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Professor Anne Tenner, Boston, USA recieves the Swedish Dental Society's International prize 2009 from the President of the society, Roland Svensson

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Water quality in water lines of dental units in the Public Dental Health Service in Göteborg, Sweden

GUNNAR DAHLÉN[1,2], ELNA ALENÄS-JARL[2], GUNILLA HJORT[1]

Abstract

◎ Presence of bacteria in high levels in the water lines of dental units is well known. The extent of this problem is however less well studied. This study was conducted to evaluate the water quality of all dental units within the Public Dental Health Service (Folktandvården, FTV) of the city of Göteborg, Sweden.

405 dental units in 35 clinics were tested. The evaluation included both "fast growing" (2 days incubation) and "slow growing" (7 days incubation) bacteria in 50 ml water sample from the units. The presence of potential pathogens e.g. coliforms, *Pseudomonas* spp and *Legionella pneumophila* were also examined.

Of the 405 dental units, 303 (75%) did not have acceptable (<100 CFU/ml fast growing and < 5000 CFU/ml of slow growing bacteria) water quality. From 61 (15%) dental units in 13 clinics L. *pneumophila* were present but usually as few cells only. Immediate measures were introduced in Legionella positive units. No coliforms or *Pseudomonas* spp were detected.

It can be concluded that the water in the dental units is generally not acceptable and does not fulfill drinking water standard. Many units have extremely high bacterial levels, which must be regarded as a risk for certain patient groups e.g. immune-compromised and older patients. A general program for desinfection of all units of the Public Dental Health Service is needed.

Key words

Dental unit water lines, biofilm, Legionella pneumophila

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Vattenkvaliteten i tandläkarutrustningarnas vattensystem vid Folktandvården i Göteborg

GUNNAR DAHLÉN, ELNA ALENÄS-JARL, GUNILLA HJORT

Sammanfattning

◎ Att vattnet i dentala unitar (tandläkarutrustningar) kan innehålla höga bakteriehalter är välkänt. Däremot är det mindre känt hur utbrett problemet är. I föreliggande studie som initierades av Folktandvården i Göteborg undersöktes samtliga unitars vattenkvalité.

405 unitar på 35 kliniker testades. Utvärderingen inbegrep både "snabbväxande" (2 dagars inkubering) och "långsamväxande" (7 dagars inkubering) bakterier i 50 ml vatten avtappat från unitens trevägsspruta. Vatten från tvättstället tjänade som referens. Studien inkluderade även närvaro av potentiella patogener som coliforma stavar, Pseudomonas och *Legionella pneumophila*.

Av de 405 unitar som undersöktes nådde inte 303 (75%) acceptabla bakterienivåer (<100 CFU/ml) av snabbväxande och <5000 CFU/ml långsamväxande) i vattensystemet. Från 61 (15%) unitar på 13 kliniker isolerades L. *pneumophila* men oftast endast som ett fåtal celler. Ingen unit hade coliforma stavar eller Pseudomonas.

Sammanfattningsvis kan sägas att vattnet i dentala unitar är generellt sett inte acceptabelt och vissa utrustningar hade extremt höga bakterienivåer som måste betraktas som en hälsorisk för vissa patientgrupper tex gamla och patienter med nedsatt immunitet. Omedelbara åtgärder vidtogs i de unitar med lite högre antal legionella. Ett allmänt program för desinfektion av samtliga unitar vid Folktandvården är nödvändigt

Introduction

The water in dental units does not reach the quality that is demanded for equipments that are so intensely used within the dental practice. This is shown in numerous national and international reports (10, 18). Dentistry has elaborated extensive hygienic protocols to reduce the risk for disease transmission for both the patients and personnel. However, dental patients should also meet clean and safe clinics and no hidden "dirty" procedures. New methods are constantly introduced in the dental practice including new equipments with complicated technical constructions that are used with little attention to hygienic aspects. All moist or water containing environments always contains microorganisms, which take the opportunity to colonize available surfaces and form biofilms. The biofilm formation is a natural phenomenon, which offers the microorganisms a number of advantages for their survival and living (4). One such advantage is the 100-1000 times higher resistance to antimicrobial agents. The water lines in the dental units are perfect environments for the microorganisms due to the slow flow of room temperate water and large surface areas of plastic material and with numerous vents and connections. Consequently, the water lines more or less constantly contain biofilms and the water harbor a high density of microorganisms, which must be regarded as not hygienic, and sometimes the water even smells and tastes bad. Also the quality of dental restorations maybe hampered. *Schneider et al.* (15) showed that bonding strength and "critical surface tension" decrease with increasing concentrations of bacteria in the dental unit water.

Biofilms on the inner surface of the water lines is not free of contagious risks. The biofilms increase the risk for establishment of more pathogenic microorganisms such as coliform, pseudomonas and not least *Legionella pneumophila*. L. *pneumophila* occurs together with a number of other Legionella species in the community water. If the biofilm harbors an increased number of these bacteria they constitute a risk for transmission and infection of the patients. Gram-negative bacteria of the biofilm produce endotoxin that may be give toxic reactions and asthma in the respiratory system, specifically in the dental personnel (12).

Legionellosis is a variant of pneumonia that develops more easily in elderly and immune-compromised individuals and can even be mortal (7). The bacteria are transferred usually by aerosols such as air-moistener, air conditioner, showers and by high-speed and ultrasonication. There is no case reported so far in Sweden, where the dental equipments have been the source. However, in every new case dentistry is suspected (2, 3, 11). Also dental personnel are commonly exposed to aerosols that may contain Legionella and reports on a higher level of antibodies in a "dental clinic population" point to the fact that this profession also is at risk (8, 12,13). At present, there are no reports on the presence and levels of *Legionella* spp in dental units in Sweden and information in this would be of great value for the planning of measures to improve the water quality.

In 2006 the Swedish Board of Health and Welfare (SBHW or Socialstyrelsen, SOS) published recommendations for the water quality in dental units (17). A threshold value was given of 100 CFU/ml for fast growing bacteria (2 or 3 days of incubation) as an acceptable standard. This is also the standard used by the Swedish Institute of Infectious Disease Control (SIIDC or Smittskyddsinstitutet, SMI, 16). The standard from the Swedish Food Authority (Livsmedelsverket, 9) also includes an additional standard for drinking water to be 5000 CFU/ml of slow growing bacteria (7 days incubation). The latter standard is due to the fact that most bacteria living in the water are autotrophic and heterotrophic and thus by nature are slow growing and will not be detected on ordinary agar media within short (2-3 days) incubation times. Concomitantly, the level of slow growing bacteria is a more adequate measure on the "contamination" and hygienic condition of the dental unit. The fast growing bacteria are those that are detached from the biofilm and can vary substantially from one time to another.

In 2006 it was decided that the Public Dental Health Service (Folktandvården, FTV) in Göteborg should perform a screening of all dental units within the organization in order to get information on the extent of dental units with not acceptable water quality. This study reports the outcome of this survey.

Materials and Methods

Clinics and Dental Units

All dental units within Public Dental Health Service in the city of Göteborg were decided to be included. One clinic was under repair and one clinic was about to move to another building and these two clincs were excluded. Twenty-three clinics for general practice involving 193 dental units were tested. Four of these units were present in four different annex clinics in separate buildings. In addition, 118 dental units were included from the "students clinics" for

adults and pedodontics within the University Dental Clinics ("Odontologen") as well as 9 specialist clinics with 87 dental units. Finally, 7 dental units were included from specialist clinics outside the University Dental Clinics (Odontologen). In all, 34 clinics and 405 dental units were included in the study.

Samples and analysis

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

The sample was collected by tapping at least 50 ml from the dental unit (the air-water-syringe) into the sample tube. Similarly, 50 ml was taken from the tap water as a reference. The samples were sent to the laboratory without special cooling procedures. The analysis was performed at the laboratory for Oral Microbiology, Institute of Odontology, Sahlgrenska Academy at University of Gothenburg according to the protocol given by the Swedish Institute of Infectious Disease Control (SIIDC, Smittskyddsintitutet, Solna, Sweden). The samples were diluted 1/100 and 0.5 ml from concentrated and from the 1/100 dilution was inoculated on agar plates with Difco Nutrient agar (Becton, Dickinson and Company, Sparks, Maryland, USA) and was allow absorbing the liquid for one hour on the bench. The plates were then incubated at 22 °C and air.

The remaining water (ca 50 ml) was filtered through a membrane filter (Nalge filterunit, 0.45 µm pore size and 47 mm in diameter, Fisher Scientific, Göteborg, Sweden),which was then treated with acid buffer (pH 2,2) for 5 minutes, neutralized with a dilution buffer and transferred to agarplates with Legionella medium (Legionella CYE agar base CM 0655, Legionella BCYE growth supplement SR0110 and Legionella MWY selective supplement SR 0118, Oxoid, Basingstoke, Hants, UK) according to the manufacturers instructions. The plates were incubated in air for 7 days at 36°C.

Nutrient agar plates were analyzed by counting all colonies under microscope (x16) after 2 (fast growing) and 7 days (slow growing) incubation. The number of slow growing bacteria was calculated as the total number of colony forming units (CFU) after 7 days minus the number of CFU after 2 days. Both values were given as CFU/ml. Special attention was given to colonies suspected to be coliforms or Pseudomonas spp. Legionella agar plates were analyzed by counting suspected legionella colonies. The colonies were then tested by latexagglutination (Dryspot Legionella Latex Test DR 0220, Oxoid) for identification of *L. pneumophila* as to serotype 1 or serotype 2-14. The number of *L. pneumophila* was given as CFU/100 ml of water.

Results

Number of bacteria in unit water

Table 1 describes the total number of bacteria (fast and slow growing) recovered from the dental units as well as from tap water of the general practice clinics. None of the clinics had acceptable values for all their units if both standards (fast and slow growing) were used. Newly installed units in one clinic that were equipped with a desinfection system (Oxygenal, KaVo Dental GmbH, Biberach, Germany) from the manufacturer had acceptable values for both standards in 10 out of 11. For the not-acceptable unit, the instructions had not been followed completely. A new sample was taken two weeks later showed acceptable values also for this particular unit. Table 2 and 3 shows the bacterial density in the specialist clinics and the "students clinics" respectively. The pattern of bacterial contamination in most dental units is also seen here.

For all included clinics at FTV in Göteborg, altogether 103 units (25%) were approved as having acceptable values for drinking water using the standard of 100 CFU/ml and 169 (41%) if only the standard for slow growing bacteria was used. Only 55 units (14%) were acceptable if both standards were used. The level of bacteria differed enormously between different units even within the same clinic. In 42 units a bacterial density of >100 000 CFU/ml was obtained, which is the highest standard for swimming pools. No correlation could be found to the frequency of use or the age of the unit.

Number of bacteria in tap water.

Tables 4-6 show the results from the tap water in connection to the dental units of the various clinics. These values should be regarded as reference for the community water and the water delivered to the dental units. Even if the CFU/ml was much lower

Table 1. Air-water-syringe General practice clinics Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
								Fast growing bacteria		Slow growing bacteria	
		Mean value	Median	Range	Mean value	Median	Range	Number	%	Number	%
1	11	6 530	3 600	180- 28 800	14 300	11 600	3 600-34 400	0	0	1	0
2	11	0	0	0	11 100	11 000	214-38 400	11	100	3	27
3	5	2 230	1 760	0-5 900	33 400	28 800	1 440-80 000	1	20	1	20
4	8	3 540	3 000	0-8 120	40 250	29 600	1 200-112 000	1	13	1	13
5	8	290	160	0-800	2 240	1 100	0-10 000	4	50	7	88
6	7	1 840	2 100	0-3 700	8 600	5 800	750-20 800	2	29	2	29
7	5	2 400	2 740	770-3 840	10 900	6 600	2 200-24 000	0	0	2	40
8	8	470	400	20-1 280	750	500	10-2 800	2	25	8	100
9	11	240	0	0-2 600	6 900	2	0-67 600	10	91	9	82
10	7	1 290	800	300-2 600	11 500	2 300	300-60 800	0	0	4	57
11	11	7	0	0-40	24 500	22 200	1 050-76 800	11	100	3	27
12	8	12 400	3 360	700-80 000	16 900	2 360	60-96 000	0	0	6	75
13	6	2	0	0-6	33 300	19 300	7 000-108 800	6	100	0	0
14	7	26 200	18 800	1 400-70 000	73 700	75 200	48 000-107 000	0	0	0	0
15	11	1	0	0-4	6 800	6 800	230-16 600	11	100	3	27
16	11	50 000	25 600	160-140 000	79 700	70 400	18 400-176 000	0	0	0	0
17	11	0	0	0	17 400	17 600	1 100-32 000	11	100	2	18
18	7	4 000	1 600	40-12 000	17 600	6 000	600-58 800	1	14	3	43
19	6	21 600	5 800	1 800-96 000	36 800	36 400	1 400-60 800	0	0	1	17
20	3	1 600	120	14-4 800	4 100	1 500	1300-9 600	1	33	2	67
21	13	2 500	600	2-16 000	5 300	1 600	240-28 000	2	15	9	69
22	9	23 800	27 000	1 600-41 600	152 000	144 000	520-286 000	0	0	1	11
23	9	80 300	76 800	4-165 200	73 900	80 000	2 000-128 000	1	11	1	11

Table 2. Air-water-syringe. Specialist clinics, FTV, Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
								Fast growing bacteria		Slow growing bacteria	
		Mean value	Median	Range	Mean value	Median	Range	Number	%	Number	%
1	7	12 700	3 200	0 -38 400	18 900	6 400	640-67 200	2	29	3	43
2	11	2 900	2 800	460-6 400	40 400	19 200	2 400-192 000	0	0	2	18
3	9	50 800	28 000	1 700-224 000	23 500	5 600	600-112 000	0	0	4	44
4	5	2 400	1 800	110- 5 800	21 000	14 100	770-55 000	0	0	2	40
5	6	300	20	0-1 400	8 200	2 900	900-24 200	4	67	4	67
6	15	30 900	600	140-96 000	17 500	12 800	0-78 400	0	0	6	40
7	6	14 300	4 000	1 300-49 600	25 900	1 200	450-108 800	0	0	3	50
8	25	17 500	2 600	4-128 00	14 800	11 600	720-37 000	2	8	5	20
9	3	2 000	2 560	6-3 380	6 400	8 420	870-9 850	1	33	1	33
10	7	8 500	420	60-44 800	10 950	4 000	1 360-32 000	1	14	4	57

Table 3. Air-water-syringe. Students clinics, FTV, Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
								Fast growing bacteria		Slow growing bacteria	
		Mean value	Median	Range	Mean value	Median	Range	Number	%	Number	%
A	12	4 700	930	180-32 000	4 800	1 200	200-22 400	0	0	8	67
B	15	1 600	360	0-10 600	38 900	1 350	150-320 000	5	42	10	67
C	16	1 740	150	0-16 000	10 300	1 700	100-96 000	7	44	12	75
D	6	4 100	1 500	140-13 600	4 100	1 420	145-15 600	0	0	4	67
E	12	8 100	3 000	70-64 000	7 900	3 600	30-24 000	1	8	8	67
F	12	3 800	3 200	240-14 400	12 000	9 200	65-44 800	0	0	5	42
G	12	6 700	2 800	1 000-38 400	8 300	2 850	660-32 000	0	0	8	67
H	12	10 400	7 000	770-43 200	20 000	19 100	6 800-60 000	0	0	0	0
L	11	980	420	0-2 900	2 300	840	170-12 000	3	27	10	91
K	10	2 500	3 000	20 4 800	14 000	10 200	900-43 700	1	10	2	20

many taps had not acceptable water according to the standards.

L. pneumophila and other pathogens

L. pneumophila was recovered from the water of altogether 61 units in 13 clinics (Table 7-9). The number was usually very low but in a few cases values of >100 CFU/ 100ml were found (13 units). One clinic had legionella in 7 out of 8 dental units in a number of >100 CFU. No other pathogens (coliforms or pseudomonas) were found.

Table 10 summarizes the total number of acceptable units if different cut off levels were used. It shows that most units are well over any of these cut off levels if no cleaning procedures are applied on the water system of the unit.

Discussion

The present study has shown that among 405 dental units at 35 clinics, a majority (75%) do not have acceptable bacterial counts (CFU/ml) in the water lines as demanded by the standard for drinking water. In 61 dental units (15%) at 13 clinics *L. pneumophila* was additionally found.

In this study we chose the air-water-syringe for sampling. This was recommended from a national consensus discussion (6). It is simple to use for sampling, all dental units have one and it is the most frequently used water line in dental units in most dental clinics. As a reference tap water close to the dental units was used. It was found that this water did not always reach the level of good quality of drinking water. This may partly be explained by the fact that most taps are connected to a sil usually made of plastic with a concomitant formation of biofilm and higher bacterial density. Even on the orifice of the waterlines in the dental unit higher bacterial counts could be due to contamination from fingers and by a reflux from patients into the waterlines (e.g. high-speed). The sample may thus have a temporary higher bacterial counts and do not mirror the normal condition. It would therefore be recommended that the orifice should be wiped off with 70% ethanol before the sample is taken.

Cooling of the samples during transportation was not considered necessary. Those microorganisms that are present in the water lines are not particular sensitive for temperature changes as long as it is below 37°C. These microorganisms have the water and water lines as their habitat and empirically it is found that the bacterial count in the transported water is stable for several days in room temperature. The requirement of cooling also has the disadvantage of a more complicated and expensive transportation in a routine setting if the ordinary mail system is to be used. The sample volume was decided to be 50 ml, because we wanted a more specific and not too small volume to be filtered for legionella detection. The institute of infectious disease control (SIIDC, Smittskyddsinstitutet SMI) recommends the use of 500 ml for legionella diagnostics. Considering again the transportation problems in a routine setting, we chosed to use 50 ml although it leads to a lower detection level. Theoretically we now have 20 legionella cells as detection limit compared to 2 cells for the SIIDC recommendation. We think, however this difference is within the methodological errors and temporary fluctuations.

A microscope was used according to SIIDC for evaluation of the fast growing bacteria, which results in higher counts compared to evaluation by the naked eye. This is simply because smaller colonies is not seen by the naked eye and will grow further and later become visible and counted as slow growing. The significance in counting fast and slow growing bacteria and to distinguish these two groups is not clear and has to be evaluated further. SIIDC is recommending 2 days of incubation while the Livsmedelsverket recommends 3 days (9, 16). The European standard is not yet decided (*Ellen Frandsen*, Aarhus University, Denmark, personal communication). Also the acceptable level for the water quality is under debate. This study shows that the majority of dental units have substantially higher values than different recommended cut off levels. The SBHW (Socialstyrelsen, SOS) decided to recommend 100 CFU/ml (17), while the rest of Europe seems to go for 200 CFU/ml (14). In USA, ADA recommends 200 CFU/ml and CDC recommends 500 CFU/ml (1). The values are for drinking water and in many countries up to 500 CFU can be acceptable. In addition, drinking water is not the same in all countries. Sweden considers it acceptable or even recommended to drink the tap water delivered by the community, while many other countries use bottled water for drinking. It may also be questioned why the standard for water in the dental units should be referred to drinking water, when the water for the patient is for rinsing and not drinking. A too low standard may be difficult to achieve and without gaining much from a hygiene point of view. It is suggested that the SOS should reconsider the standard and not apply a drinking water standard but give a standard specifically for water line of dental units. Such a standard could be set to 500

CFU/ml, which is reachable by rather simple methods and to reasonable costs. We also think that the number slow growing bacteria are the most relevant to follow for evaluation of the water lines. The number is less fluctuating between sample occasions and also better mirrors the condition of the dental units. Furthermore, it more truly reflects the response on specific measures that are performed to increase the water quality. If continuous systems for disinfection of the water are used, the sample will contain the antimicrobial agent and hamper the growth in the laboratory (i.e. viable but not growing) giving a false negative result. Thus, even if it may be regarded advantageous to obtain low values they might be false. The counts for slow growing bacteria would be more relevant since these bacteria have a better chance to grow in samples influenced by the disinfectant. Empirically, we have noticed that even 7 days is too short. Incubation times of 10 or even 14 days increases the bacterial counts significantly. This should also be an aspect to be considered by SOS in case of new recommendations and standards.

Number of fast and slow growing bacteria in the water lines of dental units in FTV of Göteborg, was generally not acceptable. Great variations were noticed, between clinics and also between dental units of the same clinic. Any indication that the bacterial level was related to branch, age or frequency of use could not be seen. The unit in fact has its own "inner life" and we do not know in detail what factors are important. The water quality delivered from the community to the building, to the clinic and to the dental unit is of course of major importance, however small and not measurable difference in bacterial counts in the water, presence of organic material, salts, pH, temperature etc may by time (months and years) result in differences in the dental unit water lines. The findings of legionella clearly showed that some clinics (buildings) had legionella while others had not. The water temperature in the water system of the building was increased as an immediate measure but had no effect on the condition and presence of legionella within the unit. The findings of legionella *(L. pneumophila)* were not surprising. This type of bacteria is always present in small numbers in the community water system, and thus if you look for it you will find it. However, the presence of legionella in the water lines of dental units emphasizes the need of measures for better water quality. An evaluation of different methods was performed as a consequence of this study and is reported separately (5).

The conclusions from this study are that the water in the dental units within the FTV in Göteborg is generally not acceptable, and some units have remarkable high levels of bacteria. In addition, *L. pneumophila* is not rare and in a few cases present in such numbers that it can be regarded as a risk for elderly and diseased patients. This report shows that immediate measures to improve the water quality of units are needed as well as more long-term strategies. The report shows the extent of the problem and it should be noted that this is probably not a unique situation for Public Dental Service in Göteborg but rather is representative for the whole country.

Acknowledgement
We thank the FTV in Göteborg and their clinics for understanding and cooperation in this study. The study was supported by the FTV of Göteborg.

Table 4. Tapwater General practice clinics, FTV, Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
								Fast growing bacteria		Slow growing bacteria	
		Mean value	Median	Range	Mean value	Median	Range	Number	%	Number	%
1	11	9	2	0-80	9 099	600	110-90 000	11	100	10	91
2	11	1	0	0-10	310	230	0-1 180	11	100	11	100
3	5	43	2	0-200	598	340	200-1 170	4	80	5	100
4	8	200	35	0-1 240	450	260	20-1 240	6	75	8	100
5	8	3	0	0-20	600	2	0-4 800	8	100	8	100
6	7	70	6	0-280	1 050	750	65-2 670	5	71	7	100
7	5	25	12	0-80	1 160	630	215-1 590	5	100	5	100
8	8	55	2	0-375	345	230	30-1 280	7	88	8	100
9	11	185	0	0-960	6 570	1 380	110-36 800	8	73	6	55
10	7	100	35	0-350	240	160	8-630	4	57	7	100
11	11	1	0	0-12	2 300	240	0-24 000	11	100	10	91
12	8	290	65	0-1 440	1 240	1 020	50-3 520	4	50	8	100
13	6	0	0	0-2	610	270	160-1 470	6	100	6	100
14	7	490	6	0-2 880	6 450	2 300	320-32 000	5	71	5	71
15	11	30	0	0-280	150	80	0-620	10	91	11	100
16	11	17 400	8 000	15-73 600	33 300	16 000	80-134 400	1	9	3	27
17	11	0	0	0	2 060	45	30-20 800	11	100	10	91
18	7	65	4	0-290	1 700	540	80.3 900	5	71	7	100
19	6	780	160	0-3 840	13 800	2 060	580-67 200	3	50	4	67
20	3	25	20	20-35	490	340	80-1 050	3	100	3	100
21	13	20	0	0-130	1 400	85	0-6 400	12	92	11	85
22	9	170	4	0-800	1 650	350	30-6 400	5	56	8	89
23	9	590	240	2.3 300	16 300	1 370	70-80 000	4	44	7	78

Table 5. Tapwater Specialist clinics, FTV, Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
		Mean value	Median	Range	Mean value	Median	Range	Fast growing bacteria		Slow growing bacteria	
								Number	%	Number	%
1	7	95	2	0-560	8 100	770	30-52 800	6	86	6	86
2	11	1 680	320	0-14 400	18 350	3 100	250-98 000	4	36	7	64
3	9	4 800	740	2-35 000	4 500	1 220	300-13 700	1	11	6	67
4	4	430	60	0-1 600	630	310	30-1 860	3	75	4	100
5	6	1	0	0-4	8 500	2 000	780-40 000	6	100	4	67
6	15	65	20	0-370	1 750	1 550	520-4 940	12	80	15	100
7	7	60	35	0-270	1 500	520	100-7 400	6	86	6	86
8	2	410	410	40-780	3 010	3 010	410-5 600	1	50	1	50
9	3	80	80	20-140	230	85	50-570	3	100	3	100
10	7	30	20	2-110	1 799	85	15-10 400	6	86	6	86

Table 6. Tapwater Students clinics, FTV, Göteborg

Clinic	Number of dental units	Fast growing bacteria			Slow growing bacteria			Acceptable dental units			
		Mean value	Median	Range	Mean value	Median	Range	Fast growing bacteria		Slow growing bacteria	
								Number	%	Number	%
A	12	40	15	0-180	150	80	12-780	11	92	12	100
B	15	1 100	380	0-4 960	13 400	4 400	560-95 100	7	47	9	60
C	16	1 000	130	0-3 320	6 400	2 320	40-43 200	7	44	11	69
D	2	180	180	40-320	15 750	15 750	1 800-29 700	1	50	1	50
E	2	390	390	380-400	270	270	220-320	0	0	2	100
F	2	12	12	8-16	180	180	30-330	2	100	2	100
G	2	460	460	20-900	770	770	330-1 210	1	50	2	100
H	2	300	300	160-440	5 950	5 950	340-11 560	0	0	1	50
L	11	160	70	10-640	860	240	15-2 400	8	73	11	100
K	5	35	25	8-80	720	880	80-1 120	5	100	5	100

Table 7. Legionella. General practice clinics, FTV, Göteborg

Clinic	Number of dental units	Serotype	CFU/100ml (highest value)	Number of tapwater samples	Serotype	CFU/100ml (highest value)
1	1	1	2	0		
2	1	2-14	4	1	2-14	2
3	0			0		
4	0			0		
5	0			0		
6	0			0		
7	0			0		
8	6	2-14	2	0		
9	0			0		
10	0	1	24	0		
11	4	1	150	0		
12	7	1	240	6	1	184
13	0			0		
14	4	1	32	2	1	24
15	7	2-14	76	0		
16	0			0		
17	0			0		
18	0			0		
19	0			0		
20	0			0		
21	0			0		
22	0			0		
23	1	1	480	0		

Table 8. Legionella. Specialist clinics, FTV, Göteborg

Clinic	Dental units	Serotype	CFU/100ml (highest value)	Tapwater
1	0			0
2	2	1	4	0
3	3	1	> 500	0
4	0			0
5	4	1	90	0
6	0			0
7	0			0
8	12	1	> 2 000	0
9	0			0
10	0			0

Table 9. Legionella. Students clinics, FTV, Göteborg

Clinic	Dental units	Serotype	CFU/100ml (highest value)	Tapwater
A	0			0
B	0			0
C	0			0
D	2	1	50	0
E	0			0
F	2	1	120	0
G	3	1	40	0
H	2	1	8	0
L	0			0
K	0			0

Table 10. Acceptable dental units at different cut off levels

	Fast growing bacteria cfu/ml (%)			Slow growing bacteria cfu/ml (%)
	< 100	< 200	< 500	<5 000
No of acceptable units	103 (25,3)	122 (30,0)	142 (34,9)	169 (41,5)

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Management of root resorption in a large orthodontic clinic

DIMITRIOS MAKEDONAS [1], ANNA ÖDMAN [1], KEN HANSEN[2]

Abstract

◎ The aim of this study was to investigate, describe and analyse how the problem of root resorption is handled in a large orthodontic clinic and if these approaches were in accordance with the recommendations and guidelines described in the literature, and to estimate the prevalence of root resorption found in the radiographic material.

All records of patients who terminated active treatment with fixed or removable appliances during the year 2004 at the Department of Orthodontics, University Clinics of Odontology, Göteborg, Sweden were examined (902 patients). In 837 records adequate information was obtained.

The factors studied included: the presence of journal recordings of predisposing factors, the presence of radiographic examinations before, during and after treatment, the frequency of radiographic examinations and the prevalence of moderate or severe root resorption reported.

The most frequent registrations were for trauma, and nail biting.
Before treatment 81.5% of the patients were examined with periapical radiographs. After 6 months of treatment the percentage was 54.5%, while 15.8% of the patients were examined twelve months after treatment. At the end of treatment 52.5% of the patients were examined.

When moderate root resorption was diagnosed during treatment the use of lower forces, resting periods and decrease of the treatment duration were the most common preventive measures. The prevalence of light root resorption was 1.9%, 3.2%, 4.9% and 8.6% at the beginning, after 6 and 12 months and at the end of treatment, respectively. Severe root resorption was found in 1.9% at the end of treatment.
In conclusion before treatment periapical radiographs were taken in most cases. The percentage of the radiographs dropped significantly at 6 and 12 months. At the end of treatment half of the patients were examined with periapical radiographs. When moderate root resorption was diagnosed the use of lower forces, resting periods and decrease of treatment time were common preventive measures. Light root resorption was found in less than 10% while severe root resorption was noted in 2% after active treatment.

Key words

Orthodontics, root resorption

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Handläggning av rotresorptioner på en större ortodontiklinik

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Sammanfattning

◎ Syftet med studien var att beskriva och analysera hur problemet kring ortodontiskt inducerade rotresorptioner hanteras på en stor ortodontiklinik i Sverige samt att undersöka om man i praktiken följer de rekommendationer och riktlinjer som föreslås kring rotresorptioner i litteraturen. Studien syftade också till att bedöma prevalensen av ortodontiskt orsakade rotresorptioner som diagnosticerades på kliniken.

Samtliga journaler och röntgenbilder på patienter som avslutade sin behandling på Specialistkliniken för ortodonti i Göteborg under 2004 gicks igenom. Totalt fanns 920 patienter och adekvata handlingar fanns dokumenterade på 837 patienter. Följande uppgifter söktes i journalerna: anteckningar om predisponerande riskfaktorer, röntgenbilder före, under och efter behandlingen samt prevalens och omfattning av diagnosticerade rotresorptioner.

Bland de predisponerande riskfaktorer var det trauma och nagelbitning som det oftast fanns noteringar om. Intraorala röntgenbilder togs på framtänderna på 81,5% av patienterna innan behandling. Efter 6 månaders aktiv behandling togs intraorala röntgen på 54,5% och efter 12 månader sjönk siffran till 15,8%. Vid behandlingens avslutning togs intraorala röntgen på 52,5% av patienterna. I de fall måttliga rotresorptioner (mellan 2 mm och upp till 1/3 del av rotlängden) diagnosticerades under ortodontibehandlingen gjordes behandlingsuppehåll alternativt användes mindre krafter eller också avslutades behandlingen i förtid. Resorptioner av mindre omfattning diagnosticerades i 1,9% vid behandlingsstart, 3,2%, 4,9% samt 8,6% vid respektive 6 och 12 månaders behandling samt vid behandlingsslut.

Konklusionerna av studien var att: Intraorala röntgenbilder togs på framtänderna på de flesta patienterna innan behandlingsstart. Antalet intraorala röntgenbilder som togs minskade påtagligt under behandlingens gång. Drygt 50% av patienterna undersöktes med intraorala röntgenbilder på framtänderna då behandlingen avslutades. Vid diagnostiserad rotresorption under aktiv behandling gjordes behandlingsuppehåll alternativt minskades krafterna eller behandlingen avslutades i förtid. Rotresorptioner av mindre omfattningen diagnosticerades i mindre än 10% och mer omfattande resorptioner beskrevs för ca 2% vid behandlingsslut.

Introduction

Root resorption is a common idiopathic/iatrogenic orthodontic problem which has received considerable interest in the literature. Among orthodontically treated populations incidences of root resorption varying from 1 to 100 per cent of the patients have been reported (9, 21). This variation depends on several factors including: criteria used for root resorption, examination methods/techniques, type of orthodontic appliance and forces, extent of tooth movement, teeth examined, duration of the treatment and the patients' age. However, the prevalence of more severe root resorption in the literature varies less and ranges from 2 to 15% (1, 6, 7, 9, 10, 11, 18, 28, 33).

It has been stated that root resorption, in a considerable number of patients (up to 20%), can be detected and diagnosed during the first 3 to 9 months after start of active treatment (22, 31).

Several factors have been associated with root resorption during orthodontic treatment. Among them, correlation have been found for the presence of root resorption before treatment (4, 7, 27), treatment duration, oral habits like nail biting (25, 26) and finger sucking (17), allergies (23), root abnormalities (34), bruxism (8), and dental trauma (3, 20).

The radiographic technique that, so far, has had the most favorable benefit to risk ratio is, despite its limitations, the intra-oral periapical technique. It provides less distortion compared to orthopantomograms and/or lateral head films with the least radiation to the patient (12, 29).

In the literature, *Malmgren & Levander* have suggested guidelines for radiographic monitoring of root resorption during orthodontic treatment, (13) and as mentioned above there are also several risk factors, mentioned in the literature, to bear in mind in the treatment planning process.

Significant parameters which have been stated in the literature, regarding treatment strategies to minimize the risks of root resorption are: the use of light and intermittent forces (2), early treatment (30), treatment interrupted by resting periods (12), oral habits control (30, 32), and radiographic monitoring after 6 months of treatment or 3 months when enhanced risk is believed to exist (24, 25). However, due to the fact that these measures are not evidence based (14), the prevention and actions to avoid severe resorption relies upon the individual practitioners' assessment.

The aim of this study was to: investigate, describe and analyze how the problem of root resorption is handled in a large orthodontic clinic and if these approaches are in accordance with the recommendations and guidelines described in the literature. The study also aimed to estimate the prevalence of root resorption found in the radiographic material.

Material and Methods

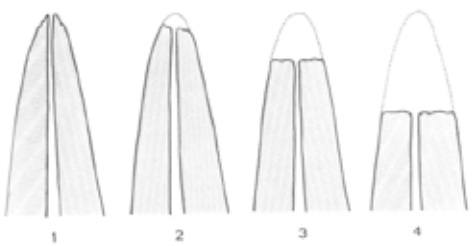
The sample consisted of records of all patients who finished active treatment with fixed or removable appliances during the year 2004 at the Department of Orthodontics, University Clinics of Odontology, Göteborg, Sweden. Records of 920 patients were found and among them, adequate information was found in 837 patients.

The parameters studied included:

- Treatment information such as type of appliances, duration of treatment and extraction of teeth.
- Journal recordings of possible predisposing factors for root resorption, (i.e. annotations of e.g. trauma, oral habits, bruxism, root shape abnormalities and preexisted root resorption).
- The radiographic evaluation of root resorption before, during and after treatment i.e. the type, frequency and of which regions radiographs were taken.
- The prevalence of moderate or severe root resorption found in the existing radiographs.
- The treatment approach and protocols followed when root resorption was diagnosed before or during treatment.

The patient journals were reviewed and the information was summarized in a computerized protocol with unidentifiable patient data. The journal annotations of root resorption were compared with the radiographic findings and interpreted into the *Malmgren* index (Fig. 1) (20).

Figure 1. Criteria for subjective scoring of root resorption. 0, no resorption; A, 1, irregular root contour; B, 2, apical root resorption less than 2 mm of original root length; C, 3, apical root resorption from 2 mm to 1/3 of original root length; D, 4, apical root resorption exceeding 1/3 of original root length.
Adapted from Malmgren et al (20)



Statistical methods

Linear regression analyses were used to test any association between root resorption (index score according to the *Malmgren index* as dependent value) and the different anamnestic and treatment parameters as age, gender, root form anomalies, trauma, resorption after 6 months of active treatment, treatment duration and extractions treatment (as independent variables). Associations were considered significant if $P < 0.05$.

Results

The total amounts of patients with adequate records who received treatment was 837, of which 502 (60%) were females and 335 (40%) were males.

The mean treatment duration was 18 months. Six hundred sixty one patients (79%) were treated with fixed appliances and 101 (12%) received removable appliances i.e. extra oral traction and activators. Seventy five (9%) received combined treatment with growth modification appliances (i.e. fixed appliances in combination with a *Herbst* telescope device) and 451 (54%) of the patients had two or more premolars extracted during treatment.

Journal recording of risk factors for root resorption.

Among the predisposing factors recorded in the patients records, the most frequent registration were notes in the patient's history regarding trauma and nail biting (Fig. 2). Trauma as a predisposing factor was recorded in 8% of the patients, while 20% of the patients were reported as being nail biters.

Root shape anomalies, pre existed root resorption and finger sucking was also considered as important predisposing factors. Root form anomalies were diagnosed in 19.8% of the patients and in 5% pre-existed root resorption was found. Two per cent of the patients reported finger sucking habits and 23% reported bruxism at start of treatment.

Use of periapical radiographs for the diagnosis of root resorption. (Fig. 3) Before treatment 682 (81.5%) of the patients were examined with periapical radiographs. After 6 months of treatment the percentage of patients who were radiographically examined, dropped to 54.5% (456 patients), while only 132 (15.8%) of the patients were examined twelve months after active treatment. At the end of treatment however, 439 (52.5%) of the patients were examined with periapical radiographs. (Fig. 3)

Figure 2. Percentage of history records taken before treatment regarding the various predisposing factors.

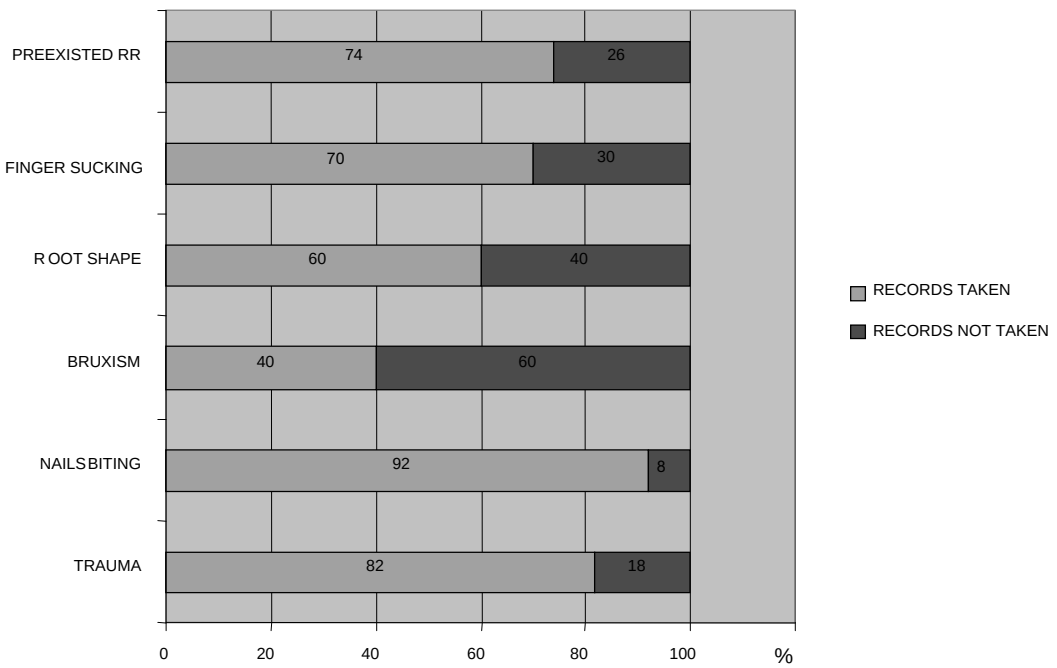


Figure 3. Percentage of periapical xrays taken in different stages of orthodontic treatment.

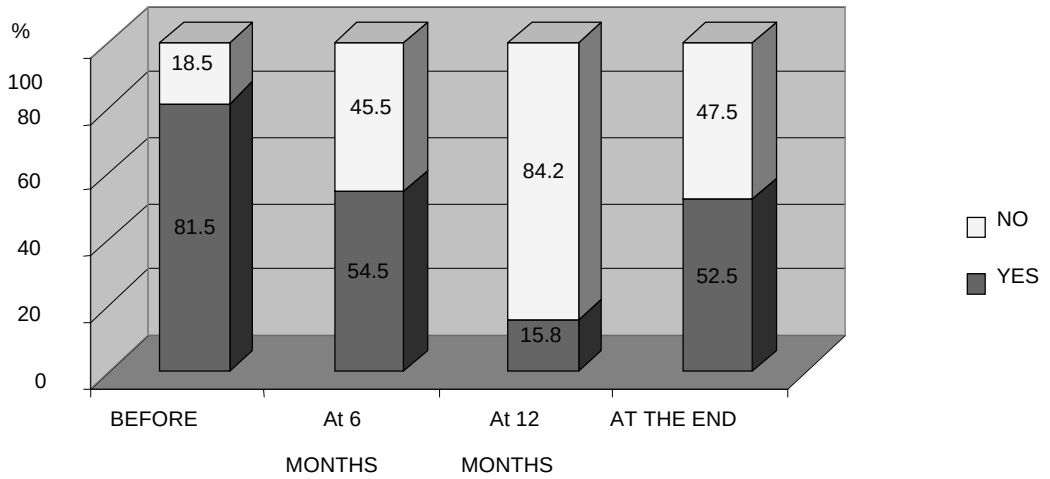


Figure 4. Percentages of panoramic radiographs performed before and after the orthodontic treatment.

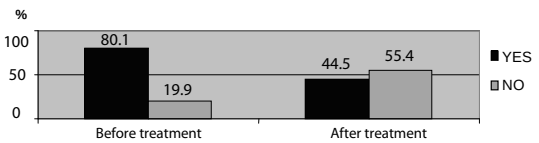
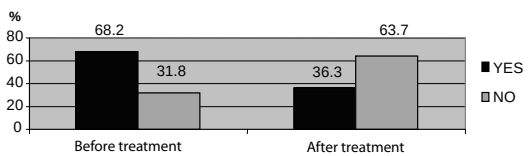


Figure 5. Percentages of cephalometric radiographs performed before and after the orthodontic treatment.



Before treatment 2.8% had neither intraoral nor panoramic radiographs while 15.7% had only panoramic radiographs but no periapicals. After treatment, 12.3% had neither intraoral nor panoramic examination radiographs while 35.2% had only panoramic radiographs but no periapical.

In 82% of the patients examined with intraoral radiographs, the examination covered the upper and lower cuspid to cuspid region while in the remaining 8% the examination was limited to the lateral to lateral region.

At six months of active treatment 78% of the periapical radiographs were taken in the upper and lower anterior region while at the end of treatment 74% were taken in the same region.

Use of panoramic and cephalometric radiographs.
Before treatment 80.1% of the patients were examined with panoramic radiographs while almost half (45%) were examined after treatment. (Fig. 4) Cephalometric radiographs were taken in 68.2% of the patients before treatment, and in 36.3% of the patients after treatment. (Fig. 5)

Neither panoramic nor cephalometric radiographs were taken in 18.4% before treatment while both types of radiographs were taken in 42.2% of the patients before treatment. After treatment the corresponding values were 30.4% and 31% respectively.

Prevalence of root resorption during and after treatment.
According to recordings in the patients journals (n=682) of those who were examined with periapical and panoramic radiographs, light root resorption was reported in 1.9%, 3.2%, 4.9%, 8.6% at the beginning, 6 , 12 months of treatment, and at the end of treatment, respectively. Severe root resorption was only reported in 1% after twelve months of active treatment and in 1.9% at the end of active treatment. (Fig. 6)

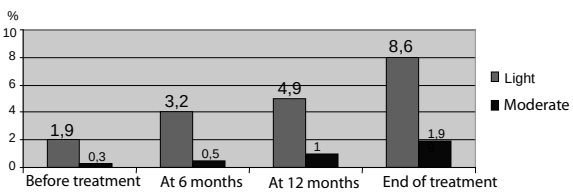


Figure 6. Prevalence of root resorption reported from the orthodontic paractitioners at the different stages of active treatment.

Table 1. Results of multivariate regression analyses using Root Width Indexes (I,II III IV) as dependent variables

Variable	Unit	Effect	P
Age at treatment start	years	0.05	.87
Sex	m(0)/f(1)	0,03	.73
Pre-existed resorption (6 months)	yes/no	0,11	<.05
Treatment duration	months	0,09	.65
Trauma	yes/no	0.04	.69
Root width Index	I, II, III, IV		
Root form anomaly	yes/no	0,09	.20
Finger sucking	yes/no	0.04	.79
Nails biting	yes/no	0.01	.84
Bruxism	yes/no	0.08	.20
Extractions treatment	yes/no	0.06	.22

Multivariable regression analysis (Table 1) revealed no significant associations between root resorption reported and: gender, treatment duration, extractions treatment, etc. Association was ($P< 0.05$.) however, found between root resorption reported at the first 6 months of active treatment and at the end of treatment (Table 1)

Treatment approaches when root resorption was diagnosed.

In 8% of the cases, root resorption was diagnosed by the orthodontists during treatment and the treatment regime was altered. In cases when moderate root resorption (from 2 mm up to 1/3 of the root length) was diagnosed, the use of lower forces, resting periods and decrease of treatment time were common preventive measures. In cases when severe root resorption (equal to or more than 1/2 of the root length), was diagnosed during treatment, the majority of the operators, stopped treatment or decreased the total duration.

Discussion

The purpose of this study was to investigate how the difficulties with root resorption are handled in daily life in a large orthodontic clinic. The number of patients treated every year at the clinic is around 1000 and treatment is mainly performed with full fixed appliances. Interceptive orthodontic treatments with removable appliances are mostly performed by general dentists in general practices in the Community Dental Health Service in Göteborg supervised by orthodontists from the specialist clinics who regularly visits these practices.

The study was retrospective. However, a study of this type can only be performed retrospectively because the intention was to investigate how things were done. A prospective study will by natural reasons change the behavior of the specialist as they know that their actions are monitored and registered.

The total material consisted of 930 patient records. Eighty three patients (9% of the total material) were excluded due to the absence, or that very limited data was found concerning journal recordings and/or radiographic examinations. The majority of the annotations in the journal records addressing predisposing factors were related to trauma, root shape anomalies and nail biting, and this is in accordance with risk factors described in the literature (5, 17, 34).

Periapical radiographs constituted the most common radiographic examination for the diagnosis of root resorption. However, in only 54% of the patients, a radiographic follow up was performed after 6 months of active treatment. This indicates that not all orthodontist follows the recommendations by Levander and Malmgren, (13, 16). The use of radiographs to estimate, predict and monitor root resorption during and at the end of treatment was considerably less than that reported in a previous survey among Swedish orthodontists conducted by the use of questionnaire. (19). This could indicate that the knowledge is there but when it comes to the daily routines other priorities are made. When however, root resorption was diagnosed before and during orthodontic treatment, the treatment precautions were in agreement with the previous survey and also in accordance with the recommendations in the orthodontic literature (19, 13, 14).

The prevalence of moderate root resorption, 3.2%, of the patients at 6 months and 8.6% at the end of treatment were in agreement with several studies of root resorption after treatment with fixed appliances (1, 28). The prevalence of severe root resorption 0.5% of the patients at 6 months and 1.9% at the end of treatment was less than has been reported in previous studies (14, 15). However, deviations in prevalence of root resorption reported in the literature are common phenomena, and depend on the material, methods and criteria used. It should also be noted that the number of patients examined radiographically, decreased significantly between the different examination stages but still 456 and 439 patients, out of 837, were radiographically examined after six months of treatment and at the end of active treatment, respectively. The prevalence of root resorption after orthodontic treatment was therefore still based on a large material.

In the present study, no significant associations were found between final radiographic outcome of root resorption and initial records of predisposing factors (Table 1) as gender, extraction-treatments, treatment duration, etc. These results are in contradiction with previously studies (4, 11, 17). It is important however, to keep in mind that this is a retrospective study, based on journal recordings and it is not known if all orthodontist in a structured manor asked questions on all predisposing factors.
In summary when the results of the present study is compared with a previous study (19) based on a questionnaire where Swedish orthodontists were asked how they dealt with root resorption in their daily practice it seems as if the predisposing factors are recorded, recommendations on treatment measures are followed but the radiographic monitoring during treatment are not performed to the extent that the orthodontists said they were doing. Or in other words, the orthodontists do not always do what they think they are doing. However, it should be noted that the evidence of early radiographic detection and prevention of severe root resorption is inconclusive and needs to be clarified in more studies (35).

Conclusions

- Among the predisposing factors recorded in the journals, the most frequent registration was for trauma and nail biting.
- Before treatment periapical radiographs were taken in most cases. The percentage of the radiographs dropped significantly at six months, while only 15% of the patients were examined at twelve months of active treatment. At the end of treatment half of the patients were examined with periapical radiographs
- In cases when moderate root resorption was diagnosed before or during treatment the use of lower forces, resting periods and decrease of treatment time were common preventive measures.
- In cases when severe root resorption was diagnosed the majority of the operators stopped treatment or decreased the total treatment time.
- Light root resorption was found in less than 10% while severe root resorption was noted in 2% after active treatment.

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Inter- and intra-individual variations in saliva secretion rates

– a comparison of unsupervised and supervised sample collection

JOHAN BLOMGREN [1], BENGT HASSÉUS[1,2]

Abstract

◉ The aim of this study was to investigate if unsupervised measurement of saliva secretion could be used instead of supervised measurement at the dental clinic. One hundred patients attending a dental clinic for regular dental care were asked to participate (group A). A control group of 40 subjects was recruited (group B). Saliva samples were collected and stimulated saliva secretion rates were determined. After instruction, subjects in both groups collected the first sample at day 1 at the dental clinic. Subjects in group A continued to collect 2 more samples at day 1 and 3 samples at each of day 3 and day 5 outside the clinic. Subjects in group B did 3 saliva samplings at day 1, day 3, and day 5 under supervision at the dental clinic. In total 9 samples from each subject were collected. Median secretion rates in group A were, in day 1, 2.1ml/min (range: 0.1-5.1); day 3, 1.9 ml/min (range: 0.1-5.3); and day 5, 1.9 ml/min (range: 0.1-5.5). Corresponding rates in group B were, in day 1, 2.1 ml/min (range: 0.6-4.4); day 3, 2.0 ml/min (range: 0.7-4.6); and day 5, 2.0 ml/min (range: 0.9-4.1). No significant difference in secretion rates appeared between groups A and B at day 1, 3, and 5 or during the 5 days of observations. Analysis of intra-individual differences in secretion rates showed that in group A there was a significant difference between measurements, while in group B measurements did not differ significantly. The intra-individual variation expressed as mean coefficient of variation during the 5-day period was 20.4% in group A and 17.3% in group B. In conclusion, measurement of saliva secretion capacity under unsupervised conditions may be a feasible method to judge saliva secretion capacity in clinical practice.

Key words

Dental care, diagnosis, hyposalivation

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Inter- och intraindividuella variationer i salivsekretionsmätning

– en jämförelse mellan oövervakad och övervakad salivsekretionsmätning

JOHAN BLOMGREN, BENGT HASSÉUS

Sammanfattning

◉ Syftet med studien var att undersöka om oövervakad salivsekretionsmätning kan användas i stället för övervakad salivsekretionsmätning, samt att undersöka relevansen av ett enstaka salivprov för utvärdering av eventuell hyposalivation hos patienten.

Etthundra patienter på en tandklinik tillfrågades om deltagande (grupp A). En kontrollgrupp på 40 patienter tillfrågades också om deltagande (grupp B). Stimulerad saliv insamlades och salivsekretionshastighet bestämdes. Efter instruktion fick försökspersonerna i grupp A och B lämna det första salivprovet på tandkliniken. Försökspersonerna i grupp A fortsatte med att samla in 2 salivprov dag 1, 3 ytterligare salivprov dag 3 och dag 5, utanför tandkliniken. Försökspersonerna i grupp B lämnade 3 salivprov per dag, dag 1, dag 3, och dag 5 på tandkliniken. Totalt samlades 9 salivprov in från varje försöksperson. Mediansalivsekretionshastighet i grupp A var dag 1, 2,1 ml/min (range: 0.1-5.1); dag 3, 1,9 ml/min (range: 0,1-5,3); och dag 5, 1,9 ml/min (range: 0.1-5.5). Motsvarande salivsekretionshastighet var i grupp B 2,1 ml/min (range: 0.6-4.4); dag 3, 2,0 ml/min (range: 0,7-4,6); och dag 5, 2,0 ml/min (range: 0,9-4,1). Det fanns ingen signifikant skillnad mellan grupp A och B när sekretionshastigheten dag 1, 3 och 5 jämfördes, under observationsperioden på 5 dagar. Analys av intraindividuella skillnader i sekretionshastighet visade att det i grupp A fanns signifikanta skillnader mellan de 9 salivsekretionsmätningarna. I grupp B var det inte någon signifikant skillnad mellan de 9 salivsekretionsmätningarna. Den intraindividuella variationen uttryckt som medelvärdet av variationskoefficienten under en 5 dagars period var 20,4% i grupp A och 17,3% i grupp B. Slutsatsen blir att oövervakad salivsekretionsmätning kan vara en användbar metod för att bedöma salivsekretionskapacitet i den kliniska vardagen, men att metoder för att kontrollera för mätningsrelaterade intraindividuella variationer måste utvecklas ytterligare.

Introduction

Saliva is of utmost importance for oral function, health, and wellbeing. This becomes evident when saliva secretion is substantially reduced for various reasons (8, 27). Xerostomia is, therefore, probably perceived as a significant problem for many patients (11, 23).

Oral dryness is a higher-level term comprising two definitions: Xerostomia is the patient's subjective perceived oral dryness, whereas, an objective measurement that confirms low saliva secretion is defined as hyposalivation (11, 14, 19, 32).

Objective measurements of saliva secretion are done to determine caries susceptibility or to investigate certain systemic diseases. *Sjögren's syndrome* is a disease with salivary dysfunction, where saliva secretion measurement is one of the diagnostic criteria (35-37). Normal saliva secretion is defined as a stimulated whole saliva secretion of more than 1.0 ml/min (1, 7). A definition of hyposalivation proposed by *Ericsson et al.* and *Nauntofte et al.* is a stimulated salivary secretion of less than 0.7 ml/min (10, 26).

In different clinical situations, as with the diagnosis of *Sjögren's syndrome,* objective saliva secretion measurements are required (37). In Sweden objective saliva measurements may also be required in order to pay dental insurance compensation to patients with disabilities who are dependent on nursing personnel, according to the reformed Dental Care Subsidy (33). Patients referred to oral medicine clinics because of oral signs and symptoms related to decreased salivation are common (24). If hyposalivation is confirmed by objective measurements of saliva secretion rates, not only treatment but also the cost of treatment for the patient and/or society may be affected. Traditionally, objective saliva measurements are comprised of resting, as well as stimulated complete saliva secretion induced by chewing.

Resting saliva secretion can also be measured by various methods. The most common method of collecting resting saliva is to have the inactive patient let saliva drop down into a funnel for collection (1, 7). In Sweden the standard method in general dental practice to determine whether a patient has an objectively impaired saliva secretion capacity is to use stimulated complete saliva secretion induced by the chewing of paraffin wax (16).

For the latter reason, we have chosen to examine this specific type of sampling in our study. Sampling can be influenced by different factors, such as chewing force and removable dentures (18, 28). The circadian rhythm prevents single saliva sampling from reflecting true saliva secretion during longer periods of time (6, 13). Therefore, we assume that repeated sampling would give more accurate salivary secretion information. Because of financial and time considerations, this is usually not the method of choice in general dental practice. Studies addressing the relevance of unsupervised saliva secretion sampling are sparse. However, *Jorkjend et al.* have shown in a study of Sjögren's patients collecting saliva samples at home that secretion capacity varies considerably over time (20). Since repeated measures of saliva secretion capacity at the dental clinic is not the method of choice, it would be of interest to investigate whether unsupervised saliva sampling by the patient at home could be used to determine saliva secretion capacity.

The aim of this study was to investigate if unsupervised saliva secretion measurement could be used instead of supervised measurement at the dental clinic, and the significance of a single saliva sample in determine hyposalivation.

Material and Methods

One hundred patients attending the Clinic for Oral Medicine, Sahlgrenska University Hospital/East, for their regular dental care were asked to participate and were consecutively enrolled in the study (group A). Also, a control group of 40 subjects amongst staff members at the hospital were asked to participate (group B). All subjects in group B received regular dental care. Some of the included subjects in group A discontinued the study prematurely. Additional subjects were consecutively enrolled until 100 subjects completed the study. In the control group none of the subjects left the study.

In group A 66 women and 24 men were enrolled (mean age 47,6 years, median age 47,5; range 20–78 years). In this group 22 patients received antihypertensive medication, 10 patients took 3 or more pharmaceutical substances a day, 5 patients took pharmaceutical substances of which dry mouth is a side effect. Six patients were registered in more than one of the categories above. Eleven patients smoked. In group B 29 women, 11 men (mean age 44,9 years, median age 45; range 30–53 years) were enrolled. Four patients received antihypertensive medication, 3 patients took 3 or more pharmaceutical substances a day, 8 patients took pharmaceutical substances of which dry mouth is a side effect. Three patients were registered in more than one of the categories above. Four patients smoked.

Subjects in the two groups received the first in-

struction at the dental clinic before the first sampling session. The method used in this study for stimulated saliva sampling has previously been described (2, 16). Briefly, a standardised piece of paraffin wax (1 g) was chewed by the subject for a period of 5 minutes. Saliva was collected in a graded test tube, which was sealed after completed saliva collection.

Subjects in group A did their first sampling on study day 1 at the dental clinic, after instruction and under supervision of a dental hygienist. All other samplings (day 1, day 3, and day 5) were collected unsupervised at a time chosen by the test subject and outside the clinic. The subjects were instructed to collect 2 additional saliva samples at day 1 and 3 saliva samples at each of day 3 and day 5. The subjects were asked to choose sample collection occasions as evenly spaced as possible over the day, but otherwise when it was most suitable to them. The subjects used a watch with a hand showing seconds to determine collection time. A total of 9 samples were collected from each subject. Test tubes with the saliva samples were returned to the dental clinic after day 5, and saliva volumes were determined and recorded, and secretion rates calculated by a dentist.

Subjects in group B did saliva sampling under supervision of a dental hygienist at the dental clinic. A watch with a hand showing seconds was used to determine collection time. Saliva volumes were determined and recorded, and secretion rates calculated by a dentist.

Intra-individual coefficients of variation (CVs) were calculated as the ratio of the standard deviation over mean salivary secretion rate of 9 samples during 5 days in each patient and expressed as a percentage (30).

The Human Ethics Committee of the University of Gothenburg approved the study (Ö 058-02).

Statistical analysis

Statistical analyses of differences between groups were done by the Mann-Whitney U test when testing differences in saliva secretion rates between two groups and by the Kruskal-Wallis test for differences between saliva secretion rates between multiple groups. When Kruskal-Wallis analysis revealed statistical significance between multiple groups, Mann-Whitney analysis was used as post-hoc test. Intra-individual differences within groups were explored using the Friedman test. Data were tested for normal distribution using the Kolmogorov-Smirnov test and were found to not be normally distributed, which is why non-parametric tests were used in statistical analysis. A p value <0.05 was considered to be statistically significant.

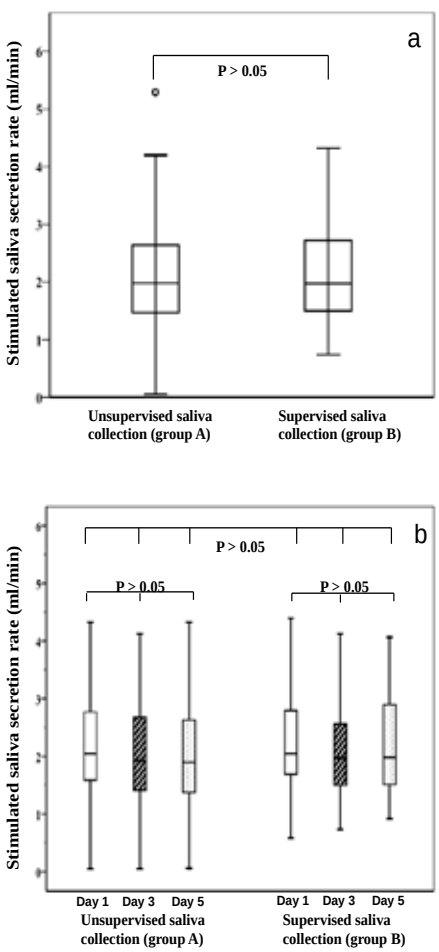
Results

Inter-individual saliva secretion rates

The mean salivary secretion rates of collected samples during 5 days for subjects in group A was 2,1 ml/min, (median 2.0; Figure 1a), and the equivalent average results for subjects in group B was 2.2 ml/min (median 2.0; Figure 1a). Groups A and B did not

Figure 1

Box plot presentations of saliva secretion rates in subjects performing 9 unsupervised sample collections (n=100; group A) and subjects performing 9 supervised sample collections (n=40; group B) during 5 days (a) and saliva secretion rates on day 1, 3 and 5 in group A and B (b). Five horizontal lines on each box graph from bottom to top represent 10th, 25th, 50th (median), 75th and 90th percentiles. Circles plotted above 90th or below 10th percentiles are individual maximum and minimum data points. P – values denote level of statistical significance.



differ significantly in saliva secretion rates ($p > 0.05$; Figure 1a). Neither could gender specific differences in secretion values be detected between group A and group B (data not shown; $p > 0.05$). The groups did not differ significantly in age ($p > 0.05$; data not shown).

Mean secretion rates in group A were, in day 1, 2.2 ml/min (median 2.1; Figure 1b); day 3, 2.1 ml/min (median 1.9; Figure 1b); and day 5, 2.1 ml/min (median 1.9; Figure 1b). Corresponding secretion rates in group B were, in day 1, 2.2 ml/min (median 2.1; Figure 1b); day 3, 2.2 ml/min (median 2.0; Figure 1b); and day 5, 2.2 ml/min (median 2.0; Figure 1b). There was no significant difference in stimulated saliva secretion rates between group A and group B in day 1, 3, and 5 ($p > 0.05$; Figure 1b). Nor were any significant differences found in secretion rates within groups A and B during the 5 days of observations ($p > 0.05$; Figure 1b).

Intra-individual saliva secretion rates

Analysis of intra-individual differences between the 9 measurements of secretion rates collected at days 1, 3, and 5 from subjects in groups A and B, respectively, showed that in group A there was a significant difference between measurements ($p < 0.001$; Table 1). However, in group B the 9 secretion measurements did not differ significantly ($p > 0.05$; Table 1).

Intra-individual variation expressed as mean CV during the 5 day period was 20.4% in group A (median 20.0; Figure 2a) and 17.3% in group B (median 16.8; Figure 2a). The mean CV during the 5 day period was significantly lower for group B compared to group A ($p < 0.05$; Figure 2a).

The mean CV in group A was, in day 1, 18.4% (median 15.8; Figure 2b); day 3, 17.3% (median 16.0; Figure 2b); and day 5, 17.0% (median 14.9; Figure 2b). Corresponding data in group B were, in day 1, 14.5% (median 11.8; Figure 2b); day 3, 16.1% (median 16.4; Figure 2b); and day 5, 12.1% (median 10.3; Figure 2b). The CV in days 1 and 3 did not differ significantly between group A and group B ($p > 0.05$; Figure 2b), but the CV in day 5 showed a significant difference between groups ($p < 0.01$; Figure 2b).

No significant differences were found comparing CV values within group A ($p > 0.05$; Figure 2b). In group B the CV for day 5 differed significantly in comparison to days 1 and 3 ($p < 0.05$; Figure 2b).

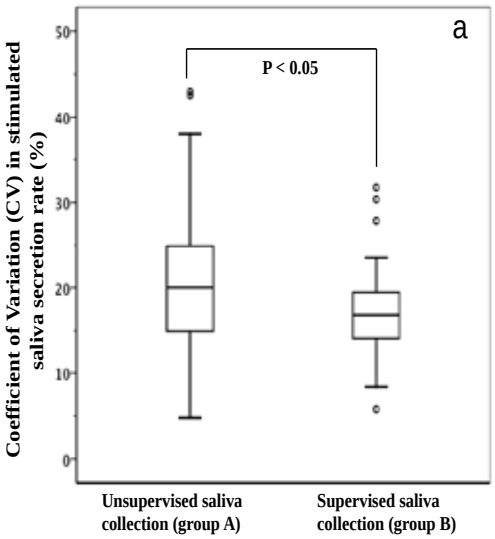
Inter- and intra-individual saliva secretion rates in subjects with high and low secretion rates

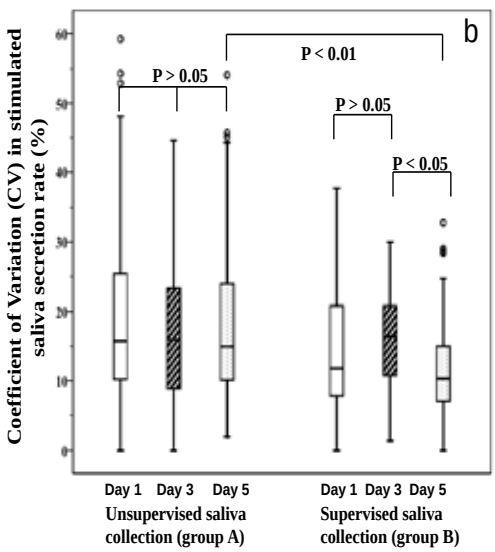
In group A 13 patients (8 women, 5 men; mean age

Table 1. Stimulated saliva secretion rates in subjects collecting unsupervised (n=100) and supervised (n=40) saliva samples. Nine samples were collected from each subject during a 5-day period.

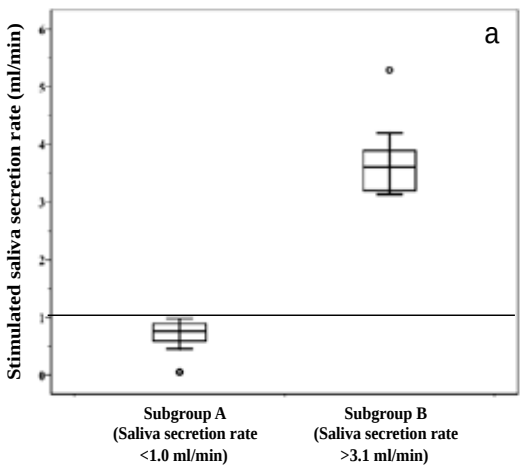
	Unsupervised saliva sample collection									Supervised saliva sample collection								
	Measurement no.									Measurement no.								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Mean saliva secretion rate (ml/min)	2.0	2.2	2.2	2.0	2.1	2.1	2.0	2.2	2.1	2,2	2,3	2,2	2,2	2,3	2,1	2,1	2,2	2.1
Median saliva secretion rate (ml/min)	2.0	2.2	2.2	1.8	2.0	2.0	1.8	2.1	1.9	2,2	2,2	2,0	2,1	2,2	1,9	2,1	2,2	1.9
Range	0.1 4.6	0.1- 5.4	0.1- 5.4	0.0- 4.6	0.0- 5.4	0.1- 5.8	0.1- 4.6	0.1- 6.2	0.1- 6.0	0.6- 4,1	0.5- 4,6	0.6- 4,6	0.7- 4,7	0.6- 5,4	0.8- 4,8	1.0 4,2	1.0- 4,2	0.8 -4.5

◎ **Figure 2a and b.** Box plot presentations of coefficient of variations (CVs) for saliva secretion rates during 5 days in subjects performing 9 unsupervised sample collections (n=100; group A) and subjects performing 9 supervised sample collections (n=40; group B) (a) and CVs for saliva secretion rates on day 1, 3 and 5 on group A and B (b) Five horizontal lines on each box graph from bottom to top represent 10th, 25th, 50th (median), 75th and 90th percentiles. Circles plotted above 90th or below 10th percentiles are individual maximum and minimum data points. P – values denote level of statistical significance.





◎ **Figure 3a and b.** Box plot presentations of saliva secretion rates during 5 days in 13 subjects performing 9 unsupervised sample collections with a mean stimulated saliva secretion capacity <1.0 ml/min (subgroup A) and 13 subjects with mean stimulated saliva secretion capacity >3.1 ml/min (subgroup B) (a). Saliva secretion rates on day 1, 3 and 5 in subgroup A and subgroup B (b). Five horizontal lines on each box graph from bottom to top represent 10th, 25th, 50th (median), 75th and 90th percentiles. Circles plotted above 90th or below 10th percentiles are individual maximum and minimum data points. P – values denote level of statistical significance.



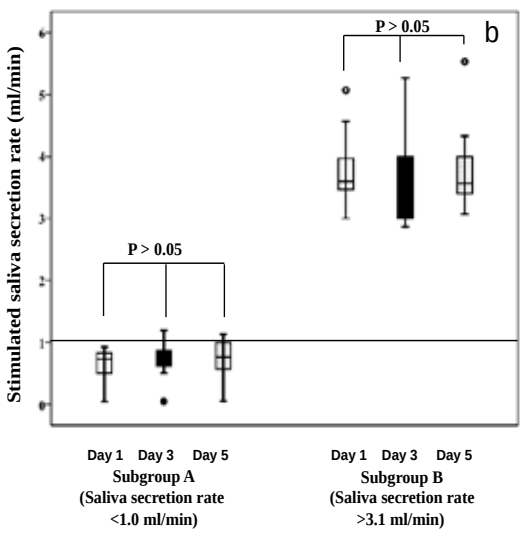


Figure 4a and b. Box plot presentations of coefficient of variations (CVs) for saliva secretion rates during 5 days in subjects performing 9 unsupervised sample collections with a mean stimulated saliva secretion capacity <1.0 ml/min (subgroup A) and 13 subjects with mean stimulated saliva secretion capacity >3.1 ml/min (subgroup B) (a) and CVs on day 1, 3 and 5 in subgroup A and subgroup B (b) Five horizontal lines on each box graph from bottom to top represent 10th, 25th, 50th (median), 75th and 90th percentiles. Circles plotted above 90th or below 10th percentiles are individual maximum and minimum data points. P – values denote level of statistical significance.

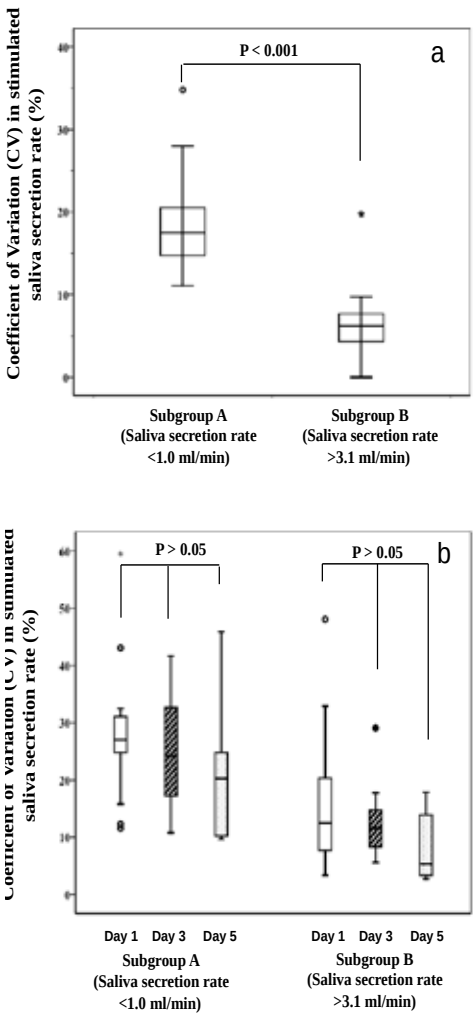
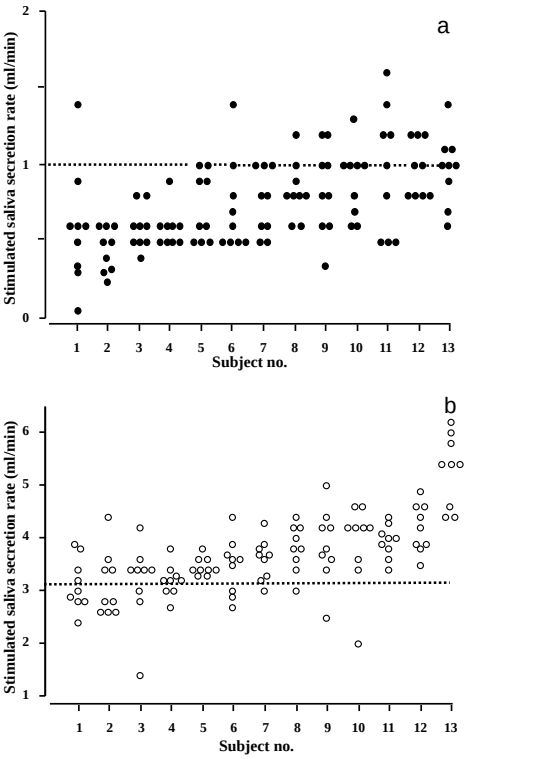


Figure 5a and b. Scatter plot presentations for saliva secretion rates during 5 days in subjects with a mean stimulated saliva secretion capacity <1.0 ml/min collecting 9 unsupervised samples (a) and 13 subjects with mean saliva secretion capacity >3.1 ml/min collecting 9 unsupervised samples (b). Dotted lines represent cut off limits.

Fig. 5



53.8 years, median age 55; range: 30–73) with a mean salivary secretion rate below 1.0 ml/min were identified. This subgroup had a mean salivary secretion rate of 0.7 ml/min (median 0.8; Figure 3a). The subgroup within group A of 13 patients with the 13 highest mean salivary secretion rates (>3.1 ml/min) showed a mean salivary secretion of 3.7 ml/min (median 3.6; Figure 3a).

Mean secretion rates in the group with low secretion rates were 0.7 ml/min (median 0.7; Figure 3b) in day 1; 0.8 ml/min (median 0.8; Figure 3b) in day 3; and 0.7 ml/min (median 0.8; Figure 3b) in day 5. There were no significant differences between mean secretion rates in days 1, 3, and 5 in this group ($p > 0.05$; Figure 3b). In the group with high secretion rates, corresponding values were 3.6 ml/min (median 3.6; Figure 3b) in day 1; 3.6 ml/min (median 3.5; Fi-

gure 3b) in day 3; and 3.8 ml/min (median 3.6; Figure 3b) in day 5. No significant differences were detected ($p > 0.05$; Figure 3b).

A comparison of intra-individual variation, expressed as coefficient of variation showed a significant difference between the groups with secretion rates <1.0 ml/min and secretion rates >3.1 ml/min ($p < 0.001$); Figure 4a). Analysis of intra-individual variation, expressed as coefficient of variation in subjects belonging to the group with secretion rates <1.0 ml/min did not show any significant differences between days 1, 3, and 5 in this group ($p > 0.05$; Figure 4b). Neither could significant differences be detected between days 1, 3, and 5 in subjects belonging to the group with secretion rates >3.1 ml/min ($p > 0.05$; Figure 4b).

Analysis of intra-individual differences between the 9 measurements of secretion rates in subjects belonging to the group with secretion rates <1.0 ml/min did not show any significant differences ($p > 0.05$; Figure 5a). In contrast, significant differences were detected within the 9 measurements registered in subjects belonging to the group with secretion rates >3.1 ml/min ($p < 0.05$; Figure 5b). In the group with mean secretion rate <1.0 ml/min, 7 out of 13 subjects showed one or more measurements with a secretion rate >1.0 ml/min (Figure 5a). In the group with mean secretion rates >3.1 ml/min, one patient presented with secretion rates between 1.4 and 4.2 ml/min (Figure 5b).

Discussion

The results of the present study show intra-individual as well as inter-individual variations in single sampling measurement values, both in the group of subjects performing unsupervised saliva sampling and in the group with supervised sampling.

Normal saliva secretion rate is defined as a stimulated whole saliva secretion of more than 1.0 ml/min (7). A definition of hyposalivation is a stimulated salivary secretion of less than 0.7 ml/min (10, 26). The fact that hyposalivation diagnoses often are based on single sampling makes evaluation of sampling reproducibility important.

Attending several appointments at a dental clinic to perform saliva measurements is time-consuming and expensive. Unsupervised saliva sample collection has been used in studies addressing intra- and inter-individual variations in sex hormones secreted in saliva (5, 15). In this study we let test subjects perform saliva collections unsupervised at times of their choice. To achieve a more accurate measure of an individual patient's saliva secretion capacity, the patient should be asked to collect saliva at several time points. This was the rationale to let a group of test subjects collect saliva unsupervised and compare the results with a group of subjects who performed supervised saliva collection at the dental clinic.

The design with repeated saliva collections during a period of days enables us to address the intra-individual variation. It is well known that saliva secretion in individual subjects shows a considerable variation due to factors such as time of day, hormonal influences, number of remaining teeth, and stress (6, 8, 12, 17, 25). In clinical practice this poses a problem when, for some reason, it has to be decided whether a patient should be assigned the diagnosis hyposalivation. The fact the subjects themselves choose time points for sample collection reflects the situation in regular dental care, whereas, appointments to the dental office usually depend on patients' requests and the dentist's schedule.

In this study there was no difference in stimulated saliva secretion rates between the group of subjects who performed unsupervised sample collections and the group who performed supervised sample collection during a 5-day period. Our study shows intra-individual variation in saliva secretion rates in the group of unsupervised sample collection. This is not in line with the findings reported by *Heintze* and co-workers who found that secretion rates are quite stable in individuals, but vary considerable from subject to subject (16). In contrast, *Laine et al.* reported a significant increase in salivary flow rates in a 7-week period (21).

In laboratory investigations the problem with intra-individual variation of repeated tests is well known (3, 4, 30). One method to describe this inevitable variation is to use a coefficient of variation (CV) when analysing data (3, 30). CV takes into account the absolute values obtained in repeated measurement and the intra-individual variation (30). In this study we assessed CV in parallel with analysing intra-individual absolute numbers of secretion rates. When CVs were used as an assessment of intra-individual saliva secretion rates, there were significant differences in the unsupervised group compared to the group where saliva samples were collected under supervision. This difference occurred between days 3 and 5 in the supervised group and was reflected in a difference also between collections at day 5 in the unsupervised group compared to day 5 in the supervised group. These findings were confirmed by analysis of the separate measurements during

the observation period that also revealed significant intra-individual differences in subjects performing unsupervised sample collection.

Thus, the inter-individual saliva secretion rates did not differ between subjects in the supervised and unsupervised group, but intra-individual variations in secretion rates were higher in the unsupervised group. This may be explained by a possible tendency among subjects in the unsupervised group to not follow the test protocol. Another possibility is that subjects performing unsupervised saliva collection collected samples at time points different from those of the subjects in the supervised group, admitting the known temporal variation of secretion rates during a 24-hour period (13, 31). The test and control groups were not matched, but all subjects in the test group received regular dental care and the groups did not differ in age distribution, so it is reasonable to assume that conclusions may be drawn from data obtained in the study.

Assessment of saliva secretion rates in patients is done as part of diagnosing hyposalivation, although it is important to bear in mind that perceived dry mouth in patients to a great extent may be explained by saliva composition (34). However, saliva secretion measurement has to be considered the method of choice in the dental care provided by clinics in general practice. In general practice it would be desirable to register both stimulated and resting secretion rates, especially since evidence has been presented that minor salivary gland dysfunction substantially contributes to dry mouth symptoms (9).

From the clinical perspective it is also important to know whether a single saliva secretion measurement gives an objective and true value of the patient's capacity to produce saliva in relation to objective or perceived dry mouth. Thus, the question of measurement of saliva secretion rates is evoked either when the patient reports dry mouth symptoms to the dentist or when there are objective findings of hyposalivation.

It was of interest to further analyse our data in the subjects with low secretion rates. We identified a subgroup in the group that collected saliva in an unsupervised manner and with a mean salivary secretion rate during the test period of <1.0 ml/min. A corresponding subgroup with the highest mean salivary secretion rates was also identified. Interestingly, we could not detect any significant differences in intra-individual secretion rates between the measurements in the subjects with low secretion rates, but there were significant differences in intra-individual secretion rates in subjects with high secretion rates. Probably high capacity to produce saliva results in a wider range in salivary gland function. A majority of subjects with low secretion rates had one or more measurements above the cut-off limit (>1.0 ml/min). Although not reaching statistically significant difference, it can be concluded that single saliva secretion measurements vary considerably. This is in line with results reported in a study by *Jorkjend et al.* that found considerable intra-individual variation in both resting and stimulated saliva secretion rates in patients with *Sjögren's syndrome* (20). This emphasises that establishing a diagnosis of hyposalivation on one single measurement of saliva secretion raises a risk to misinterpret the patient's saliva secretion capacity.

A variety of systemic diseases influence saliva secretion capacity (27). In this study the medical history amongst study subjects disclosed various medical conditions and different medical treatments. In the group of subjects collecting saliva unsupervised there was a dominance of smokers and persons taking antihypertensive drugs, compared to the supervised group. Also, the unsupervised group contained more subjects taking three or more drugs on a daily basis than the supervised group. In contrast, the group of subjects collecting saliva samples under supervision contained a slightly higher number of subjects using drugs where "dry mouth" is stated as a side effect in the Swedish pharmaceutical register. Thus, the groups were neither completely balanced nor too disparate in factors known to affect saliva secretion to obviate drawing cautious conclusions from comparisons of the groups.

Oral status is known to correlate with saliva secretion (12, 22). The influence of missing teeth or removable prosthetic devices on salivary secretion was not addressed in this study. However, mean and median ages of the two groups were approximately equal, and all subjects had dental care on a regular basis, which implied no major imbalance in oral status between the groups. The gender representation in the test population was disproportionate. However, in this study we did not find any significant difference in average saliva secretion rates between men and women in the studied groups, in contrast to earlier reports that women produce less saliva than men (29).

Several subjects in the test group dropped out of the study. Reasons for discontinuing the study were difficulties in chewing paraffin and that the paraffin wax crumbled or got stuck in various parts of

the mouth. Because the study was blinded regarding patient identification, subject discontinuation could not be followed up. Additional subjects were consecutively enrolled until the predefined number of study patients was achieved.

Although desirable, not all known factors affecting saliva secretion were controlled for in this study. However, our data are likely to reflect ordinary patients receiving regular dental care in Sweden.

In conclusion, stimulated saliva secretion rates did not differ between the group that collected unsupervised saliva samples during five days and the group that collected supervised samples. However, analysing the intra-individual coefficients of variation, as well as intra-individual variation in absolute numbers of secretion rates, we found a significant difference in the group that performed unsupervised sample collection compared to the group that performed supervised sample collection, indicating the necessity for further development of the unsupervised saliva sampling technique. The present study elucidates the importance of carefully evaluating the impact of a single saliva secretion measurement when assigning a patient the diagnosis hyposalivation. Further studies and protocols that enable unsupervised saliva sample collection at several time points during a period of days are warranted to increase diagnostic safety for patients and cost effectiveness in daily clinical care.

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One year clinical performance and post-operative sensitivity of a bioactive dental luting cement

– A prospective clinical study

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Abstract

◎ A one-year clinical study was performed on the efficacy of a bioactive dental cement (Ceramir C&B) with calcium aluminate and glass ionomer components. The study was performed on 38 crown and bridge abutments in 17 patients. Preparation parameters were recorded, as well as working-times, setting-times, and other handling characteristics. Baseline data were also recorded for gingival inflammation (GI) and pre-cementation sensitivity. Post-cementation parameters included sensitivity, gingival tissue reactions, marginal integrity and discolorations.

All patients were seen for recall examinations at 30 days, and 6 months. For sixteen patients one-year recall data were collected on retention and subjective sensitivity. Fifteen subjects were available for one year clinical examinations.

Three independent examiners found the working and setting time of the cement to be well within expected limits and that cement removal was easy.

Four patients reported low-grades of immediate post-cementation sensitivity, however, this disappeared after an occlusal adjustment or without intervention within one month.

At 12 months no retentive failures were recorded and no subjective sensitivity reported. All crowns were rated in the "Excellent" quality category for marginal integrity. Both GI-scores and scores for tooth sensitivity decreased during the course of the study. One year recall data yielded no incidence of secondary caries and no visible marginal discoloration. The new cement was thus found to perform favorably as a luting agent for permanent cementation.

Key words

Dental cement, cementation, luting cement, bioactive, crowns, bridges, gold, PFM

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En 1-års studie av de kliniska resultaten vid användning av ett bioaktivt fastsättningscement

– En prospektiv klinisk studie

S R JEFFERIES, C H PAMEIJER, D APPLEBY, D BOSTON, J LÖÖF, P-O GLANTZ

Sammanfattning

◎ En 1-årig klinisk studie av ett nytt fastsättningscement (Ceramir C&B) för metalliska och keramiska konstruktioner har genomförts på 17 patienter och totalt 38 gjutna kronor. Stödtändernas preparationsgeometri noterades liksom hanterings-egenskaper för det testade cementet, som huvudsakligen består av en vattenbaserad blandning av kalcium-aluminat och s.k. glassjonomer. Vid cementeringstillfället gjordes även bedömningar av status hos det marginala parodontiet kring stödtänderna (GI-index) och förekomst av eventuell ökad grad av känslighet hos de preparerade tänderna.

Samtliga patienter genomgick klinisk undersökning efter en och sex månader och 15 patienter även efter ett år. I samband med dessa undersökningar bedömdes det marginala parodontiets status liksom kantanslutningen och eventuella missfärgningar kring rekonstruktionerna. Eventuell ökad känslighet hos stödtänderna noterades även.

Det testade cementet var mycket lätt att hantera enligt tre oberoende bedömare, som också påpekade lättheten att blanda cementet och att applicera cementfyllda kronor på de preparerade tänderna.

Fyra patienter rapporterade viss ökad känslighet i stödtänder efter cementeringen. Detta försvann emellertid antingen direkt efter justering av ocklusala kontakter eller spontant under den första månaden efter cementeringen.

Varken lossnanden, stödtänder med karies eller ökad känslighet kunde noteras vid ettårskontrollen efter kronornas cementering. Alla kronor bedömdes dessutom ha perfekt kantanpassning utan missfärningar. Slutligen noterades ett kontinuerligt förbättrat status (GI-index) hos det marginala parodontiet kring kronorna. Det testade cementet (Ceramir C&B) ansågs mot denna bakgrund ha stor potential som permanent fastsättningscement för metalliska och keramiska konstruktioner.

Introduction

Long-term success of fixed restorations depends on a range of factors (5)including the quality of the luting agent(2). Biocompatibility, insolubility and resistance against degradation, are for example requirements to maintain the seal at the margins of the restorations thus preventing ingress of bacteria, leakage, sensitivity and secondary decay(18) .

Historically the progression of luting agents include in succession, zinc phosphate, polycarboxylate, glass ionomer, resin, and resin modified glass ionomer cements. These cements are now followed by a hybrid calcium aluminate glass ionomer cement (Ceramir C&B, Doxa Dental AB, Uppsala, Sweden) intended for permanent cementation of cast restorations and all-zirconia or all-alumina crowns.

The aim of this study was to assess the clinical performance of Ceramir C&B as a luting cement for cast high-gold alloy and noble metal porcelain-fused-to-metal (PFM) restorations.

Material and Methods

Thirty eight (38) crown and bridge abutments were cemented in 17 patients (8 males and 9 females, aged 25 to 79 years) . Thirty-one of the selected teeth were vital and 7 non-vital. The study included 6 bridges with a total of 13 abutment teeth (12 vital/1 non-vital). One fixed splint comprising of two (2) endodontically treated abutment teeth, was also included in the study. Of the remaining twenty three (23) single crowns, 19 were on vital and 4 on non-vital teeth. Twenty-three (23) of the crown and bridge units involved anterior, and fifteen (15) posterior teeth.

The study protocol and informed consent form were approved by the Institutional Review Board at Temple University, Kornberg School of Dentistry. All participating subjects signed an informed consent form prior to participation in the study.

This tested cement is a water-based composition comprising of calcium aluminate and glass ionomer components. The detailed composition has been described by Lööf(14) . It has been demonstrated to be bioactive and is currently approved for marketing in the United States.

The cement was provided in powder-liquid form. The powder was supplied in pre-dosed vials and the liquid in a dropper bottle. Powder and liquid were dispensed and mixed by each of three evaluators according to the manufacturer´s instructions.

The target mixing time was one minute and the corresponding working time 2 - 2.5 minutes. The cement parameters evaluated by the investigators were: dispensing, mixing, working time, and setting time, seating characteristics and ease of cement removal (Table 1).

Clinical baseline data consisted of: gingival inflammation index (GI)(13) and pre-cementation sensitivity according both to categorical and Visual Analogue Scale (VAS) based measurements (see Table 1). Post-cementation parameters were pulpal reactions, soft tissue reactions, marginal integrity, discoloration of cement margin, retention, post-cementation sensitivity and gingival inflammation index (GI), (Table 1).

Table 1. Parameters used in a Clinical Study of a bioactive luting agent (Ceramir C&B®)

Handling characteristics	Clinical parameters
Dispensing	Sensitivity (Categorical)
Working-Time	Retention
Mixing	Soft Tissue Reaction
Seating Characteristics	Marginal Integrity
Setting-Time	Marginal Discoloration
Ease of Cement Removal	Caries
	Visual Analogue Scale (VAS) - Sensitivity
	Gingival Inflammation Index (GI)

A one-week post-op telephone call recorded subjectively the patient's comfort. Full recall examinations were carried out after 30 days, 6 months and 12 months. Marginal adaptation was measured clinically using a modified so-called Ryge USPHS Criteria(4). During the try-in appointment the units were evaluated for their clinical acceptance.

After cementation the crowns was evaluated for marginal fit and marginal staining using the same modified Ryge/USPHS criteria. The gingival appearance was evaluated pre and post operatively by means of the gingival index. Finally, clinical photographs were made of selected restorations immediately following placement of the crown(s) or fixed partial denture(s), and also at one , six and twelve month recall appointments. These photographs consisted of digital color (2x2) photographs taken at a magnification of approximately 1:1.

Results

Baseline data

The examination of the cement handling characteristics showed that mixing of the cement, cement working time, and viscosity of the cement during placement and seating was satisfactory. The ease of mixing, the excellent working time (2-2.5 minutes), and the low, "mousse-like" viscosity were consistently favorably commented on by all three investigators. Clinically, it was determined that the final setting time was within 4 to 5 minutes.

In all cases, try-in of restorations prior to cementation indicated complete seating of the casting(s) with respect to fit and marginal adaptation The favorable consistency and viscosity of the cement appeared to insure complete seating of all castings. Removal of excess set cement from the margins was also noted to be "easy" for all restorations. No patients noted any adverse taste and no patients experienced immediate post-cementation hypersensitivity. In 16 of the 17 patients, there was no immediate post-cementation tissue response. In one patient slight bleeding occurred after cementation probably due to soft tissue reactions from the temporary restoration.

Assessments conducted immediately after cementation indicated "Excellent" readings (Alpha according to the Ryge/USPHD system) for post-cementation marginal integrity, as well as for marginal discolorations (= no evidence of discolorations).

Baseline data on key clinical performance characteristics are summarized in Tables 2 and 3.

Tooth sensitivity:

The mean pre-cementation Visual Analogue Assessment score (VAS) was 7.63 + 11.63 millimeters (range 0 - 32 millimeters), but only 7 of 17 subjects registered VAS scores above zero. In all these subjects, the positive VAS score correlated to a subjective, categorical rating to sensitivity higher than "none".

Table 2. Number of subjects and restorations evaluated in a one-year study of a bioactive luting agent and results of quality evaluations of crown retention and post-operative sensitivity

	Baseline	1 Month	6 Months	1 Year
No. of Subjects	17	17	17	16*
No. of Restoration /Abutments	38	38	38	35*
% Alpha – Retention	100%	100%	100%	100%
% Alpha – Categorical, Subjective Post-Operative Sensitivity	58.8%	88.2%	100%	100%

Table 3. Number of subjects and restorations evaluated in a one-year study of a bioactive luting agent and results of Gingival Index measurements(GI) and quality evaluations of marginal integrity and discolorations and the presence of caries.

	Baseline	1 Month	6 Months	1 Year
No. of Subjects Recalled	17	17	17	15
No. of Restoration/Abutments	38	38	38	31*
% Alpha – Absence of Caries	100%	100%	100%	100%
% Alpha – Marginal Integrity	100%	100%	100%	100%
% Alpha – Marginal Discoloration	100%	100%	100%	100%
Average VAS Score	7.6 mm	3.1 mm	0.4 mm	0.2 mm
Average Gingival Index	0.56	0.10	0.11	0.16

The patient-based assessments of tooth sensitivity showed that 7 of 17 subjects had experienced some degree of pre-cementation sensitivity but phone contacts at seven to ten days after cementation showed that only four patients still indicated some degree of slight post-operative discomfort. One of these patients, who had pre-existing dentinal sensitivity due to exposed dentin below the marginal finish line in tooth #8, characterized the response as "slight to none" and also noted that the situation had improved substantially since the cementation of the restorations. Another patient noted slight sensitivity to hot and cold, while the third one indicated a sensation of pressure around his bridge work, rather than any specific tooth sensitivity. In this patient the discomfort disappeared spontaneously without intervention. All three patients were offered the opportunity to return immediately prior to their scheduled one-month recall appointment, but all of them indicated the situation was not severe and could wait until the one-month recall.

One patient returned between the initial cementation visit/seven-day phone contact and the one-month recall with sensitivity related to a hyperocclusion. This problem disappeared spontaneously after an occlusal adjustment.

Periodontal conditions and Caries:

16 out of the 17 patients presented GI-scores of 0-1 during the pre-cementation period. Nine of these patients scored baseline GI- values of zero (0), while the rest scored a value of 1. Only one patient registered a gingival index score of 2.

No caries lesions were recorded in any of the participating subjects.

One and six-month data:
Detailed one-month and six-month recall data have been reported elsewhere (7). At both one and six-month examinations the cement performed well without failures or undesirable side-effects.

12 month data:
After 12 months 15 subjects and 31 out of 38 restorations/abutments were available for clinical examination. One of the two patients that were unavailable for recall had relocated over 500 miles from the study site and did not respond to a certified-return receipt letter. The other subject was unable to attend due to a serious illness. When contacted by telephone, this subject, however, indicated that all cemented restorations were in place and functioning well. This subject's responses were therefore included in the calculations for retention and subjective post-operative sensitivity.

The 12 month recall data for key clinical performance parameters are presented in Tables 2 and 3. Data presented in Tables 2 and 3 show that at the one-year recall none of the fifteen patients reported any tooth/tissue sensitivity and that for all the restorations both the marginal integrity and discoloration criteria received "Excellent" scores. Furthermore, no caries was noted in association with any of the examined restorations. Thirteen out of 15 patients had GI scores of 0, indicating very low levels or absence of gingival inflammation. One patient scored a GI index of 2 and another one of 0.5. In general terms these data indicate that the gingival situation around the cemented restorations had improved from baseline to 12 months.

Statistical analyses:
The twelve-month data included mean GI-scores of 0.16 ± 0.51, which compare favorable with the baseline, pre-cementation scores of 0.56 ± 0.62. A statistical analysis (Student's t-test for paired data) showed a statistically significant difference with a p-value of 0.049.

At the twelve-month recall, the mean VAS scores were 0.2 ± 0.78 mm, with a range of 0 to 3 millimeters. Additionally, 14 of 15 subjects were noted to register VAS scores of zero at the 12-month recall. These values are one order of magnitude less than the corresponding pre-cementation scores, and at or below the scores registered at six-months. A statistical analysis (Student's t-test for paired data) of these data showed a statistically highly significant difference between the pre-cementation and twelve-months values (p=0.036). Furthermore, none of the examiners recorded any tooth/tissue sensitivity.

Discussion

While the apparent longevity and stability of zinc phosphate luting cement is still useful as a basis for comparison1,9,10, cements for luting of fixed dental restorations have undergone significant compositional changes over the last 50 years. A wide range of cements with a variety of chemistries are thus available for permanent cementation of fixed restorations(8). As cement failures are still a major complication in fixed prosthodontics(3,7) there is, however, still a need for development of better luting cements.

A number of the presently available cements have undergone systematic clinical evaluations e.g. by *Pameijer*(16), *Jokstad & Mjör*(9), and *Jokstad*(10). Most studies conclude that acid-base reaction cements, such as zinc phosphate and glass-ionomer cements, perform well over long-term periods (9,10,16), but that newer cement chemistries, such as resin-modified glass ionomers, resin cements, and self-adhesive resin cements, also appear to display acceptable clinical performance. In many instances, however, these new cements have been tested over relatively short time-periods (1,12,19).

Long-term success of cemented restorations depends on retention as well as maintenance of the integrity of the marginal seal. Marginal seals can in general terms be established through bonding/adhesive techniques or mechanical interlocking. Efforts to obtain chemical adhesion (as in polycarboxylate and glass ionomer cements) have been one approach to improving the performance of dental luting cements. The presence of fluoride to many of these cements aims at protecting the tooth in the event of cement breakdown or disintegration. Only limited data exist, however, to support such a protective mechanism e.g. in glass ionomer cements(15).

The cement (Ceramir C&B) tested here introduces an additional possible retentive and protective mechanism, namely bioactivity. When this cement is immersed in physiological phosphate buffered saline solutions, hydroxyapatite (HA) is formed(14). This formation of HA, which appears after about 7 days, demonstrates that the cement possesses dynamic self-sealing properties, and it can be speculated that actual remineralization may take place also under clinical conditions. Such a protective mechanism could provide a durable seal e.g. of the tooth/cement/restoration interfaces. Furthermore, the areas of marginal breakdown that may appear over

time, may potentially also be addressed through a bioactive resealing via deposition of hydroxyapatite. Additional research will be necessary to test these potential capabilities.

The introduction of any new luting cement necessitates systematic assessments of its clinical performance with controlled observations from pre-cementation to long post-cementation time periods.

The objective of this study was therefore to provide initial one year data regarding the clinical performance of this water-based cement with calcium aluminate and glass ionomer components for permanent cementation of high noble all-metal and porcelain-fused-to-metal restorations.

Three independent clinical investigators concluded that hand mixing of the powder and liquid components was easy resulting in a smooth, creamy mix and that the working and setting times (2 - 2.5 and 4 – 5 min. respectively) were comparable and perhaps superior to those of other cements. These unanimous observations indicate that the cement is easy to handle during a key stage of any permanent cementation procedure.

The observations are furthermore in line with the expected character of an aqueous mix with essential Newtonian flow properties. The consequent lack of substantial visco-elasticity is probably a main reason for the fact that there was no evidence of premature setting or viscosity build-up and no difficulty to seat the restorations during placement. It could also contribute to the observation that the "clean-up" for the cement was rated as "easy" and that cement removal was found to be similar to that of resin modified glass ionomers (RMGI), i.e. a distinct gel consistency formed within a few minutes permitting easy removal. Here it should also be noted that in contrast to resin-modified glass ionomer (RMGI) and self-adhesive resin cements, this new cement does not form an oxygen inhibited layer on its surface thereby making "clean-up" even easier. Therefore there is no need to rush the removal, as can be the case with resin-based luting cements, which can snap-set to a hard consistency, making early removal mandatory.

Post-operative sensitivity is a fairly common early complication in fixed prosthodontics (12). This factor was measured both qualitatively and quantitatively and demonstrated that the situation improved from the baseline level up to the 1 year recall. Recorded incidents of post-cementation tooth sensitivity were further subjectively characterized as "slight", and not directly associated with the cement. Rather, the noted post-cementation occurrences of sensitivity were found either to be due to occlusal pre-maturities or to the presence of exposed, sensitive root dentin below the marginal finish line of the final restoration. All incidences responded either to minor occlusal adjustments or diminished with the passing of time. As noted in Table 2, at the 1 year recall period, all the recalled subjects indicated absence of pain or discomfort associated with the cemented restorations. This is indicative of a high degree of biocompatibility of the tested cement.

The gingival situation was noted to improve from pre-cementation to post-cementation levels as demonstrated by the results of statistical analyses of the GI scores.

No retentive failures were noted at recall examinations. As the angle of convergence (AC) of all prepared teeth was recorded, it should be noted that the majority of preparations were described as being "normal". It is of interest to note that although a small number of preparations were described as having greater than preferred AC, none have experienced failure thus far. Crowns and abutments that are used as retainers for removable partial dentures are exposed to comparatively higher varying functional stress levels. Some such crowns were incorporated in this study but none has experienced any untoward retentive failures. Caries was not an issue at any time during this study, but can be so especially in prolonged studies including patients with a history of recurrent caries attacks. The possible caries preventive actions from the above mentioned bioactivity and the incorporation of fluorides need to be tested in longer term studies.

While further clinical assessment of this cement is necessary, it can be concluded that thus far, its clinical performance has been good and warrants further investigation, particularly as its potential bioactive properties offers promising advantages.

Acknowledgements

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Abstracts

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Subjects **Nos**

Professor Anne Tenner, The Forsyth Institute, Boston, USA recieved 2009 the International Prize of the Swedish Dental Society for outstanding scientific contributions in microbiological research in periodontology

1

Oral Hygiene Reduces Mortality from Pneumonia among Elderly in Nursing Homes or Hospitals

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Aim: The aim was to investigate the preventive effect of oral hygiene on pneumonia and respiratory tract infection, focusing on elderly in hospitals and nursing homes, by systematically reviewing effect estimates and methodological quality of randomized controlled trials (RCTs) (Sjögren et al., J Am Geriatr Soc 2008;56:2124-2130).

Material and Methods: Literature searches were conducted in the Medline database, the Cochrane library databases, and by hand-searching reference lists. All obtained publications were analyzed for the interventions (or topics) studied, main conclusions, strength of evidence, and methodological items related to study design. All included RCTs were further analyzed for effect magnitudes, and methodological details. Absolute risk reductions (ARRs) and numbers needed to treat (NNTs) were calculated.

Results: Fifteen publications, including five RCTs, fulfilled the inclusion criteria. There was a wide variation in the design and methodological quality of the studies included. The RCTs revealed positive preventive effects of oral hygiene on pneumonia and respiratory tract infection in hospitalized, or nursing home resident elderly, with ARRs from 6.6 % to 11.7 %, and NNTs from 8.6 to 15.3 individuals.

Conclusion: Mechanical oral hygiene has a preventive effect on mortality from pneumonia, and on the development of non-fatal pneumonia in hospitalized, or nursing home resident elderly. Approximately one out of ten cases of death from pneumonia in nursing home resident elderly may be prevented by improving the oral hygiene status. Future research in this area should be focused on high quality RCTs with appropriate sample size calculations.

2

Medical screening in dental settings

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Aim: Many people have undiagnosed hypertension or diabetes without clinical signs and symptoms and are therefore exposed to a great risk of medical complications. Studies have reported an association to periodontal disease. 80 % of the Swedish population visits dental settings regularly. The aim of this study was to examine, in a medical screening in a dental practice, how many patients with periodontal disease that had undiagnosed hypertension or diabetes.

Material and Methods: 171 consecutive patients were recruited on their regular recall in a general Swedish dental practice. The study sample was divided into three risk groups: 30-39 years old with high BMI, 40-64 years old and 65 years old and older. Dental professionals administered a health-questionnaire, performed a periodontal examination of 5 representative teeth and exercised a medical screening by registering blood pressure, pulse and plasma glucose.

Results: Of 129 dental patients with less than 4 periodontal pockets and/with bleeding on probing (BOP), 19 had undiagnosed hypertension or diabetes. Out of 40 dental patients with 4 or more periodontal pockets with BOP, 5 had undiagnosed hypertension or diabetes. Furthermore, 14 patients received antihypertensive and/or antidiabetic medications. 11 percent of the dental patients had undiagnosed hypertension and 3 percent had undiagnosed diabetes.

Conclusion: It was found that among the patients on regular recall in a general dental practice, undiagnosed hypertension or diabetes was not an uncommon finding and seemed to be more common among patients with periodontal disease. Dental professionals can therefore play an important role in identifying people with undiagnosed hypertension or diabetes.

3

Factors of importance to maintaining regular dental care after a behavioural intervention for adults with dental fear: a qualitative study

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Aim: Dental phobia is prevalent in the general population and can be successfully treated through cognitive behavioural therapy, which results in patients being able to cope with dental treatments. The aim of this study was to increase the understanding of factors of importance for maintaining regular dental care after completion of a cognitive behavioural therapy programme.

Material and Methods: A qualitative study design was used. Fourteen individuals who had successfully completed the programme and had thereafter been referred to a general dental practitioner were interviewed. An interview guide with open-ended questions was used. The interviews were tape recorded and transcribed verbatim. The texts were analysed using descriptive and a qualitative content analysis (Grounded theory).

Results: The manifest analysis identified four content areas: experience of dental care, content of the behavioural therapy programme, perception of therapy and impact on quality of life. The latent analysis identified influence on quality of life, security, activity and barriers to dental care as categories. Although all informants had successfully completed the dental fear treatment programme, only a few of them stated that they had an uncomplicated relation to dental care afterwards. Barriers to dental care were lack of money and fear. A sense of security was conclusive to coping with dental care and a respectful approach on the part of the dental care personnel was essential to development of this sense.

Conclusion: Confidence in one's own ability to cope with dental care and the right to guide the treatment were important. Thus the theme in the present study was Self-efficacy and respectful dental care personnel.

4

In vivo comparison of a laser fluorescence method with a combination of digital radiography and visual inspection for initial caries detection on approximal surfaces

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Aim: The aim were 1) to study the applicability of a laser fluorescence method, DIAGNOdent pen TM for detection and quantification of approximal caries in vivo and 2)to compare the diagnostic accuracy of clinical examination ie, bitewing examination in combination with visual inspection and DIAGNOdent pen on approximal caries detection

Material and Methods: Fifty one subjects with high caries risk between age 15 and 19 and with no frank cavitations on the approximal surface of the first molars were recruited in the project. The subjects were examined first with the combination of visual inspection and bitewing examination and then the with DIAGNOdent pen. The diagnostic performance of DIAGNOdent pen was analyzed in terms of sensitivity, specificity and Spearman Rank correlation coefficient using bite-wing examination and visual inspection as gold standard.

Results: The sensitivity and specificity for initial caries detection were 0.40 and 0.72 with a cut-off point of 4. The corresponding values for manifest caries detection were 0.50 and 0, 98 with a cut off of 13. Spearman rank correlation coefficient 0.23 between bitewing examination and visual inspection on one side and DIAGNOdent pen readings on the other side.

Conclusion: Based on the present study we conclude that the diagnostic performance of DIAGNOdent pen in terms of sensibility and specificity of initial caries was limited.

▷ 5

Evaluation of automatic exposure control in a direct digital intraoral system.

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Aim: The aim of this study was to evaluate the performance of the automatic exposure control (AEC) in an intraoral digital system.

Material and Methods: Three series of radiographs were captured with the activated AEC on seven dry mandibles adhered to different thicknesses of Plexiglas, which represented soft tissue. Exposure times required for each radiograph of the specimens were analysed as functions of the added Plexiglas thickness. Differences in mean grey levels between pairs of the three images obtained from the same specimen were analysed by employing the subtraction technique. Additionally, four radiographs were manually exposed of all seven mandibles with one layer of Plexiglas, which employed one and two steps below and above the registered automatic exposure time. Six observers evaluated the series of radiographs exposed with one layer of Plexiglas in a random order. The observers were instructed to classify the quality of the diagnostic images as unacceptable, acceptable, or excellent.

Results: The results demonstrated a good correlation between the exposure times determined by AEC and Plexiglas thickness (r 5 0.85). Mean grey level values for subtraction images obtained from radiographs exposed with different thickness of Plexiglas with activated AEC indicated that almost identical radiographs were obtained, regardless of the Plexiglas thickness. The subjective observer evaluation of the most satisfactory radiographic image quality as a function of exposure time demonstrated that the highest scores were for radiographs exposed with the AEC function activated.

Conclusion: The AEC function may accurately determine the appropriate exposure times related to object thickness, providing radiographs with satisfactory image quality, and may thus be advantageous in clinical radiographic work.Published in Dentomaxillofacial Radiology (2009) 38, 407–412.

6

Caries risk profiles in schoolchildren over two years assessed by Cariogram

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Aim: To evaluate longitudinal changes in caries risk profiles in a group of schoolchildren in relation to caries development over a 2-year period.

Material and Methods: The Cariogram-model was used to create caries risk profiles and to identify risk factors in 438 children being 10-11 years at baseline. The assessment was repeated after two years and the caries increment (new dentine lesions or progression of proximal lesions on bitewing radiographs) was recorded. The frequency of unfavourable risk factors were compared between those considered at the lowest and the highest risk.

Results: Fifty percent of the children remained in the same risk category after two years One third of the children (31.6%) were assessed in a higher risk category while 18.4% showed a lower risk. Those with increased risk compared with baseline developed significantly more caries than those with an unchanged risk category (OR 4.0, 95% CI 2.4-6.7). The most frequent unfavourable risk factors among those with high risk at baseline were high salivary mutans streptococci and lactobacilli counts as well as frequent meals.

Conclusion: The findings suggest that the caries risk profile is relatively inconsistent in schoolchildren over a period of two years and highlight the importance of regular risk assessments for appropriate decisions on preventive care and recall intervals.

7

Carbonated water's effect on enamel in vitro

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Aim: The objective of this study is to investigate if carbonated water erodes enamel in vitro and if so, how this is affected by the solution's fluoride content.

Material and Methods: Twenty one intact premolars extracted for orthodontic reasons were selected for the study. The teeth were coated with nail polish leaving a rectangular window on the buccal surface. The teeth were placed in triplicates of seven solutions of 500 ml (see Figure). The control solution as well as the carbonated and fluoridated solutions was based on regular tap water from Malmö. Fluoride concentrations were measured before the experiment and pH before and after. After four weeks in the solutions, the nail varnish was removed and the teeth were examined visually and tactilely by the authors, using an explorer in addition to light microscope examination and photography at 62x (Leica Wild M7A). The tactile examination was done separate and blindly by both authors and the results were compared. In case of different scores an agreement was reached. The teeth were scored for erosion on a 4-graded scale (0-3) where 0 was no step between unexposed and exposed enamel and no rough surface and 3 was a clear step between unexposed and exposed enamel and a clearly eroded rough surface. The groups were compared to each other and ranked from most to least eroding.

Results: This study has demonstrated that carbonated waters can cause erosion to enamel in vitro. Erosion fades with increased fluoride concentration. Thus, the higher the fluoride content, the lower the erosion. Given our hypothesis, Ramlösa, with its high fluoride content should be the least erosive solution. This however was not the case. Teeth exposed to Ramlösa showed the highest degree of erosion. The fluoride concentration is not solely responsible for modifying erosion; a more important factor seems to be the calcium concentration of the solution. The mineral content of the solution may be a more important factor than fluoride regarding the erosive properties of carbonated water. One explanation could be that high calcium content lowers the critical pH, since calcium is a component of hydroxyapatite. The result of this study cannot directly translate to in vivo conditions. Rather, it shows what happens under extreme conditions. The amount of solution (500 ml) was too large for saturation of minerals to occur. Consequently, the erosion could forego under the entire exposure. The seal of the bottles may have leaked CO_2 during the experiment, most likely accounting for the subsequent pH rise in the solutions. The teeth in the study lacked the natural defense factors. The fluoride concentrations needed to significantly reduce erosion were as high as 3-5 ppm but through high calcium content, a solution's erosive effect can be noticeably reduced.

Conclusion: With increasing fluoride concentration, a lower degree of erosion can clearly be seen on enamel in vitro. An even stronger factor was the calcium content, a solution's erosive effect can be markedly reduced, even more so than what can be achieved with reasonable fluoride concentration through a high calcium content.

◎◎◎ **8**

Comparison of Saliva-Check Mutans & IgA with Cariogram for caries risk assessment

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Aim: The purpose of the present preliminary study was to evaluate the use of two rapid semi-quantitative detection kits (Saliva-Check Mutans and Saliva-Check IgA mutans, GC, Japan) for assessing the caries risk using the computer-based program Cariogram as a reference method

Material and Methods: Stimulated saliva samples were collected from 26 subjects aged 23 to 73 years. Portions of 0.25 ml saliva were tested by Saliva-Check Mutans for determination of the number of S. mutans per ml saliva. After 15 min a red line in the test detection window indicated S. mutans numbers of >5-105 cfu/ml saliva. The level of salivary immunoglobulin A (IgA) to mutans streptococci were examined using the Saliva-Check IgA test kit. Portions of 0.1 ml were mixed with buffer and applied into the test device. The presence or absence of a red line after 15 min indicated a high or low level of IgA, respectively.

Results: By combining these two test systems each patient was classified into one of four groups from low to high caries risk. The groups were compared with the results from the Cariogram which evaluated caries-related variables such as caries experience, saliva, presence of mutans streptococci and lactobacilli, diet, oral hygiene and use of fluoride. Compared with the Cariogram data, the detection kits showed 10 of 18 subjects to have a low chance and 8 of 8 subjects to have a high chance to avoid caries.

Conclusion: The data suggest that the combination of the two test systems could be used for caries risk assessment.

9

Clinical routines in endodontic practice reported by general practicing dentists after a programmed education in endodontics

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Aim: To survey the clinical endodontic routines of general dental practitioners (GDPs) in public dental service clinics in the Swedish county Sörmland, and to assess the effect of an educational intervention on the adoption of a Ni-Ti rotary system.

Material and Methods: GDPs in the Intervention County (IC) underwent an educational programme in evidence based endodontics and Ni-Ti rotary technique (NiTiR). A follow-up questionnaire was mailed to 98 GDPs in the IC and to 97 GDPs in a county used as Control County (CC), where no specific training had been provided. The questionnaire concerned clinical endodontic routines and instrumentation techniques.

Results: The overall response rate to the questionnaire was 87%. In both counties more than 90% of all GDPs reported they always or generally used rubber dam, determined working length, used 0.5% buffered NaOCl for irrigation, and calcium hydroxide as interappointment dressing. Two of three GDPs reported they generally or always informed the patient of the prognosis. Every second GDP reported routines for postoperative follow-up. The NiTiR was reported to be completely adopted by 77% of the GDPs in the IC, and by 6% in the CC, $p<0.001$. In the IC 79% of the GDPs reported that they completed instrumentation in one treatment session, compared to 32% in the CC, $p<0.001$. The "single-cone" mode of root canal obturation was reported to be significantly more frequent among GDPs in the IC than in the CC, $p<0.001$.

Conclusion: There was no difference in the reported clinical endodontic routines between the GDPs in IC and CC. GDPs who had undergone an educational programme in NiTiR instrumentation reported a successful integration of the technique into daily clinical practice.
It is still unknown how root canal treatments performed with NiTiR in general dental practice will influence treatment results, compared to when manual techniques with stainless steel instruments are used. The findings of this study will therefore be further investigated aiming to evaluate root filling quality and the outcome of endodontic treatments performed in the IC before (2002) and after (2005) the implementation of NiTiR. 425 root filled teeth in each group will be followed-up four and seven years respectively after the performed root canal treatments.

10

The efficacy of laser therapy as an adjunct to chemo-mechanical disinfection of infected root canals. A systematic review.

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Aim: The aim of this study was to evaluate the efficacy of laser therapy as an adjunct to chemo-mechanical disinfection of infected root canals.

Material and Methods: A PubMed and CENTRAL literature search with specific indexing terms and a hand search were made with stated limits and criteria. Relevant publications were retrieved, followed by interpretation. The level of evidence for each included publication was assessed as high, moderate or low. The initial search process resulted in 158 publications. After reading the abstracts and hand searching the reference lists of all included publications, 26 were read in full-text and interpreted according to a data extraction form. Five were included in the systematic review and were given a level of evidence.

Results: The included five studies were heterogenous regarding several aspects such as study designs, diagnoses, end point measures, treatment, sampling and cultivation procedures wich made a meta-analysis impossible. Each included study received a low level of evidence, primary due to lack of a power analysis, blinding and reproducibility. Thus, the evidence grade was insufficient.

Conclusion: The results does not necessarily imply that laser should not be used as an adjunct to conventional chemo-mechanical root canal treatment, but instead point out the need for high-quality studies to be performed in the future.

◎ ◎ ◎ 11

Understanding motives for change - a qualitative study among general practising dentists

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Aim: To seek an understanding of the motives for change of clinical practice among general dental practitioners (GDPs) following an endodontic educational intervention.

Material and Methods: Fifteen participants (2 clinical managers, 10 GDPs, 3 dental nurses) who had participated in the endodontic educational programme were invited and participated in the study. The study has an interpretative approach, a qualitative study design based on phenomenological philosophy. Data were gained through thematic in-depth interviews, exposing the course of events before and after implementation of the endodontic educational programme. Two interviews with open-ended semi-structured questions were performed with each participant. The interview technique encouraged the participant's narrations on the chosen themes to be told in their own words and from their own point of view. The interviews were digitally recorded and verbatim transcribed. The text was initially read through by the authors in order to acquire a sense of the whole and then divided into separate meaning units followed by a condensation into "cores of significance". The analysis, which is not yet completed, will have a special focus on, not only what the participants talked about, but especially how they expressed themselves. Patterns representing different aspects of motives for change of clinical practice will be identified and classified into categories and subcategories. Finally, the content of the categories will be summarized in concepts reflecting important aspects of the GPD´s motives for change following the endodontic educational intervention.

◎ ◎ ◎ 12

Presence of JP2 and non-JP2 clonal types of Aggregatibacter actinomycetemcomitans in Ghanaian adolescents - a pilot study

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Aim: The prevalence of aggressive periodontitis in major segments of the human population is below 1%. A much higher prevalence is observed in adolescents in certain African countries such as in Morocco where a highly leukotoxic clone (JP2) of A. actinomycetemcomitans is prevalent and a likely etiological agent of the disease. While the Arabic populations in the Mediterranean part of Africa frequently are colonized with JP2 clone strains, only sporadic information is available concerning its prevalence and potential association with disease in sub-Saharan countries. Aims: To determine the prevalence of JP2 and non-JP2 clonal types of A. actinomycetemcomitans and to examine the periodontal status in Ghanaian adolescents for comparison with similar data collected in Morocco.

Material and Methods: Periodontal status was evaluated in 49 individuals (mean age 12.9 yrs) at two schools in Accra, Ghana by measuring periodontal attachment loss. Two dental plaque samples, one pooled from four incisor sites and one from four first molar sites, were collected from 24 adolescents for subsequent determination of serotype and leukotoxin promoter typing of A. actinomycetemcomitans by PCR.

Results: 20.8% of adolescents were colonized with JP2 clone strains. Two out of 49 (4.0%) individuals presented initial signs of periodontitis.

Conclusion: Despite heterogeneous genetics of Ghanaian and Moroccan hosts, JP2 clone strains of se- ▷

rotype b are equally prevalent in these populations whereas the overall prevalence of A. actinomycetemcomitans is higher among Moroccan adolescents. Around pubertal age, comparable proportions of Ghanaian and Moroccan adolescents have periodontal attachment loss. Larger studies in Ghanaians are needed to elucidate the potential association between presence of various clonal types of A. actinomycetemcomitans and periodontal disease status at individual and at site level.

◎ ◎ ◎ 13

Periimplantitis in a specialist clinic of periodontology. Frequency and risk indicators.

O Carcuac

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Aim: To describe some clinical features of patients with clinical signs of peri-implantitis and to identify risk indicators of peri-implantitis in a periodontitis prone population.

Material and Methods: The investigation was conducted as a retrospective cross-sectional study on a consecutive referral population at the Department of Periodontology at Skanstull, Public Dental Service, Stockholm County Council, Sweden. Subjects referred by general dentists or dental hygienists between January 2002 and December 2007 for peri-implantitis treatment were collected from a computer database. This study included 377 implants in 111 patients examined by eight periodontists. Anamnestic, clinical and radiographic variables were collected from the records. In all analyses, the statistical computational unit was at subject level. Results were considered statistically significant at $p<0.05$.

Results: The mean age of the subjects at the examination was found to be 56.3 years (range 22-83) for females and 64.1 years (range 27-85) for males. The mean number of remaining teeth was found to be 10.5 (s.d. 8.89) and the mean number of implants was 5.85 (s.d. 3.42). A significant and positive correlation ($r=0.36$, $p<0.001$) was found between age and number of lost teeth, while age was not significantly associated to the degree of marginal bone loss. The age group 20-39 years had significantly more teeth, fewer implants and fewer implants with peri-implantitis compared to age group >40 years. The percentage of implants with peri-implantitis was significantly increased for smokers compared to non-smokers ($p=0.04$). In the group of non-smokers, 64% of the implants had the diagnosis peri-implantitis, while the corresponding relative frequency for smokers was 78%. Most implants with peri-implantitis were found in the maxillary front region (48%). The marginal bone loss around implants with peri-implantitis did not differ significantly between different implants positions. Five implants were disintegrated and they were found in the maxilla. The median of follow-up time after implant placement was 7.4 years and the observation period was not significantly correlated to the degree of bone loss around the implants. A positive and significant correlation was found between the degree of marginal bone loss in remaining teeth and the degree of bone loss around implants with peri-implantitis ($p=0.04$).

Conclusion: The results of the present study indicate that smoking as well as previous history of periodontitis are associated with peri-implantitis and may represent risk factors for this disease.

◎ ◎ ◎ 14

Detection of the highly leukotoxicic JP2 clone of Aggregatibacter actinomycetemcomitans in members of a Caucasian family living in Sweden

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Aim: The oral bacterium, Aggregatibacter actinomycetemcomitans is associated with aggressive periodontitis. Leukotoxin produced by this bacterial species is suggested to be an important virulence factor involved in the pathogenesis of the disease. A specific clone (JP2) of the bacterium, characterized by a particular deletion in the promoter region of the leukotoxin operon, expresses a relatively high amount of leukotoxin. Carriers of the JP2 clone

exhibit significant enhanced risk for developing disease compared with individuals carrying other genotypes of A. actinomycetemcomitans. While being detected frequently among individuals of African descent, there are very few reports on Caucasians colonized with the JP2 clone. Further, several reports have indicated that the JP2 clone preferentially appears to colonize younger individuals. The aim of this paper is to report on the history of periodontal disease and microbiological findings in members of a Swedish family.

Material and Methods: After collection of dental plaque samples from all family members, A. actinomycetemcomitans and other periodontitis-associated bacterial species were quantified by conventional culture technique. Detection of A. actinomycetemcomitans in the samples and leukotoxin promoter typing, serotyping, and further characterization of A. actinomycetem-comitans isolates were done by PCR. The family members were also genotyped by population genetic analysis.

Results: In a family with genetically verified European ancestry, the JP2 clone of A. actinomycetemcomitans, serotype b, but not non-JP2 clonal types of A. actinomycetemcomitans, was detected in samples from two of the family members, a daughter (33 years of age) and her mother (62 years of age). In the samples from the daughter the JP2 clone comprised more than 50% of total viable bacterial flora. In the samples from the father a non-JP2 clonal type of A. actinomycetemcomitans, serotype c, was found.

Conclusion: The present report provides further cases of JP2 infected Caucasians to the almost negligible number of earlier cases of this kind. In addition, it is shown that the JP2 clone also can be detected in adults. Furthermore, it is concluded that this highly leukotoxic clone of A. actinomycetemcomitans contributes to the disease progression also in Caucasians.

◎ ◎ ◎ 15

Surgical treatment of peri-implantitis using a bone graft substitute with or without a resorbable membrane; 3-year radiographic control

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Aim: To evaluate, over 3 years, the treatment effect following two different surgical treatment modalities of peri-implantitis lesions.

Material and Methods: Thirty-six patients having a minimum of one osseointegrated implant, with a progressive loss of bone to 3 threads (1.8 mm) following the first year of healing combined with bleeding and/or pus on probing were involved in this study. The patients were assigned to two different treatment strategies. After surgical exposure of the defect, granulomatous tissue was removed and the infected implant surface was treated using 3% hydrogen peroxide. The bone defects were filled with a bone graft substitute (Algipore®). In 17 patients (Group 1) a resorbable membrane (Osseoquest®) was placed over the grafted defect before suturing. In 19 patients (Group 2) the graft was used alone. During a three years follow up period the patients attended a supportive care program every 3 months and were seen by a periodontist once a year.

Results: Thirty-two patients with 56 implants fulfilled the 3 year follow up examination. The plaque index at the follow up exam at 3 years was 11 ± 9. Four patients did not comply with the supportive therapy and were lost during the follow up period. Mean defect fill at one and three years was 1.5 ± 1.3 and 1.4 ± 1.3 respectively (p=0.4).

Conclusion: The defect fill obtained after 1 year was inmost cases maintained over the 3 year follow up period.

▷ ◎ ◎ ◎ 16

Dental plaque and periodontitis affect inflammation biomarkers and atherosclerosis

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Aim: To study the influence of dental plaque on development of periodontitis and matrixmetalloproteinase-9 (MMP-9) and tissue inhibitor of MMPs (TIMP-1) in plasma and the development of atherosclerosis.

Material and Methods: In 1985 a random sample of 3273 individuals, aged 30-40 years, was studied. Of them 1676 individuals underwent clinical oral examination. After 18 years 50 persons without chronic periodontitis were re-examined in 2003. They comprised 16 persons without periodontitis in 1985 but with chronic periodontitis in 2003 (H-D group), and 31 periodontally healthy both in 1985 and 2003 (H-H group). At the end of the study 22 were women and 25 men, 53.5 (± 2.7 SD) years old. Blood samples were taken and MMP-9 and TIMP-1 were analyzed. Ultrasonographic measurement was used for determination of common carotid artery intima-media thickness (IMT), calculated intima media area (cIMA) and atherosclerotic plaque. Students t-test, Fisher´s exact t-test and multiple logistic regression analyses were used for statistics.

Results: In 2003 plaque index for H-H group was 0.18 (±0.16SD) and H-D group 0.46 (±0.36SD) ($p<0.001$). MMP-9 in plasma from patients in the H-H group contained 88.71 (±100.66 SD) and H-D group 181.09 (± 106.08 SD) ng /ml and TIMP-1 97.37 (± 43.91SD) and 154.74 (±52.38 SD) ng /ml ($p<0.001$). IMT was in subjects in H-H group 0.58 (± 0.07SD) mm and in the H-D group 0.69 (± 0.07SD) mm ($p<0.01$) and for cIMA 11.24 (± 1.82SD) mm2 and 14.56 (± 5.11SD) mm2, respectively ($p<0.01$) In the H-H group 50 % had carotid plaque, in the H-D group 86.7 % ($p<0.05$). Periodontitis was found as the principal independent predictor of IMT (odds ratio [OR], 6.8; $p=0.015$).

Conclusion: Development of chronic periodontitis seems to be associated with early carotid atherosclerosis and increased presence of carotid plaque.

◎ ◎ ◎ 17

Status of coronary heart disease 5-8 years after percutanous intervention in relation to periodontal conditions.

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Aim: Periodontitis has been considered as a risk factor for coronary heart disease (CHD). The aim of this study was to investigate if there were any differences in angina pectoris and new coronary interventions in relation to periodontal health or disease in patients 5-8 years after percutaneous coronary intervention (PCI).

Material and Methods: In 81 patients (64 men and 17 women, mean age 67 years) with severe angina pectoris that underwent PCI between 2000 and 2003 at the University Hospital, Linköping, periodontal conditions were recorded. In 2008 the patients were periodontally re-examined. Bone loss was determined on radiographs and periodontal disease experience was classified into five groups according to Hugoson & Jordan (1982). A questionnaire was used to evaluate degree of angina pectoris (*Rose et al. 1977*).

Results: The mean number of teeth was 22 (range 5-28). According to symptoms of CHD the patients were divided into 4 groups: no new symptoms of angina pectoris, angina pectoris once a month or less, angina pectoris once a week, and severe symptoms that had resulted in a new PCI. According to periodontal experience group the angina groups were distributed as follows: Periodontal experience group 1+2 (no periodontal boneloss); 13 subjects had no new symptoms of angina pectoris, 2 had angina once a month or less and 1 had a new PCI. In periodontal experience group 3 (moderately advanced periodontitis), 11 subjects had no new symptoms of angina pectoris, 11 had angina once a month or less, 2 had angina once a week, and 12 had a new PCI. In periodontal experience group 4 + 5 (advanced periodontitis), 14 subjects had no new symptoms of CHD, 7 had angina pectoris once a month or less, 6 had angina once a week, and 2 had a new PCI. Fishers exact test showed significant difference between the severity of new CHD symptoms in relation to periodontal experience group ($p=0,003$)

Conclusion: The results indicate a relation between periodontal disease and the occurrence of recidive angina pectoris 5-8 years after PCI

◎ ◎ ◎ 18

Influence of dietary supplementation with Lactobacillus reuteri on the oral flora of healthy subjects

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Aim: The aim of this study was to assess whether supplementation of L. reuteri could have an impact on the oral microbiota.

Material and Methods: Twenty-three healthy people aged 29 to 63 years were included. A randomised double-blind placebo-controlled study was executed consisting of 12 persons in the test group which was given the study product twice a day for twelve weeks containing L. reuteri (an equal mix of ATCC 55730 and ATCC PTA 5289 at a total of 2x108 CFU/dose) and the control group of 11 persons having corresponding placebo. Pre and post of study period plaque index and oral health status (gingivitis, probing pocket depth, bleeding on probing) were measured together with sampling of supra-, subgingival plaque and saliva collection. Microbiological analysis was done by using checkerboard DNA-DNA hybridization technique and selective culturing for lactobacilli determination. Four weeks after the last intake of the product reassessments of plaque and saliva was performed.

Results: No difference in general oral health could be observed between the groups after L. reuteri supplementation. Plaque index increased significantly in the control group after twelve weeks (p= 0.023). A significant increase in total Lactobacillus counts occurred in both groups ($p<0.05$). The probiotic intervention resulted in a significant increase of L. reuteri ($p=0.008$) corresponding to 13.8% of the total lactobacilli count. A distribution ratio of 1:4 (ATCC 55730 / ATCC PTA 5289) between the two installed L. reuteri strains in saliva was noticed. Termination of intervention resulted in a wash out of L. reuteri. A significant increase was found for most bacterial species in both groups and both in supra- and subgingival plaque during the test period. There was no significant difference detected for any of the bacterial species between the groups neither in plaque location. The ratio between "bad/good" supragingival bacteria decreased for the test group, however, not significant. The corresponding ratio for subgingival bacteria decreased significantly for both groups ($p<0.05$) with no significant difference between the groups.

Conclusion: The supplementation of L. reuteri did not affect general oral health. Presence of L. reuteri in saliva is only temporary and washed out after termination of intervention. Microbiologically no significant effect of the probiosis was observed. It cannot be concluded whether L. reuteri was established in the plaque of the test group or not.

◎ ◎ ◎ 19

Estrogen down-regulates the chemokine CCL3 in LPS treated human periodontal ligament cells

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Aim: Investigate whether LPS induces CCL3 production in human periodontal ligament (PDL) cells and if estrogen regulates CCL3 levels.

Material and Methods: Cells were collected from three subjects who were referred for extraction on orthodontic indication. The middle third of the periodontal ligament was scraped off and PDL cells were allowed to migrate from the periodontal tissue explants. In a first series of experiments the cells were divided into two groups: LPS (500ng/ml) treated cells and control (untreated) cells. In a second series of experiment the cells were devided into one experimental group (500ng/ml LPS + 100 nM 17βestradiol) and one control group (500ng/ml LPS). Cells were treated with LPS with or without 17βestradiol for 24 h. The CCL3 gene activity was de- ▷

termined by using quantitative RT-PCR and CCL_3 protein expression by using ELISA.

Results: Estrogen down regulated the CCL_3 gene in human PDL cells by 35-55 %. Down-regulation of CCL_3 gene activity was observed in cells derived from all three subjects. Preliminary results show that LPS up-regulates the CCL_3 in human PDL cells. CCL_3 protein was detected in PDL cells and experiments on regulation of CCL_3 protein by LPS and estrogen are currently running.

Conclusion: Estrogen attenuates the inflammatory chemokine CCL_3 in LPS treated PDL cells, suggesting that estrogen may have an anti-inflammatory effect via this mechanism.

◎ ◎ ◎ 20

The effect of Nd:YAG laser in periodontal pockets. Comparison between SRP alone to laser in combination with SRP.

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Aim: To examine the potential advantage of combined SRP (Scaling and Root Planing) plus 1064 nm Nd:YAG laser to SRP alone in the treatment of periodontitis.

Material and Methods: SRP + laser were used on one side of the lower jaw while the other side was treated with SRP alone. At baseline, GCF (Gingival Crevicular Fluid) samples were taken from teeth 36, 35, 45 and 46, and levels of MMP-8, IL-1, 4, 6, and 8 were measured. Microbiota was sampled and analysed for 12 bacteria. 30 patients were included, randomly assigned to left or right side. The laser power was 4 W, 80 mJ per pulse, 50 Hz, water and air cooling, pulse width 350 µs.

Results: After three months follow up, PPD (Probing Pocket Depth), PI (Plaque Index), GI (Gingival Index) and GCF volume were all reduced more on the SRP + laser side compared to the SRP-alone side. SRP + laser reduced the amount of IL-1βand MMP-8 more than SRP alone.

Conclusion: SRP together with one single treatment with a Nd:YAG laser reduced clinical signs of periodontitis more than SRP alone.

◎ ◎ ◎ 21

Clinical evaluation of local antibiotic treatment in smokers with chronic periodontitis in a maintenance care program.

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Aim: To evaluate if local antibiotics, 8.8 % doxycycline gel, can improve periodontal healing in smoking adults in a maintenance care program.

Material and Methods: In a double-blind randomized controlled study 20 smoking patients were selected from a maintenance care program. Each subject demonstrated at least 5 probing pocket depths (PPD) ≥ 5mm with bleeding on probing (BOP) in a minimum of 5 teeth. The patients were divided into 2 groups, the test group (8.8 % doxycycline gel, Atridox®) and the control group (placebo gel). At baseline and 3 months after treatment a clinical registration was performed, including PPD, clinical attachment level (CAL), BOP, and plaque index (PlI) at 4 sites of test- and control teeth. Gingival index (GI) was performed using Periotron® at 2 sites of all index-teeth. At baseline all subjects received full-mouth scaling followed with application of test or placebo gel in all index pockets. After gel application 0.1 % chlorhexidine was used for mouth rinsing during 7-10 days, since no mechanical oral hygiene was allowed during that period.

Results: There were 16 patients left in the end of the study. Four subjects in the test group had to be excluded because of disease. Three months after treatment significant improvement for PPD was shown both in the test ($p=0.0313$) and the control group ($p=0.0020$). Significant improvement for the control group was also demonstrated for CAL and BoP. There were no significant differences in any parameter in the change after 3 months between test - and control groups. When the results from all teeth (including index teeth) were analyzed significant improvement was shown in PPD both in the test ($p=0.0313$) and the control group ($p=0.0039$). Significant improvement for the control group was

also demonstrated for CAL, BOP and GI. There were no significant differences between test and placebo treated dentitions.

Conclusion: This study could not show any statistically significant clinical differences between the test - and control groups based on results of index teeth as well as all teeth. This means that local antibiotic treatment with 8.8 % doxycycline gel (Atridox®) did not show any additional effects to scaling. The results, however, showed significant improvement of periodontal pockets after subgingival scaling in both test- and control groups.

◎ ◎ ◎ 22

Stability of unilateral posterior crossbite correction in the mixed dentition - a 3-year follow-up

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Aim: The aim of this study was to compare and evaluate long-term stability of crossbite correction with Quad Helix or expansion plate in the mixed dentition.

Material and Methods: In this RCT-study 40 patients with unilateral posterior crossbite were randomized to be treated with either Quad Helix or expansion plate. The inclusion criteria were: mixed dentition, unilateral posterior crossbite, no sucking habits or previous orthodontic treatment. The long-term stability was evaluated after 3 years by study cast measurements. Twenty subjects with normal occlusion were included as controls. Success rate, maxillary and mandibular transverse dimensions, overjet and overbite were registered.

Results: Stability of crossbite correction was equal for the two treatment methods. Although a transversal expansion was achieved, the width of the maxilla in the treatment groups did not reach the mean width of the normal group. No significant difference was seen for overjet and overbite.

Conclusion: The long-term stability of posterior crossbite correction with Quad helix and expansion plate was equal. However, after three years, the maxillary width of the treated crossbite patients was still smaller than for the normal group.

◎ ◎ ◎ 23

The occlusal and dentoalveolar changes in adults between the ages of 23 and 62 years.

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Aim: To analyze the occlusal and dentoalveolar changes in adults between the ages of 23 and 62 years.

Material and Methods: Eighteen adults (Swedish dentists),16 men and 2 women, with no tooth loss or tooth extractions or no history of prosthodontic or orthodontic treatment were followed during an average period of 38.4 years. Documentation was based on study casts taken between 1949 and 1989 at the Department of Stomatognathic physiology, Faculty of Odontology Malmö. Malocclusion traits, overjet, overbite, dental arch length and width as well as Little´s irregularity index were registered. The data was analysed with Student´s t-test. The method error, determined according to Dahlbergs formula, ranged from 0.2 to 0.3 mm.

Results: A significant increase (1.0 mm, $p<0.01$) in Little´s irregularity index in the mandible and a decrease in mandibular arch length (0.5 mm, $p<0.05$) were found. The maxillary and mandibular intercanine width decreased 0.8 and 1.0 mm, respectively ($p<0.001$). The malocclusion traits, overjet and overbite remained unchanged during the observation period.

Conclusion: Small dentoalveolar and occlusal changes occurred in adults during the 38 years observation period and the changes were considered clinically insignificant.

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Pattern and amount of changes after orthodontic correction of upper front teeth 7 years postretention

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Aim: To investigate the amount and pattern of changes of maxillary front teeth 7 years postretention which previously were retained with a bonded retainer.

Material and Methods: The study group consisted of 27 patients. Study models before treatment (T1), at debonding (T2), 1 year after removal of the upper bonded retainer (T3) and 7 years postretention (T4) were present. The irregularity index (sum of contact point displacements) and the rotations of front teeth toward the raphe line were calculated.

Results: The irregularity index of the maxillary front teeth change very little or not at all during the first year postretention. Further change long-term resulted in irregularity index of mean 2.0 (range 0.0 – 5.8). The contact relationship between the laterals and centrals seems to be the most critical. Forty rotated teeth in 21 patients were corrected more than 20 0. Mean relapse during the first year postretention was 6.7 degrees. Mean changes during 7 years was 8.2 degrees (range 0.0-19.3).

Conclusion: Relapse of upper front teeth retained with a bonded retainer is minor both short- and long-term. If permanent retention is required after 3 years of retention, it is enough to retain the incisors.

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TMD in consecutive patients referred for orthognathic surgery

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Aim: To answer the question whether temporomandibular disorders (TMD) were more common in a group of individuals referred for orthognathic surgery than in a control group. The hypothesis was that a higher frequency of signs and symptoms of TMD and diagnosed TMD would be found in the patient group compared with the control group.

Material and Methods: A sample of 121 consecutive patients referred for orthognathic surgery at the Department of Oral Maxillofacial Surgery, Malmö University Hospital, Sweden, was interviewed and examined regarding signs and symptoms of TMD and headaches. A control group was formed by 56 age- and gender-matched individuals attending the Department of Oral Diagnosis, Faculty of Odontology, Malmö University, Sweden, and Public Dental Health Clinic in Oxie, County of Skane, Sweden. TMD diagnoses were used according to Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).

Results: The patient group showed more myofascial pain without limited opening, disc displacement with reduction, and arthralgia according to RDC/TMD than the control group. The patient group also had more symptoms and signs of TMD in general.

Conclusion: The hypothesis was confirmed since patients who were to be treated with orthognathic surgery had more signs and symptoms of TMD and higher frequency of diagnosed TMD compared with the matched control group.

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Changes in molar position in women with loss of teeth: long term aspects

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Aim: The aim of this study was to analyse changes during a 10-12 year period: a) in tipping of molars with a mesial space due to missing tooth/teeth and b) of overeruption of molars with no supporting antagonist.

Material and Methods: The material consisted of panoramic radiographs from a study of women´s health performed in Gothenburg in 1968/69 –

2004/2006. The panoramic radiographs were taken with an interval of 10-12 years. For the present study, panoramic radiographs of 312 of the 50-year-old women group were selected with respect to either of the following criteria's: 1) a molar in the upper or lower jaw with a mesial space due to missing tooth/teeth and 2) a molar in the upper or lower jaw with no antagonist. The panoramic radiographs were scanned and digital images were created. The digital images were analysed by a computer program (FACAD, Illexis AB). Changes in inclination and over-eruption of molars and premolars (controls) were measured on the digital images. Linear measurements were expressed in per cent of the ratio between the distance from the cusp tip to the reference line and the tooth length. Tipping and over-eruption measurements were recorded on all investigated molars.

Results: Molars with missing antagonists were more common in the upper jaw. There was a statistical significant increase in over-eruption of molars compared with the adjacent premolars (controls). Small elongation changes were noticed in a large number of premolars and molars irrespectively if the tooth had an antagonist or not. The elongation was however, more pronounced in molars without antagonists. The results showed that molars with a mesial space due to a missing tooth were more common in the lower jaw. The mean changes in inclination, both for the molars and the control premolars mesial to the edentulous area, were small and not statistical significant.

Conclusion: Molars without antagonists elongate in adults during a 10-year period but the changes are small. Premolars and molars with antagonists also elongate but these changes are smaller. Molars and premolars with a mesial/distal space respectively does not tip in a consistent pattern in adults

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Kemiska och morfologiska aspekter av artificiell karies i primära tänders emalj

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Aim: The individual diversity in the concentration of minerals in enamel may contribute to an individual progress of caries. Therefore, it is of importance to relate the mineral concentration in the enamel with the pattern of how enamel demineralise in teeth from different individuals.

Material and Methods: Eighteen teeth were included in the present study from 18 different children aged 3-17 years old. The patients were referred to the department of Pediatric dentistry and their second primary molar was extracted for different odontological reasons. Artificial caries was produced on the buccal surface in a window 3x3 mm, with 0.1mol/l lactic acid, pH 5.3 in an 8% methyl cellulose gel at 37°C for 30 days. The teeth were then sectioned in bucco-lingual direction, in 200 µm thick sections. The sections were analyzed in a light microscope, in microradiographs, scanning electron microscope (SEM) and with energy dispersive X-ray analysis (EDX). The normal enamel and the affected enamel were analyzed with EDX with respect to carbon, oxygen, nitrogen, phosphorous and calcium.

Results: An artificial lesion was found in all sections. All surfaces remained intact; the appearance of the surface was either 1) chalky & rough, 2) chalky & glossy or 3) tooth coloured & glossy. The depth of the lesion ranged from 40-115 µm (mean=75±5.3 µm). The composition of elements fluctuated individually in the enamel. The ratio of Ca/P varied from 1.37-2.62 (mean=2.13±0.9), when measured as mass percent of carbon, oxygen, phosphorous and calcium.

Conclusion: Individual variations in depth of carious lesion were seen when exposing enamel to demineralising solution. The depth of the lesions was correlated to the appearance of the surface and to the ratio of Ca/P in the individual tooth.

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Dental fear and behavior management problems in a group of immigrant children in Stockholm

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Aim: The aim of this study was to increase the knowledge about patients with immigrant background who were referred to a clinic specialized in pediatric dentistry. The reason for referral was dental fear or dental behavioural management problems. The records were examined according to: Relevant background information such as socioeconomic status and residence, number of decayed teeth and treatment received at the clinic for pediatric dentistry.

Material and Methods: The aim of this study was to increase the knowledge about patients with immigrant background who were referred to a clinic specialized in pediatric dentistry. The reason for referral was dental fear or dental behavioural management problems. The records were examined according to: Relevant background information such as socioeconomic status and residence, number of decayed teeth and treatment received at the clinic for pediatric dentistry. The study design is a retrospective record study. Records of patients with immigrant background referred because of caries and behavior problems were collected during a period of three months from two clinics for pediatric dentistry. Patients with immigrant background were selected by their names. A total number of 119 records of patients with foreign names were found during the time of collection. 43 of those records had documentation of the patients immigrant background. Patients with physical and mental disorders were excluded from the study. Data concerning age, sex, number of cavitated teeth and treatment modality was collected from the selected records. A reference group consisting of patients with nonimmigrant background was collected during the same period of time. They were selected on the same criteria. The total number of records in this group was 133.

Results: There was significantly more children in the immigrant group from socially deprived areas (n=24/43) compared to the reference group (n=12/133). There was also a significant higher prevalence of caries in primary teeth in the immigrant group compared with the nonimmigrant group. There was no difference between the groups regarding treatment modality.

Conclusion: As expected, there was more caries detected in the immigrant group than the nonimmigrant group.
There was no discrimination regarding treatment modality between the two groups.

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Tooth wear and lifestyle factors in young adults

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Aim: Tooth wear is the sum of loss of tooth surfaces caused by erosion, attrition and abrasion. Relatively few studies are published on tooth wear in young adults. The present study aims to analyse the prevalence of tooth wear in relation to some lifestyle factors.

Material and Methods: Five hundred 20-year olds have been longitudinally followed from 1 year to 20 years of age concerning oral health and lifestyle factors, including consumption pattern and oral hygiene measures. At 20 years of age, the individuals were exposed to a clinical and radiographic examination and an individual tooth wear score concerning attrition in upper and lower incisors, erosion in maxillary incisors on buccal and lingual surfaces and erosion in first and second molars on occlusal surfaces was collected.

Results: Consumption of soft drinks once a day or more is associated with a higher tooth wear score compared to no consumption of soft drinks (p=0.02). Consumption of soft drinks once a day or more is associated with a higher prevalence of small dentin exposures (cuppings) on first molars compares to no consumption of soft drinks, however, not significant. Body Mass Index at 15 and 20 years of age is not associated with small dentin exposures (cuppings) on first molars or total tooth wear (N.S.) Smokers had higher total tooth wear score compares to non-smoking individuals (p=0.009).

Conclusion: A large number of individuals showed presence of tooth wear and most common is attrition. Erosion with small dentin exposures is more prevalent on first molars than on second molars. This indicates that the etiological influence might have occurred earlier in life.

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A longitudinal study of oral health in preschool children with asthma

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Aim: The aim of the present study was to investigate caries and its determinants in preschool children with and without asthma, followed from 3 to 6 years.

Material and Methods: Caries, plaque and gingivitis were examined at 3 and 6 years of age in 64 asthmatic children and 50 matched, healthy control children. In connection with the examinations, the parents were interviewed about various oral health-related factors.

Results: Initial caries increment between 3 and 6 years of age was statistically significant higher for children with asthma compared to children without asthma ($P < 0.05$). Asthmatic children had more bleeding gingivitis and a higher consumption of sugary drinks than healthy children at 3 years of age ($P < 0.05$). At both 3 and 6 years of age, the asthmatic children were more frequently mouth breathers than healthy children, only statistically significant for 6 year olds ($P < 0.05$).

Conclusion: Preschool children with asthma at 3 years of age run a higher risk of developing caries lesions until 6 years of age compared with children without asthma. The asthma disease appears to trigger caries development and generates a more serious caries situation in preschool children.

◎ ◎ ◎ 31

No waiting list anymore – how did we do it?

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Aim: At the Department of Paediatric Dentistry in Jönköping, Sweden, children and adolescents receive specialist dental care, having been referred to the Department from dentists and physicians. For many years, the waiting time was up to 1 year, and return visits were booked after 3–4 months. During 2007 part of the staff at the Department took part in an educational program for improved access for patients. It was arranged by Qulturum, Department for Learning and Innovation, Jönköping County Council, Sweden. The program included four learning sessions over a nine month period with working periods in between. The aim was to eliminate the patient waiting list, to improve access, and to offer treatment appointments within reasonable time.

Material and Methods: First the activities at the Department of Paediatric Dentistry were investigated in detail by measuring the clinical supply and the external and internal demand. Then, in order to balance supply and demand, a plan of action was made. Increase the supply: • Priority to patient time, e.g. avoid meetings and courses during hours intended for patient work. • No serial booking, i.e. book only one return visit at a time. Reduce the demand: • Accept only referrals that are clear specialist cases. • Optimize guidelines for return visits. • Encourage telephone consultations instead of referrals • Increase the external activity, e.g. visits by the senior consultants to the general dentistry clinics. Handle variations: • Secure the availability of the emergency times of the day. Eliminate the "rucksack": • Eliminate the existing queue of referrals, the "rucksack", by working some extra clinical hours during a few summer weeks in 2007.

Results: Clinical work has been given a new perspective at the Department, the waiting list is eliminated, and access is improved. Ever since August 2007, the clinic does no longer have a waiting list. New patients receive their first appointments within one month. A return visit can be booked within 3–4 weeks. Improved access, measured as the third next available ▷

appointment, is sustainable during the last two-year-period. We always accommodate emergency cases on the same day, and we receive fewer emergency telephone calls from dentists and parents. The Public Dental Service has noticed the successful changes at the Department, and in 2007 awarded the Head of the Paediatric Dentistry a diploma.

Conclusion: Up to the April 2007 the Department of Paediatric Dentistry in Jönköping, Sweden, had problems with overcrowded appointment schedules and an increasing queue of referrals. During many years attempts to find solutions had been made in vain. In order to increase access we took part in a developmental program, "Bra mottagning" (Good clinic). We analyzed the problems, made a report of the present situation, put up measurable goals and developed new strategies to increase access. The supply was increased and the demand was reduced. Our goals were reached in August 2007. The waiting list was eliminated and access improved. The result, measured as the third next available appointment, is sustainable during the last two-year-period.

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The composition of the salivary pellicle is substrate specific

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Aim: The aim of this study was to show an alternative way to investigate differences in pellicle composition and to examine if the pellicle composition was different between different dental materials and human enamel.

Material and Methods: This study utilized two-dimensional gel electrophoresis (2-DE) to illustrate compositional differences between in vitro salivary conditioning films (denoted pellicles) formed on human enamel as well as on the dental materials titanium and poly methyl methacrylate (PMMA). The salivary pellicles were formed by immersing each substrate in individual tubes containing small volumes of freshly collected whole saliva. After 2 hours of pellicle formation the remaining saliva proteins in the tubes were visualized by means of 2-DE and silver staining.

Results: The results showed that the protein patterns regarding proteins below 100 kDa in size were different depending on the surface used. Several protein groups and/or individual proteins were shown to be distinct for each surface type used.

Conclusion: The present findings support the hypothesis that the underlying material has an influence on the salivary film composition, as some proteins seemed to be specifically adsorbed on the different substrates. Further, surface roughness, surface free energy, surface chemical composition and surface charge seem to be important factors for variations in pellicle composition between human enamel, titanium and PMMA surfaces.

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Contact allergy from gold in patients with oral lichen planus

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Aim: Clinical relevance of positive skin patch tests for contact allergy to gold in the oral cavity is still controversial or unknown. This study investigated presence of dental gold restorations and the frequencies of contact allergy to gold in two groups of patients: (i) patients with oral lichen lesions (OLL) and (ii) a control group of patients with suspected allergic dermatitis (dermatitis patients).

Material and Methods: Eighty-three patients with OLL and 83 age- and gender-matched dermatitis patients were tested epicutaneously with gold sodium thiosulfate (GSTS). All patients with OLL and 39 dermatitis patients underwent an intraoral clinical and radiographic examination. Presence of dental restorations were registered in another 44 dermatitis patients in a reduced clinical examination.

Results: No significant difference in frequency of contact allergy to gold was found between patients with OLL and the control group (28.9% and 22.9%, respectively, $p = 0.376$). Number of dental gold alloy restorations did not differ significantly between the two groups ($p = 0.433$). Mean number of tooth surfaces restored with dental gold was 19.7 in patients with OLL and 15.5 in controls.

Conclusion: The frequency of contact allergy to gold is high in patients with OLL but not significantly higher than in matched controls. Because the between-group difference in number of tooth surfaces restored with gold was nonsignificant, it still cannot be decisively concluded that OLL could be a manifestation of an allergic reaction to gold.

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Implant-retained single crowns: A clinical, radiographical and patient satisfaction retrospective study

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Aim: To present clinical and radiographic treatment results on implant-retained single crowns over a ten-year period and compare these results with other similar follow-ups. Further, to evaluate the patients apprehension and acceptance of the performed treatment.

Materials and Methods: All 81 patients, 38 men and 43 women, referred to one specialist clinic during December 1996 to September 2006 and treated with implant-retained single crowns where called to a follow-up. Fifty-one (63.0%) of the patients (mean age 24.0 years, SD. 3.09) came to the follow-up. The patients had 71 implants installed, 46 (64.8%) of these were Brånemark System® (Nobel Biocare AB, Göteborg, Sweden), 21 (29.6%) Replace® (Nobel Biocare) and 4 (5.6%) Astra® implantat (Astra Tech AB, Mölndal, Sweden). Dental record data where collected and complications were registered at the five-year follow-up. Bone loss was radiological determined at crown placement and at the time for the follow-up (mean 5.6 years). The patients answered a questioner according to GOHAI index and crown quality was determined according to the CDA index. The significance level was set to 5 % ($p<0.05$).

Results: One implant was lost before loading, giving a cumulative success rate for implants of 98.6% after five years. No implant was lost after loading. The Brånemark System® implants had a mean bone loss between baseline and follow-up of 0.04 mm and Replace® implants 0.16 mm on average. The bone levels of the Astra® implants were unchanged. Among the followed-up implants, 11.4% where judged to be in infra occlusion. The probability of infra-occlusion increased over time after implant installation ($p=0.015$). The GOHAI index showed high values, indicating a high quality of life. The CDA index also showed high scores for the single crowns: 97% were in the acceptable groups ”excellent” or ”acceptable” for colour and surface, 97% for anatomy and 100% for marginal integrity.

Conclusions: This study confirms the favourable results presented in other studies on implant-retained single crowns.

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Clinical evaluation of Procera Zirconia Maryland Bridge in replacing central and lateral incisors

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Aim: The aim of this prospective study was to evaluate the long-term clinical survival of Procera Zirconia Maryland Bridge with a rough-porous bonding surface. The utilized product was only available for research purposes and is currently under further development.

Material and Methods: Patients were treated at the department of prosthodontics, Eastman Institute and S: t Erik's hospital, Stockholm. The study started in September 2007. A total of 29 anterior resin-bonded fixed partial dentures with a zirconium oxide framework were made in 28 patients. The bridges were only made with a two retainer design and bonded with a luting resin containing phosphate monomer, Panavia F. The bonding surface of the wings was modified to produce micromechanical retention.

Results: Two patients were excluded from the study and 27 units were re-examined after 6-24 months. Fourteen of these prostheses failed; the failures were evoked by debonding, fracture of the retainer, or a combination of both. SEM-EDS analysis showed that the bonding surface of the wings was affected and contaminated with glass elements (porcelain).

Conclusion: The Procera zirconia-framed Maryland Bridge improves the esthetics by eliminating the problem of grey out of the abutment teeth caused by metal-ceramic resin-bonded fixed partial dentures (RBFPD). However, it could not demonstrate a similar survival rate to metal-ceramic RBFPD and therefore it could not be considered as a predictable restorative alternative. The modified bonding surface of the wings can easily be contaminated with porcelain and affected by sandblasting. Success of these types of restorations may rely on design and bonding surface of the restoration, appropriate tooth preparation, and careful selection of patients. Recommendations are purposely given to refine the bridge before introducing it for clinical use.

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Patient satisfaction after receiving dental implants with immediate loading in the edentulous atrophic maxilla - 1- year results of a prospective study using the OHIP 49 questionnaire

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Aim: The aim of this work was to evaluate patient satisfaction with the Oral Health Impact Profile 49 before and after treatment with implants and implant-supported bridges in the maxilla. Six implants were placed in the maxilla and loaded within 24 hours after installation with a temporary restoration. 20-24 weeks later the permanent restoration was delivered.

Material and Methods: The present study was performed as a multi-center study at two locations. 51 edentulous patients with severe atrophy of the maxilla (Lekholm & Zarb index C, D, E & 3, 4) were included in the study. Six implants were placed in the maxilla and loaded within twenty-four hours after installation with a temporary restoration. Patients received implants in the maxilla using the implant Osseo Speed™ (ASTRA TECH AB, Mölndal, Sweden). 20-24 weeks later the permanent restorations were delivered. Patients were asked to fill in the OHIP 49 questionnaire prior to implant surgery and at three occasions after treatment. OHIP 49 contains seven subgroups (psychological disability, functional limitation, physical pain, psychological discomfort, physical disability, social disability and handicap).

Results: Baseline satisfaction scores for the two different centres displayed no statistical differences. Treatment resulted in improved total OHIP 49 scores at both centres with no significant difference in-between centres. Furthermore, no significant differences were observed in any of the individual pre- and post-treatment OHIP 49 domains between centres. All seven subgroups showed a statistically significant improvement in their post OHIP score. Of the seven domains, domain six and seven (social disability and handicap) showed the lowest improvement and had the lowest pre-treatment score compared to domain one to five during implant treatment (psychological disability, functional limitation, physical pain, psychological discomfort, physical disability).

Conclusion: The OHIP 49 questionnaire used in this work revealed that patient satisfaction increases after treatment with a fixed restoration on implants loaded within 24 hours. This study also indicates that domains one to five (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability) are the most important domains when trying to satisfy implant patients. Domain six and seven (social disability and handicap) seems to be of less significance for patients during their implant treatment experience.

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Prevalence of symptoms related to temporomandibular disorders in 50- to 75-year-old subjects

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Aim: To assess the prevalence of 3 temporomandi-

bular disorder (TMD) symptoms and awareness of bruxism in 3 cohorts of subjects aged 50, 65 and 75 years.

Material and Methods: Identical questionnaires were in 1992 and in 2007 sent to all subjects born in 1942 and living in two Swedish counties. In 2007 the same questionnaire was also sent to all persons born in 1932 and living in the same counties. Of the 50-, 65- and 75-year-old subjects 8888, 8313 and 5195 responded (response rate 71.3%, 73.1%, 71.9 %). This study focused on 4 questions on the severity of TMD and bruxism. Each question had 4 response alternatives: no, some, rather severe and severe problems.

Results: The great majority reported no or only some problems related to TMD. Less than 3 % of the responders considered their TMD symptoms to be rather great or severe. The mean prevalence of TMD-related symptoms and of reported bruxism was greater in women than in men in all 3 age groups. The differences between the age cohorts were small among the men, whereas the oldest (75-year-old) women demonstrated a marked lower prevalence of TMD symptoms and bruxism than the younger women.

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Vibration threshold in masseter muscle: Reliability and effect of tooth clenching – a pilot study

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Aim: This study evaluated (i) the test-retest reliability of vibrotactile sensitivity and (ii) effects of tooth-clenching exercises on vibrotactile sensitivity, pressure pain thresholds (PPT), and self-reported spontaneous pain and fatigue in the masseter muscle.

Material and Methods: Twenty-five healthy females (mean age: 42 ± 12) participated in the study. Vibration threshold (VT) was assessed and calculated as the mean of vibration perception threshold (VPT) and vibration disappearance threshold (VDT). Three measurements of VPT and VDT each were made on the right masseter muscle with a Vibrameter™ (Somedic, Hörby, Sweden). To assess reliability, test-retest measurements were conducted with 10 minutes and 1 week interval. Tooth-clenching effect on VT was measured in 13 of the 25 participants (mean age: 45 ± 11). Maximal voluntary clenching (MVC) was assessed before trial start and used to determine a submaximal level of force (50% of MVC). PPT was measured with an algometer (Somedic) and self-reported pain and fatigue were reported before and after the 30-min tooth-clenching exercises.

Results: The interclass correlation coefficient (ICC) was used to describe VT reliability. The 10-minute test-retest ICC was 0.92 (95% CI 0.81 - 0.96), and the 7-day test-retest ICC was 0.59 (95% CI 0.08 - 0.82). The mean VT was 1.6 ± 0.9 µm before and 1.9 ± 1.1 µm after tooth-clenching ($P=0.1$). Tooth-clenching resulted in a significantly lower PPT ($P<0.05$) than before clenching; pain intensity ($P<0.01$) and fatigue ($P<0.001$) were significantly higher after tooth-clenching.

Conclusion: This study found acceptable reliability for the VT. PPT, spontaneous pain, and fatigue but not VT were influenced by tooth-clenching.

▷◎◎◎ 39

Oral parafunctions and lifestyle in young adults and temporomandibular disorders

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Ai:m: The aim vas to investigate effects of chewing gum chewing, nail biting and oral piercing on stomatognatic system and association to facial pain.

Material and Method: The study comprises 124 pupils in the third level, on scientific and media program at high school. Half the group live in a city and half in small town or countryside in Värmland. The pupils answered a questionnaire regarding parafunctions noticed, symptoms of temporomandibular pain and /or dysfunction, use of analgetics and sick-leave. A clinical examination of the temporomandibular joints and muscles, mandibular movements, mucosal signs of parafunction and signs and degree of attrition was performed in 116 of the pupils. Statistical analysis was performed with SPSS.

Result: Chewing gum chewing was reported by 86 % of the subjects, 25 % with a daily use and 11 % four hours or more a day. Daily use of chewing gum was correlated with headache($p<.01$) difficulties to open wide($p<.05$), and for girls reported locking($p.05$) and tenderness to palpation of the TMJ($p<.01$). Nail biting was reported by 48 % of the subjects, and daily biting by 12 %. Daily nail biting was correlated with headache($p<.05$). Oral piercing was found in 14 % (17 % girls, 9 % boys), the media pupils had significant more piercing($p<.001$) compared to the scientific pupils, but with uneven distribution between the classes. Oral piercing was correlated to muscle tenderness to palpation and dysfunction($p<.05$) and to tinnitus and headache ($p<.05$). Headache was reported by 79 % of pupils, 39 % had headache once or more, 6 % of girls reported daily headache. Symptoms once a week or more was reported by 7 % for facial pain, 4 % for locking and TMJ clicking by 18 %, with daily occurrence for 6 % of girls. According to the Helkimo dysfunction index 23 % of the pupils were classified as index II and III (31 % of the girls and 12 % of the boys). Reported symptoms had result sick-leave for every fifth pupil, 11 % used analgetics once a week or more(15 % girls, 6 % boys). Consulting professional help for TMJ symptoms had 13 % of girls and 2 % of boys.

Conclusion: Throughout the study girl had higher figurers of reported symptoms, of signs and degree of dysfunction, use of analgetics and medical consultations. There is an association between chewing gum use and oral piercing with facial pain and or temporomandibular pain and dysfunction.

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Reliability of intraoral quantitative sensory testing (QST)

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Aim: The prevalence of orofacial pain is reported to be around 20%. The most common location is intraoral, including recurrent and persistent pain conditions. Clinical signs and symptoms have been reported to overlap between nociceptive and neuropathic pain conditions, leading to difficulties in differential diagnosis. Somatosensory changes are important clinical features of neuropathic pain, and a comprehensive clinical examination including orofacial as well as qualitative and quantitative somatosensory examinations has been recommended for chronic intraoral pain investigations. The German Research Network on Neuropathic Pain (DFNS) has recommended a protocol with 13 quantitative sensory testing (QST) measures for detecting somatosensory abnormalities. Reliability is an important scientific property and has been adequately tested for cutaneous QST, but not for intraoral sites. The aim of this study was to evaluate the inter-examiner and intra-examiner (test-retest) reliabilities of the DFNS protocol at intra- and extraoral trigeminal sites.

Material and Methods: Twenty-one healthy volunteers from Malmö University, Malmö, Sweden (13 women and 8 men, mean age 40.4 years, range 24–71) participated. Two independent examiners previously trained in the DFNS QST protocol examined the participants using the entire protocol. Each participant was examined twice on the same day, once by each examiner (inter-examiner reliability). After 1–3

weeks, one examiner re-examined all participants (intra-examiner reliability). The measurements were made on the skin of the right cheek, the tip of the tongue, and bilaterally on the gingival mucosa of the upper premolar region. The intraclass correlation coefficient (ICC) or kappa was used to calculate variations.

Results: Most tests had acceptable to excellent inter-examiner (ICC 0.41–0.89) and intra-examiner (ICC 0.43–0.87) reliability. For each test, inter- and intra-examiner reliabilities at intra- and extraoral sites were similar. No significant differences between right and left sides were found intraorally.

Conclusion: We conclude that inter- and intra-examiner reliabilities of most QST measures according to the DFNS protocol are acceptable for assessing somatosensory function in the orofacial region.

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Reciprocal influence on the incidence of symptoms in trigeminally and spinally innervated areas

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Aim: Temporomandibular disorders (TMD), headaches, and spinal pain show co-morbidity and may therefore influence each other. The hypothesis tested is that the presence of any of these conditions will increase the risk of onset of new symptoms within a 2-year period.

Material and Methods: The study population comprised 280 dental students, who were examined three times at 12-month intervals. The incidence was calculated for a 2-year period, based on subjects without the defined symptom at baseline. Each participant was classified into five different case-control groups, representing incidence cases or no incidence (controls) of (1) nonpain TMD symptoms; (2) jaw pain; (3) headaches; (4) spinal pain; and (5) TMD pain. Presence of headaches and of spinal pain and signs and symptoms of TMD at baseline were used as independent variables in logistic regression analyses, controlling for age and sex.

Results: Incidence cases with TMD pain reported spinal pain at baseline significantly more often than the controls, and were mostly women. Incidence cases with headaches and incidence cases with jaw pain significantly more often had signs of TMD and reported spinal pain at baseline, compared to controls. Incidence cases with nonpain TMD symptoms or spinal pain significantly more often presented with signs of TMD at baseline.

Conclusion: Our findings show that pain and dysfunction in trigeminally innervated areas and pain in spinally innervated areas mutually predict the onset of new symptoms in dental students, indicating common pathophysiological mechanisms and individual vulnerability. This may be of importance in risk assessment and treatment planning of individuals with musculoskeletal pain.

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The trabecular pattern in the mandible as bone fracture predictor

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Aim: The aim of the present study was to explore the possibility of using sparse trabecular pattern on mandibular periapical dental radiographs to identify individuals with highest probability of previous fracture

Material and Methods: In a cross-sectional study, alveolar trabecular pattern was classified as sparse, alternating dense and sparse, or dense using intraoral radiographs from 358 individuals (120 men and 238 women, mean age 64.5yrs) including 60 with previous reported skeletal fractures. Bone mineral density (BMD) by DXA was recorded for 250 of these subjects

Results: Sixty-four individuals had a sparse trabecular pattern in the mandible, twenty-six (41%) had suffered a bone fracture in adulthood. Two hundred and thirteen individuals had alternating sparse and dense trabecular patterns, 33 (16%) reported previous bone fractures. Eighty-one had dense trabecular patterns in the mandible and one (1.2%) of these reported a previous bone fracture. This difference in frequency of bone fractures between sub- ▷

jects with different trabecular patterns is marked and highly statistically significant (p<0.0001). Compared with individuals with denser trabecular pattern, those with sparse had a higher risk for fracture (OR=5.4; 95% CI: 2.9-10.3; p<0.0001). Excluding individuals under 70 increased the estimate of fracture risk in those with sparse trabeculation (OR=6.3). Neither BMI, BMD, nor sex gave significant estimates of fracture risk but age was associated with marginally elevated risk (OR=1.004; 95% CI: 1.000-1.008, p=0.048). Trabecular pattern was significantly positively correlated with BMD (r=0.50, p<0.0001), with BMI (r=0.20, p<0.001), negatively with fracture (r=-0.33, p=0.0001) but not correlated with age. No correlation was found between BMD and fracture.

Conclusion: This study demonstrated that dense trabecular pattern on dental radiographs is associated with very low frequency of bone fracture whereas sparse trabecular pattern is related to an increase in number of self-reported fractures. Sparse trabecular pattern seems to identify more individuals with fracture than BMD especially in old individuals. Our findings indicate that dentists may play a useful role in identifying individuals with increased fracture risk.

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Compulsive behaviour and decreased levels of Oxytocin in SHR rats restrained from running.

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Aim: To assess compulsive behaviour of Spontaneous Hypertensive Rats and Oxytocin-like immune reactivity in blood-plasma

Material and Methods: Spontaneous hypertensive rats (SHR) were divided into three groups of 8 rats: Control group (no running), abstinent group (running for 5 weeks) and running group (continuous running for 6 weeks). After 5 and 6 weeks compulsive behaviour was assessed by using an open cage model and assessing self-mutilation of paws. After 6 weeks blood plasma was collected and Oxytocin-like immune reactivity (-LI) was measured with radio immune assay.

Results: The level of Oxytocin-LI in blood plasma was lower in the Running group (34, 9 +/- 5, 9 pmol /l, p<0, 001) and in the Abstinent group (25, 4 +/- 2, 6 pmol/l, p<0, 001) compared to the Control group (43, 8 +/- 10, 9 pmol/l), respectively. Oxytocin-LI correlated with aggression (r= 0, 6; p<0, 005) and explorative behaviour (r=0, 6; p< 0, 001). The degree of self-mutilation was significantly higher in the abstinent group compared to control group (p<0,005) and higher compared to the running group (p<0, 05).

Conclusion: This study suggests that decreased oxytocin-LI in blood plasma after running and experimentally induced abstinent behaviour can be linked to a compulsive behaviour (1) in the spontaneous hypertensive rats. The neuropeptide Oxytocin affects mood (2) and the autonomic nervous system (3) in a sedating manner (4). However, the effects are dose dependent (5). Spontaneous hypertensive rats (SHR) have a compulsive behaviour (6) due to their breed (7). In this study we designed a model for experimentally induced compulsive behaviour, were rats were abstinent from running after 5 weeks. The rats in this abstinent group showed the same aggressive behaviour as the Running group, but a higher degree of self-mutilation (8) as form of compulsive behaviour (9). Abnormalities of Oxytocin systems can be seen in several neuropsychiatric disorders, including obsessive-compulsive disorder (10). The association of oxytocin with obsessive-compulsive disorder (12) has led to the investigation of certain neurohormonal factors, including changes in Oxytocin levels (13).

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Periosteal expansion of rabbit mandible with an osmotic self-inflatable expander

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Aim: The aim was to evaluate a new technique for intraoral expansion of soft tissue with a self-inflatable expander in rabbits.

Material and Methods: A self-inflatable soft tissue expander was placed bilaterally in eight rabbits under the periosteum of the mandible through an extraoral approach. This expander consisted of an osmotic active hydrogel, a vinyl pyrrolidone, and methylmethacrylate, surrounded by a perforated si-

licone envelope. The initial size of the hydrogel was 2.5 x 7.5 x 3.0 mm. The size after maximal swelling was 5.6 x 11 x 6.0 mm. The number and size of the perforations in the surrounding silicone envelope adjusts the expansion speed .The silicone envelope had a flat end to permit fixation of the expander to the bone, which prevents the expander from moving while it is expanding. The flat end has no expansion potential and is used as a control area. The expander was left to self-inflate for two weeks, after which the animals were killed and specimens collected for histological examination.

Results: The self-inflatable soft tissue expanders expanded the periosteum. There were no dehiscences or infections. Histological observations showed no signs of any inflammatory reaction and there was no evidence of bony resorption. New bone had formed at the edges of the expanded periosteum. In the control area no new bone had formed.

Conclusion: The osmotic soft tissue expander model for intraoral soft tissue and periosteal expansion suggests a promising way of creating a surplus of soft tissue that can be used to cover bone grafts.

◎ ◎ ◎ 45

Sublingual varices in relation to smoking and cardiovascular diseases

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Aim: The purpose of this study was to investigate the relation between sublingual varices, cardiovascular disease (CVD), and smoking.

Material and Methods: We studied 281 patients over 40 years old in this observational study. During a check up visit, sublingual varices were sought on the lateral border of the tongue. Results were classified into two groups: grade 0 (few or none) and grade 1 (moderate or severe). Information about CVD and smoking was obtained from the patients and recorded. Multiple logistic regression analysis was used to assess the influence of particular variables on the incidence of sublingual varices.

Results: The presence and number of varices increased with increasing age, and the overall incidence was 98/281 (35%). Fifty-one of the patients were smokers (18%) and 45(16%) had CVD, usually hypertension.

Conclusion: Sublingual varices were significantly associated with age (odds ratio OR 1.1), smoking (OR 2.4), and CVD OR 2.7).

◎ ◎ ◎ 46

Altered inorganic elemental composition in dental enamel and dentin in primary teeth from Turner syndrome females

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In Turner syndrome (TS), one X-chromosome is missing, or is defect. The amelogenin gene, located on the X-chromosome, has a key role during amelogenesis. In this paper primary teeth from TS patients were analysed. Qualitative and quantitative changes in the inorganic composition of TS enamel were found, in addition to morphological deviations. Using polarized light microscopy higher frequencies of subsurface lesions and irregular rod free zones within enamel were revealed. Similarly, scanning electron microscopy showed TS enamel rods with atypical sizes and directions. With X-ray micro analysis, high levels of calcium and phosphorus as well as low levels of carbon were found in both TS enamel and dentin. In TS enamel the Ca/P ratio was elevated, indicating a loss of phosphorus in hydroxyapatite. Using microradiography a lower degree of mineralization was found in TS enamel. In order to identify specific element patterns being critical and characteristic for the diagnose TS, rule induction analysis was performed. Low levels for carbon in enamel and dentin were the most critical attributes for the outcome TS. The conclusion of this study was that an impaired X-chromosome expression has an impact on dental hard tissue formation, possibly due to altered levels of amelogenin.

◎ ◎ ◎ **47**

Temporomandibular disorders before and after whiplash trauma.

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Introduction: Whiplash Associated Disorders (WAD) still cause problems in many individuals after traffic accidents, although the risk for prolonged disability have been reduced with modern protection systems. Symptoms and signs indicating temporomandibular disorders (TMD) can occur in connection with the car accident but may also develop later. There are no prospective studies regarding the occurrence of earlier symptoms and signs indicating TMD in WAD patients and if this has importance for the development of TMD.

Aim: To evaluate the occurrence of TMD before and after whiplash trauma.

Material and method: A prospective study of 146 individuals (81 women and 65 men) with WAD I-III after car accidents in 1997-2001, comprising a structured questionnaire and clinical examination by a physiotherapist in the acute stage after trauma and after one year.

TMD before the accident was considered to exist if:
1. Affirmative reply was given on the question "have you had difficulties to open your mouth and/or chew the last three months before the accident?"
2. Report of an existing tooth grinding/tooth clenching habit, jaw pain, jaw sounds, feeling of jaw locking or usage of an occlusal splint at any time before the accident at the primary clinical examination.

Signs indicating TMD were considered if:
1. Painful mandibular movements were noted.
2. An asymmetrical jaw movement, meaning visible deviation from the vertical line between the incisors of the upper and lower jaw of more than 2 millimetres was seen.
3. Reduced mouth opening was found, meaning that the distal interphalangeal joints of the subject's fingers 2, 3, and 4 could not be inserted vertically between the front teeth.

Results: No patient stated mouth opening/chewing difficulties during the last three months before the accident, but 10 men (15%) and 17 (21%) women had or have had TMD before the accident. At the primary examination, three men (5%) and three women (4%) reported mouth opening/chewing difficulties, and signs indicating TMD were noted in 37%, independently of sex and age, with a strong relationship to reported TMD before the accident (OR: 8.7; 95% CI: 2.7-27.9; $p < 0.001$). After one year, nine women and no men reported mouth opening/chewing difficulties. Eight (10 %) had developed these problems.

Conclusion: Symptoms and signs indicating TMD may develop after whiplash trauma, both in acute and later stages, irrespective of earlier problems.

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