information about dental care now and in the future.

**Conclusion:** Hypohidrotic ectodermal dysplasia is not seldom over-looked in early child health care. There is a need to increase knowledge about HED among dental and medical professionals. A short and appealing DVD film on a rare syndrome can be a useful tool.



 36

### A retrospective study of etiology and emergency treatment of avulsed permanent teeth during 1972-2001

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**Aim:** To investigate if alterations, in etiology and treatment during three decades, have had any influence on the final outcome of treatment of avulsed permanent teeth.

**Material and Methods:** A group of 180 patients with the total of 241 avulsed permanent teeth were studied. The patients were treated at the Department of Paediatric Dentistry, Institute for Postgraduate Dental Education, Jönköping Sweden. The study is based on retrospective observations of dental records and is the first part of an investigation regarding the outcome of treatment of avulsed permanent teeth. Information regarding etiology, emergency treatment and the management of complications have been noted. In order to visualize changes of these aspects over time, the results have been presented divided into three decades.

**Results:** An equal number of avulsed teeth were treated in all three decades. Of the 241 avulsed teeth, 20 % were not replanted. More boys than girls were involved in accidents causing exarticulations, although the number of accidents involving girls has increased during the last decade. Maxillary incisors are most commonly involved and the study also showed that most accidents happen at the ages of 8 to 9 years. A few of the accidents that happened at 18 to 19 years of age they involved boys only. It could also be noted that bicycle accidents increased during the second decade. Sixty-six % of the avulsed teeth were replanted within 3 hours. Milk has become the most commonly used transport medium for avulsed teeth during the two last decades. Type of fixation has during the time span studied altered from dental splint to steel wire-composite fixed appliances. Fixation time has decreased during the three decades. In a future study, the relationship between these background factors and the long term treatment results of avulsed permanent teeth will be examined.

 37

### Healing of root fractures treated with short or long splinting time

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**Aim:** The objective was to study the healing of intra-alveolar root fractures after a short splinting time (1–3 weeks) and those with a long splinting time (1–3 months).

**Material and Methods:** The material consisted of 42 teeth with intra-alveolar root fractures and short splinting time treated at the Institute for Postgraduate Dental Education in Jönköping 1973–2002, 17 teeth with short and 324 teeth with long splinting time from Eastman Institute (Stockholm) and 60 teeth from Rigshospitalet (Copenhagen) with long splinting time. Radiographs and case report forms from the individuals were used in the evaluation which was done according to the criteria presented by Andreasen et al 1994. All individuals were in the ages 6-19 years and the follow up time was more than 12 months.

**Results:** Healing after short splinting time showed no significant difference in healing pattern between Jönköping and the Eastman Institute. The success rate for healing was the same after short (Jönköping 85 %) and long (Rigshospitalet 75 %, Eastman Institute 77 %) splinting time. There was a difference in distribution of teeth with hard tissue healing after long splinting time (Rigshospitalet 38 %) compared with short splinting time (Jönköping 22 %). In teeth having root fractures with a small diastase ( $\leq 1$ mm) failures were significantly more common after long splinting time (Rigshospitalet 28 %) compared with short splinting time (Jönköping 8 %).

**Conclusion:** There seems to be small differences in the healing pattern of intra-alveolar root fractures after short or long splinting time although a long splinting time seems to increase the possibility of hard tissue healing but also an increased risk for pulp necrosis/granulation tissue formation. Further evaluation and analyse of this material will be presented.

38

### Effects on blood pressure after treatment of obstructive sleep apnea with an oral appliance with mandibular advancement, a 3 year follow-up.

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**Aim:** The study purpose was to investigate if reduction of obstructive sleep apnea with oral appliance therapy (OA) affects blood pressure (BP) in hypertensive patients in a short-term and long-term perspective.

**Material and Methods:** Twenty-nine consecutive patients with verified obstructive sleep apnea (OSA); defined as apnea index (AI) > 5 and/or apnea-hypopnea index (AHI) >10/hours, received as a treatment an OA with mandibular advancement. The reference BP was measured at 3 study visits; before treatment, after 3 months and after 3 yrs of treatment, respectively. The BP was measured twice at those visits with an automatic unit and the second value was registered as the BP of the visit. The treatment effect of OSA was measured after 3 months use by a repeated somnographic registration wearing the OA. At this short-term evaluation after 3 months the patients were asked about the compliance and the frequency of OA use nights/week. At the long-term follow up after 3 years use of OA the patients answered questions about altering in and hypotensive medication, frequency in use of OA (nights/week), weight gain or loss and a self-report of general well-being. A complete response to treatment was considered as success when a normalization of nightly breathing occurred, defined as AHI<10.

**Results:** Between baseline and the short-term evaluation 4 patients changed treatment. A complete treatment response of OSA was achieved in 25 of 29 patients. The remaining 25 patients were called for a long-term follow-up after 3 years. Three patients were unable to participate. At the 3 years follow-up the remaining 22 treated patients had a statistically significant reduction for the systolic BP of -15.4mm Hg and for the diastolic BP of -10.3mm Hg. This significance was received between baseline and the short-term evaluation ( $p < 0.001$ ), and, remained at

the long-term follow-up. All 22 patients reported a good general well being after 3 years of treatment.

**Conclusion:** OA therapy reduced blood pressure in both short-term and long-term perspectives in patients with OSA and hypertension.

39

### Systemic serotonin influences bone tissue destruction of the temporomandibular joint in rheumatoid arthritis

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**Aim:** The aim of this study was to investigate if systemic serotonin (5-HT) influences longitudinal changes of temporomandibular joint (TMJ) structural changes in patients with rheumatoid arthritis (RA).

**Material and Methods:** Seventeen patients, 15 females and 2 males, with a median (25th/75th percentile) age of 47 (35/56) years with RA and TMJ involvement were included. Radiographic examination of the TMJ regarding caput and temporal extension of erosions as well as bone loss was performed twice with a median interval of 33 (29/37) months. The change in extension of erosions or bone loss between the two examinations was also assessed for each patient. Venous blood samples obtained at the two occasions were analyzed for erythrocyte sedimentation rate and thrombocyte particle count as well as serum levels of C-reactive protein, rheumatoid factor and 5-HT.

**Results:** Extension of total TMJ erosions was positively correlated to serum level of 5-HT ( $r_s = 0.55$ ,  $n = 17$ ,  $p = 0.022$ ). The serum level of 5-HT was positively correlated to thrombocyte particle count ( $r_s = 0.49$ ,  $n = 17$ ,  $p = 0.043$ ), which in turn was positively correlated to rheumatoid factor titer ( $r_s = 0.64$ ,  $n = 13$ ,  $p = 0.018$ ). The rheumatoid factor titer was positively correlated to C-reactive protein ( $r_s = 0.56$ ,  $n = 13$ ,  $p = 0.046$ ). The calculated change in total TMJ bone loss was positively correlated to the change in serum level of 5-HT ( $r_s = 0.71$ ,  $n = 14$ ,  $p = 0.004$ ). The change in serum level of 5-HT was positively correlated to change in erythrocyte sedimentation rate ( $r_s = 0.67$ ,  $n = 13$ ,  $p = 0.013$ ). The

▷ observed changes in extension of total TMJ erosions and bone loss were positively correlated to the C-reactive protein level at the first examination ( $r_s = 0.66$ ,  $n = 17$ ,  $p = 0.004$  and  $r_s = 0.71$ ,  $n = 17$ ,  $p = 0.001$ , respectively). At the same time, the observed change in extension of total TMJ erosions was positively correlated to the rheumatoid factor titer at the first examination ( $r_s = 0.61$ ,  $n = 13$ ,  $p = 0.025$ ).

**Conclusion:** In conclusion, this study suggests that high serum level of 5-HT is related to presence of TMJ erosions as well as longitudinal increase in TMJ bone loss. The influence of 5-HT seems to be associated with the systemic inflammatory activity.

◎ ◎ ◎ 40

### The effectiveness of a prefabricated occlusal appliance in a long-term perspective

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**Aim:** To compare the long-term effectiveness of a prefabricated occlusal appliance with a stabilization appliance in myofascial pain patients.

**Material and Methods:** Sixty-five patients at two centres for Stomatognathic Physiology in Finland and Sweden were included in a randomized controlled trial. The 65 patients were randomly assigned to a prefabricated appliance (R-group, 32 patients) or a stabilization group (S-group, 33 patients). A general practitioner performed the treatment with the appliances. The mean age of the patients was 38 years (S.D.2) and 37 years (S.D.3) respectively in the groups. The patients were interviewed regarding symptoms and clinically examined according to RDC/TMD. At the 6 months- and 1 year follow-up of the appliance therapy an evaluation of the treatment outcome regarding pain according to the visual analogue scale and overall rating of pain according to the verbal scale was performed.

**Results:** All patients had the clinical diagnosis myofascial pain and had been suffering from 3 months to 40 years with a mean of 6 years. The R-group included 27 women and 5 men and the S-group 30 wo-

men and 2 men. At baseline there were no differences between the groups regarding frequency of pain, number of years suffering from the pain or worst or mean pain during the last six months. At the 6-months follow-up a 30% pain relief was achieved in 75% and 70% in the R- and S- groups and a 50% pain relief in 69% and 70%, respectively. When evaluating the treatment outcome according to a verbal scale the percentage of patients reporting themselves to be better, much better or symptom-free was 81% and 73% in the two groups. At the 6-months follow-up an increased open bite was registered in one patient. The 30% and 50% pain relief in the R- and S- groups were 78%, 64% and 72%, 52%, respectively. According to the verbal scale patients reporting themselves to be better, much better or symptom-free was 81 % and 64 % in the two groups. All calculations were done on an intent-to-treat basis.

**Conclusion:** In a long-term perspective both appliances seemed to have an equal effectiveness in the treatment of the patients suffering from myofascial pain. The prefabricated appliance can be recommended as a long-term treatment modality when used night or daytime only. Frontal open bite should be regarded as a contraindication.

◎ ◎ ◎ 41

### Validity and precision in repeated positioning of half gape size

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**Background:** Jaw opening and gape size during everyday jaw actions relates to both central neural settings and somatosensory feedback. To gain further knowledge about mechanisms behind jaw motor control we have analysed the ability of achieving a defined gape size in healthy young subjects.

**Aim:** To analyse the validity and precision in repeated positioning of half maximal gape size.

**Subjects and Methods:** Ten healthy subjects, five females and five males (mean age 24 years) participated in the study. Before the experiment, the sub-

jects performed five preparatory jaw opening-closing movements, five maximal jaw openings followed by five half maximal jaw openings (half maximal gape size, HG). In addition, the movements were performed for self-estimated and instructed HG, respectively. An optoelectronic technique was used to simultaneously record movements of the mandible and head-neck while the subjects were instructed to; 1) keep the teeth in light contact, 2) achieve HG and keep this position for five seconds and 3) open maximally before bringing the teeth in light contact. This test protocol was repeated ten times each for self-estimated HG and instructed HG.

**Results:** During the five seconds period while maintaining HG, all subjects typically showed an “initial HG” (IHG), followed by a decrease in amplitude before gaining a stable HG position. For self-estimated HG, the decrease was 19% for males and 15% for females. For instructed HG, the decrease was 13% for all subjects. For self-estimated HG, all subjects systematically underestimated half maximal gape size, males by 19% and females by 14%. The corresponding values following instructed HG were 16% and 13%. The coefficient of variation (CV) for self-estimated HG was 4.6 for males and 6.0 for females. The corresponding values for instructed HG were 3.5 for males and 5.6 for females.

**Conclusion:** The results suggest that jaw opening to half maximal gape size is performed with low validity but high precision.

◎ ◎ ◎ 42

### Incidence and prevalence of myofacial pain. A 1-year prospective study on dental students

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**Aim:** The aims of this study were to examine the 1-year period prevalence, incidence, and course of myofacial pain and to analyze whether female gender, dental occlusion, and oral parafunctions have an influence on these signs and symptoms

**Methods:** The study population comprised 308 den-

tal students, examined at the start of their dentistry course and reexamined after 1 year. Case histories were collected using a questionnaire. The clinical examination included palpation sites of muscles, a submaximal clenching test, measurements of maximal mandibular mobility, and classification of morphological and functional dental occlusion.

**Results:** The 1-year period prevalence of frequent myofacial symptoms was 19%. The incidence of myofascial pain, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), was 4%. The female students presented an almost fourfold incidence rate of myofacial symptoms compared with male students. Nonsymptomatic subjects were predominantly found among men, and among those without awareness of bruxism, with bilateral contact in centric relation (CR), and a stable mandibular position in centric occlusion (CO). Variations in morphological occlusion did not show any relation to myofacial symptoms, and neither did contact patterns in eccentric positions.

**Conclusion:** Female dental students were more prone to developing frequent myofacial pain and to perceiving local muscle soreness compared with male students during a 1-year period. Both self-reported bruxism and registered mandibular instability in CO showed association with the 1-year period prevalence of myofascial signs and symptoms in the jaw-face region.

◎ ◎ ◎ 43

### “Grin and bear it” – attitudes and experiences of Sami females with and without persistent symptoms of temporomandibular disorders

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**Aim:** The aim of this study was to analyse attitudes and experiences of Sami females with longstanding, frequent and intense symptoms of temporomandibular disorder (TMD).

**Material and Methods:** Seventeen Sami females living in the north of Sweden were selected for inter-

views. The selection was based on the answers in two consecutive questionnaire studies and the outcome of a clinical examination. Ten females with persistent, frequent and intense symptoms of TMD were included. Seven females with no signs or symptoms of TMD were selected as negative cases. The interviews followed a pre-tested thematic interview guide covering life history, the Sami heritage, and health experiences/attitudes. The interviews were transcribed verbatim. Data analysis was based on Grounded Theory. To improve trustworthiness, triangulation and negative case analysis were applied.

**Results:** The core category derived from the data was “Grin and bear it”, summarizing the expressions that these women used to describe their situation. The core category emerged from four categories, namely (1) stress and strained events; (2) expressions of cause; (3) feelings of being deviant; and (4) the wish to go on. All the women had similar experiences, both negative and positive, of life and the Sami heritage. The women in the symptom group expressed more feelings of being an outsider and of being unsafe, as well as loneliness and uneasiness, with limited social support. The main difference between cases and negative cases that emerged in the analysis seemed to be the way the women coped with life situations. The negative cases handled difficulties in life by leaving these experiences behind and striving to get on with their life. To succeed in this strategy they relied heavily on support from family and friends.

**Conclusion:** These findings generated the hypothesis that patients with persistent, frequent and intense symptoms in the jaw-face and head-neck region may benefit from support, in the form of education and rehabilitation, from TMD groups, to improve their sense of coherence and social network.

◎ ◎ ◎ 44

### **A comparison of self-assessed chewing ability and dental status over 10 years in 50-year-old subjects.**

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**Aim:** The aim was to longitudinally study changes over a 10-year period of self-assessed chewing ability and dental status in a population sample of 50-year-old subjects.

**Material and Methods:** Identical questionnaires were sent to all subjects born in 1942 living in two Swedish counties in 1992 (N=8888) and in 2002 (N=8260). The response rate was 71 % for the 50-year-old subjects in 1992 and 75 % for the 60-year-old subjects in 2002. Of those who answered in 1992, 74% responded in 2002, and 5008 answered to the question on chewing ability both at age 50 and 60.

**Results:** There were small but statistically significant changes in dental status (similar in men and women) during the 10-year period between age 50 and 60. The proportion of those with any type of removable prosthesis increased from 6.4 % to 8.3 %. The self-assessed chewing ability was less good at age 60 than at age 50 ( $P < .001$ ). There was a moderate association between number of teeth and chewing ability at both 50 ( $r = .37, P < .01$ ;) and 60 years of age ( $r = .41, P < .01$ ). Approximately 80 % of complete denture wearers, both at age 50 and age 60, considered their chewing ability good, whereas those with other types of removable dentures were less satisfied at age 60 than at 50. Those who were complete denture wearers both at age 50 and 60 made similar assessments at both examinations. Those who were dentate without removable prosthesis at age 50 but had received any type of removable denture during the follow-up period assessed their chewing ability poorer than 10 years earlier.

**Conclusion:** In this longitudinal study, chewing ability was reported to be less good at age 60 than at age 50 in all groups with varying number of natural teeth. In contrast to the dentate subjects, complete denture wearers had a stable level over the 10-year period, with approximately 80 % assessing their chewing ability as good both at age 50 and age 60.

◎ ◎ ◎ 45

### **Relationship between symptoms of temporomandibular disorders and dental status, general health and psychosomatic factors in two cohorts of 70-year-old subjects**

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**Aim:** Objectives: To study the prevalence of symptoms of temporomandibular disorders (TMD) in two cohorts of 70-year-old subjects examined 8 years apart and analyse the relationship between such symptoms and dental status, general health and various background factors.

**Material and Methods:** Two cohorts of 70-year-old subjects, born in 1922 (n = 422) and 1930 (n = 491) respectively, were examined with an interval of 8 years. A TMD symptom index (0 - 5) was established on answers to five questions related to TMD symptoms.

**Results:** There were no statistically significant differences between the two cohorts for prevalence of TMD symptoms and TMD index, neither for headache, neck ache, bruxism and chewing ability. TMJ sounds was the most prevalent symptom, 14 %, whereas other TMD symptoms had low prevalence. The distribution of the TMD symptom index showed that 81 % reported no symptoms, 15 % 1 symptom, 3 % 2 symptoms and 1 % 3-5 symptoms. Single TMD symptoms and the TMD index exhibited significant associations (P < 0.001) with bruxism, headache, neck pain and several general health and psychosomatic factors, but with dental status only in women. Logistic regression showed that bruxism, neck pain, mouth dryness and a number of psychosomatic factors were associated with the TMD index.

**Conclusion:** Besides TMJ sounds (14 %), other TMD symptoms were rarely reported by the 70-year-old subjects. The TMD index was significantly associated with bruxism and several general health and psychosomatic complaints but with dental status only in women.

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### **Undergraduates and graduates perception of achieved competencies in temporomandibular disorders (tmd) and orofacial pain (op) in a problem-based dental curricula**

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**Aim:** To assess undergraduates and graduates perceptions of their education with respect to acquired competencies regarding TMD/OP and examination, diagnoses, treatment and prognosis of patients suffering from TMD and OP.

**Material and Methods:** Undergraduates during year 2006, students of course 1 (C1; n=55), course 6 (C6; n=31) and course 10 (C10; n=55) and dentists graduated in 2000 and 2001 (G 0/1; n=60) were invited to fill in a questionnaire comprising 11-44 questions depending on educational level. Questions about personal experience of pain, understanding and attitudes toward TMD /OP, perception of clinical competencies and satisfaction with their dental profession were included. The questionnaires contained open-ended and short questions and questions to mark on a 11 point numeric rating scale (NRS). A 5-point scale was used for perceived importance and satisfaction regarding clinical competencies.

**Results:** The response rate was 80-100 %. Six percent had never experienced severe pain. The importance of understanding patients with TMD/OP was rated very important (NRS 9-10) and the attitudes in relation to given statements about patients with TMD and OP were expressed positive. The perception of clinical competencies increased overall with the levels of education. The mean scores for importance and satisfaction of clinical competencies presented by students of C10 and graduates were high and above 4.0 for the majority. The graduates satisfaction with their professional situation was high (NRS 8.9) as well as the respondents rating of their undergraduate education including management of TMD/OP patients (NRS 8.6). All respondents but one had treated patients with TMD/OP during this year. One third of the responding graduates expressed a need for additional training in e.g. pharmacological treatment and evaluation of treatment outcome.

**Conclusion:** The perception of acquired clinical competencies in TMD and OP increased overall with levels of education and the importance as well as the satisfaction with the education was highly rated.





### **Intraoral temperature detection and pain thresholds. Reliability, influence of time, and size of stimulation area.**

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**Aim:** To investigate the reliability and influence of time and size of the stimulation area on cold detection, warm detection, and painful heat thresholds.

**Material and Methods:** Thirty healthy individuals (15 females and 15 males, mean age 24.9 years, range 20–31 years) participated in the study. The subjects were recruited among Malmö University students. Thresholds for warm detection (WDT), cool detection (CDT), and heat pain (HPT) were measured using a thermotester (MSA - Modular Sensory Analyzer, Somedic®). The intraoral thermode was custom-made with a 9 x 9-mm square surface (0.81cm<sup>2</sup>). Four acrylic tips that could be attached to the top of the thermode were made (tip areas: 0.50 cm<sup>2</sup>, 0.28 cm<sup>2</sup>, 0.125 cm<sup>2</sup>, and 0.00 cm<sup>2</sup>). Baseline temperature was set at 37.0°C, and the temperature change rate at 1.0°C/s. Patients were instructed to push a stop-button when the threshold was reached. The average of three measurements was recorded. The stimuli were repeated at 4–6-s intervals. Participants were examined on three occasions: at baseline, after 2 weeks (2w), and after 6 weeks (6w). Measurements were made on the tip of the tongue. Two operators who had been calibrated in the investigation method made the measurements.

**Results:** Reliability: Acceptable to excellent reliability (test-retest) was found for cool detection thresholds (ICC 0.51), warm detection thresholds (ICC 0.48), and heat pain thresholds (ICC 0.88). Influence of time: Significant differences were found for some measurements made at 2- and 6-week intervals. For cold detection thresholds, measurement differences between baseline and the 2- and 6-week follow-ups were significant ( $p < 0.05$ ); for warm detection thresholds, differences between baseline and the 6-week follow-up were significant ( $p < 0.05$ ); for heat pain thresholds, differences between baseline and the 2- and ( $p < 0.05$ ) and 6-week ( $p < 0.01$ ) follow-ups were significant. Influence of stimulation area: Thresholds for cold detection, warm detection, and painful heat

all decreased with increasing stimulation area, but the association was weak.

**Conclusion:** Measurements of cool detection, warm detection, and painful heat thresholds on the tip of the tongue with Somedic's MSA have acceptable to excellent reliability. Threshold measurements varied considerably over a 6-week period. Spatial summation on the tip of the tongue was small.



### **Somatosensory abnormalities in atypical odontalgia:**

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**Aim:** The purpose was to compare intraoral somatosensory findings in patients with AO with an age- and gender-matched control group.

**Material and Methods:** Forty-six AO patients and 35 controls were included. Inclusion criteria for AO were pain in a region where a tooth had been endodontically or surgically treated, persistent pain > 6 months, and lack of clinical and radiological findings. The examination included qualitative tests and a battery of intraoral quantitative sensory tests (QST): Filament tactile detection threshold, filament prick pain detection threshold, pressure pain threshold, brush-evoked allodynia dynamic and brush-evoked allodynia electric, repetitive pin-prick test and thermal thresholds.

**Results:** Most AO patients (85%) had qualitative somatosensory abnormality compared with only a few of the controls (14%). The most common abnormalities in AO patients were pin-prick 67.4%, cold 47.8%, and touch 46.5% compared with 11.4%, 8.6%, and 2.9%, respectively, in the control group ( $P < 0.001$ ). Between-group differences were seen for a number of intraoral QST: Filament tactile detection threshold, filament prick pain detection threshold, dynamic brush-evoked mechanical allodynia, elec-

tric brush-evoked (vibrating) allodynia, repetitive pin-prick sensitivity and pressure pain threshold ( $P < 0.01$ ). There were no differences in thermal thresholds. Individual somatosensory profiles revealed complex patterns with both hyper- and hyposensitivity to intraoral QST. Differences in pressure pain thresholds and cold detection thresholds ( $P < 0.02$ ) were also observed at the hand.

**Conclusion:** Significant abnormalities in intraoral somatosensory function were observed in AO, which may reflect both peripheral and central sensitization of trigeminal pathways. A more generalized sensitization of the nociceptive system may also be part of the AO pathophysiology.

◎ ◎ ◎ 49

### **Influence of intra- and extraoral sites and size of stimulation area on thermal detection and pain thresholds. A methodological study**

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**Aim:** This study compared cool detection thresholds, warm detection thresholds, and heat pain thresholds at intra- and extraoral locations and measured the influence of spatial summation.

**Material and Methods:** Thirty healthy individuals (15 females and 15 males, mean age 24.9 years, range 20–31 years) participated in the study. Thresholds for warm detection (WDT), cool detection (CDT), and heat pain threshold (HPT) were measured using a thermotester (MSA - Modular Sensory Analyzer, Somedic®). The intraoral thermode was custom-made with a 9 x 9-mm square surface. The average of three measurements was recorded. Four intraoral sites (gingival regions 24 and 34, tip of the tongue, lower lip) and two extraoral sites (infraorbitalis, thenar) were measured in each participant. To measure spatial summation, five acrylic covers (tip areas: 0.81 cm<sup>2</sup>, 0.50 cm<sup>2</sup>, 0.28 cm<sup>2</sup>, 0.125 cm<sup>2</sup>, 0 cm<sup>2</sup>) were made to fit the thermode. Five measurements on the tip of the tongue were averaged for each acrylic cover.

**Results:** Of the extraoral sites, the cold detection threshold was significantly higher and the heat pain threshold was significantly lower at the infraorbitalis than at the thenar. Of the intraoral sites, the cold detection threshold was significantly higher than at any of the other intraoral locations; the heat pain threshold was significantly lower on the tip of the tongue than on the lower lip. Warm detection and heat pain thresholds rose slightly with increasing thermode size, and this association was more pronounced than for cold detection thresholds.

**Conclusion:** Temperature thresholds differed significantly between several anatomical sites, and the association between size of stimulation area and temperature thresholds was weak.

◎ ◎ ◎ 50

### **Comparison of pain and tolerance thresholds between Middle-Easterns and Swedes: A case-control study**

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**Aim:** This study evaluated whether pain and tolerance thresholds differed between two different cultures.

**Material and Methods:** Pain perception, threshold, and tolerance were measured using an algometer, a Painmatcher®, and a cold-pressor test in 32 Middle-Eastern and 32 Swedish adults (16 men and 16 women in each group). Inclusion criteria for the Swedes were that the patient and the two most recent generations were born and raised in Sweden and for the immigrants that the patient and the patients' parents were born in the Middle-East (Iraq, Iran, Lebanon, Syria, or Palestine) and were of Middle-East heritage. Participants were recruited among Malmö University students.

**Results:** Although pain pressure thresholds as detected by the algometer differed non-significantly between Middle-Eastern and Swedish participants, differences in pain tolerance were significantly lower in the Middle-Eastern group ( $P < 0.01$ ). The Painmatcher found no significant between-group differences in pain perceptions, thresholds, and tolerances. The

▶ cold-pressor detected significant differences with lower pain tolerance in the Middle-Eastern group ( $P < 0.01$ ) but not pain threshold.

**Conclusion:** Although no significant differences in pain thresholds were found between Middle-Eastern and Swedish individuals, a tendency for pain tolerance to be lower in the Middle-Eastern group was observed.

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### **Gender differences in pain and tolerance thresholds**

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**Aim:** This study evaluated whether pain and tolerance thresholds differed between the genders.

**Material and Methods:** Pain perception, threshold, and tolerance were measured using an algometer, a Painmatcher®, and a cold-pressor test in 32 Middle-Eastern and 32 Swedish adults (16 men and 16 women in each group). Participants were recruited among Malmö University students.

**Results:** Although pressure pain thresholds measured with the algometer differed non-significantly between genders, significant lower pain tolerances were found in women ( $P < 0.01$ ). Painmatcher measurements of pain threshold ( $P < 0.05$ ), and pain tolerance ( $P < 0.001$ ) were significantly higher in men, while pain perception was significantly higher in women ( $P < 0.01$ ). No significant differences in pain or tolerance thresholds were detectable with the cold-pressor test.

**Conclusion:** Only a trend toward differences in pain thresholds was observed between the genders, but this difference was more pronounced with lower pain tolerances for women.

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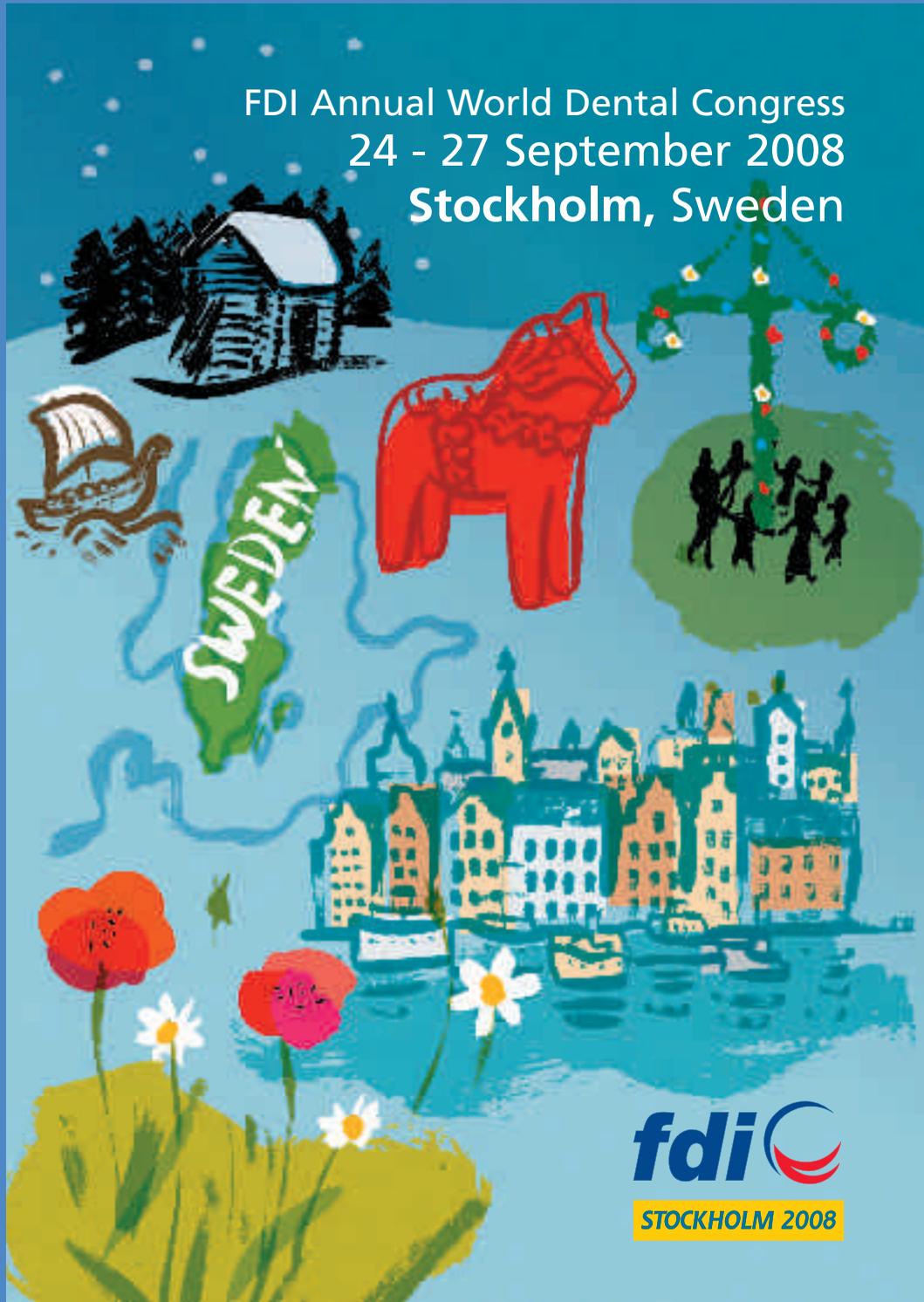
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## Contents of Volume 31, 2007

Title	Page	Issue	Title	Page	Issue
<b>Bakke, Bergendal, McAllister, Sjögren, Åsten</b> Development and evaluation of a comprehensive screening for orofacial dysfunction	75	2	<b>Nylén Tofeldt, Johnsson, Kjellberg</b> Evaluation of orthodontic treatment, retention and relapse in a 5-year follow-up: A comparison of treatment outcome between a specialist and a post-graduate clinic	121	3
<b>Bengmark, Nilner, Rohlin</b> Graduates' characteristics and professional situation. A follow-up of five classes graduated from the Malmö Model	129	3	<b>Pilgård, Söderfeldt, Hjalmer, Rosenquist</b> Dimensions of good work for employees in oral and maxillofacial surgery in Sweden	147	3
<b>Crossner, Unell</b> A longitudinal study of dental health from the age of 14 to 41	65	2	<b>Rabe, Holmén, Sjögren</b> Attitudes, awareness and perceptions on evidence based dentistry and scientific publications among dental professionals in the county of Halland, Sweden: A questionnaire survey	113	3
<b>Heijs, Dietz, Norén, Blanksma, Jälevik</b> Morphology and chemical composition of dentin in permanent first molars with the diagnose MIH	155	4	<b>Rosén, Stecksén-Blicks</b> Experience of dental care for children with congenital heart disease among Swedish dentists	85	2
<b>Hägglin, Berggren, Hakeberg, Edvardsson, Eriksson</b> Evaluation of a Swedish version of the OHIP-14 among patients in general and specialist dental care	91	2	<b>Sandberg, Fors</b> The HIDEP model - a straightforward dental health care model for prevention-based practice management	171	4
<b>Isaksson, Söderfeldt</b> Oral status and treatment needs among elderly within municipal long term care 2002-2004	45	1	<b>Ståhlacke, Söderfeldt, Unell, Halling, Axtelius</b> Patients satisfaction with dental care in one Swedish age cohort Part I - descriptions and dimensions	103	2
<b>Johansson, Axtelius, Söderfeldt, Sampogna, Paulander, Sondell</b> Patients' health in contract and fee-for service care	27	1	<b>Ståhlacke, Söderfeldt, Unell, Halling, Axtelius</b> Patients satisfaction with dental care in one Swedish age cohort Part II - wath affects satisfaction	137	3
<b>Johansson, Nylén Tofelt, Kjellberg</b> Subjective evaluation of orthodontic treatment and potential side effects of bonded lingual retainers	35	1	<b>Sundqvist, Wenneberg, Magnusson</b> Comparison of individual prediction of treatment outcome made by a TMD specialist and a TMD-trained general dental practitioner in patients with temporomandibular disorders	55	2
<b>Kashani, Kanagaraja, Khanberg</b> A randomized double-blind comparative study of Biolight® light therapy following surgical extration of impacted lower third molars	165	4	<b>Abstracts</b> of free communications and posters presented at the 44 <sup>th</sup> Annual Congress of the Swedish Dental Society, Gothenburg, November 8-10, 2007	181	4
<b>Källestål, Fjelddahl</b> A four-year cohort study of caries and its risk factors in adolenscents with high and low risk at baseline	11	1			
<b>Lagervall, Jansson</b> Relationship between tooth loss/probing depth and systemic disorders in periodontal patients	1	1			

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