

# Clinical Oral Investigations

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**Across European Borders**  
**Prevention, Restoration and Aesthetics**

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## Prologue

The meeting was opened with two pregress symposia about endodontics and ceramics, followed by a half-day session about clinical aspects of bleaching and long-term results. One of the main topics was minimally invasive therapy, cavity preparation and prevention, in which new preparation systems as well as chemo-mechanical removal of caries were discussed by speakers from Switzerland, Germany, Sweden, France and the United States. Another main topic was caries diagnosis and caries risk assessment, where new biochemical evaluation tools as well as physical and optical devices were treated. In the preventive sector, workshops and symposia were presented on the safety and efficiency of powered toothbrushes and caries prevention with (amine) fluoride. Simultaneously, sessions about restorative and esthetic dentistry, for example, on the newest development in restorative materials and light polymerization (expectation and reality) provoked great interest.

The main topic on the second day involved prevention of caries and erosion. It started with “stopping demineralization with ozone” and the “biological approach in dental caries” by Lynch and Beighton from the UK. The diagnosis and risk factors of erosion as well as the management and prevention of erosive tooth wear were discussed by Gans and Lussi from Germany and Switzerland. Time was also given to the reasons, prevention and therapy of non-caries cervical lesions. For half a day van

Meerbeek (Belgium), Schmalz (Germany) and Watson (UK), as well as Degrange (France), Haller (Germany) and Pascual Moscardo (Spain), showed the present development of dentin adhesives from the biological and mechanical side to clinical application.

There was a comprehensive discussion of the managing of aging patients — ranging from “aging population, problem or opportunity” to “root caries and prosthodontic treatments in elderly patients” and “the rational use of oral care products and the care of the elderly”. In restorative dentistry, during the second day of the meeting, discussion focused on CAD/CAM and ceramic restorations as well as on problems with conventional or adhesive luting, repair of restorations and guidelines in operative dentistry. Highlights for practicing dentists included several workshops for brilliant adhesive anterior and posterior restorations presented by Vanini and Hugo as well as by Spreafico, Klaiber, Jedyneckiewicz, Ernst and others. Last but not least, poster presentations showed the extremely high level of that meeting.

The meeting was well attended (over 1,000 participants) and demonstrated the state of the art, presenting much new information for both scientists and dentists in daily practice. This issue of *Clinical Oral Investigations* publishes *some of the presentations abstracts*.

Prof. Dr. R. Hickel (President EFCD)

Prof. Dr. D. Heidemann (President DGZ)

## 1

**Cleaning efficacy of interdental brushes in different interdental space types**

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**Introduction:** No information is available which factors influence the cleaning efficacy of interdental brushes. **Aim:** To evaluate in vitro the cleaning efficacy of interdental brushes in different types of interdental spaces. **Methods:** Interdental brushes with diameters of 2, 3, 4 and 5 mm (Curaden AG) were tested in 8 pairs of extracted human molars combined to simulate two types (isosceles and equilateral) of interdental spaces with 4 sizes each. After coating the teeth with a dye to simulate plaque, digital images were taken from the proximal surfaces in a highly standardized setup. The teeth were repositioned and the proximal surfaces were cleaned in a reproducible manner. Post-brushing images were taken as before. After digital subtraction, the cleaned area was measured by pixel count. Percentage of cleaned surface area was taken as cleaning efficacy. **Results:** The cleaning efficacy was 10.1±7.8% (2mm), 16.8±9.6% (3mm), 23.0±9.7% (4 mm) and 22.5±7.8% (5 mm) in equilateral interdental spaces. In isosceles the cleaning efficacy was 13.2±5.1% (2 mm), 20.0±4.7% (3 mm), 26.6±7.7% (4 mm) and 25.9±7.0% (5 mm), respectively. The differences between the different types of interdental spaces were statistically significant (Wilcoxon test for paired samples,  $p<0.05$ ) for the 2 mm brush but not for the larger brushes. **Conclusions:** Smaller interdental brushes are more sensitive with respect to the cross sectional shape of the interdental space than larger brushes in terms of cleaning efficacy.

## 2

**Effect of a crossover design on the 24-hours plaque regrowth**

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**Introduction:** The cleaning efficacy of different toothbrushes is often tested in a plaque regrowth crossover design, i.e. participants have to abstain from oral hygiene, repeatedly. This might influence the amount of plaque accumulation. As the baseline plaque is the most important confounder for the amount of plaque reduction those changes would significantly influence the outcome of the study. **Aim:** To investigate whether or not a crossover design would influence the 24-hours plaque regrowth. **Methods:** In two separate toothbrush studies with a crossover design, 158 participants volunteered to abstain twice (T1 and T2) for 24 hours from all oral hygiene procedures prior to the test. The time between the two arms of each study was 12 days. Plaque accumulation was measured by one calibrated examiner using the Turesky modification of the Quigley & Hein Index. **Results:** The overall 24-hours plaque regrowth resulted in scores of 2.10±0.60 (T1), and 1.67±0.56 (T2;  $p<0.001$ ; Wilcoxon test for paired samples). The most pronounced differences were found at proximal (T1: 2.20±0.58; T2: 1.74±0.54;  $p<0.001$ ) and lingual sites (T1: 1.56±0.60; T2: 0.98±0.43;  $p<0.001$ ). As these areas are difficult to reach it is unlikely that the differences are the consequence of violations of the regrowth protocol. **Conclusions:** Repeating plaque regrowth within 12 days results in a significant lower plaque accumulation, especially at sites, which are difficult to reach. This might significantly influence the outcome of cross-over study designs.

## 3

**Evaluation of the Efficacy of a Novel Toothbrush Design**

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**Introduction:** Toothbrush designs are evolved rapidly to improve the efficacy of plaque removal. **Aim:** To compare cleaning efficacy of a newly developed manual toothbrush with an oblique tuft surface design (soft: A; hard: B), a toothbrush with crossed bristles (C), and a standard flat trim toothbrush (D) in a clinical single-use single-blind randomised splitmouth study. **Materials and Methods:** 45 healthy subjects abstained from all oral hygiene procedures for 48 hours. After registering the amount of plaque accumulation (Turesky modification of the Quigley & Hein Index at 6 sites per tooth) subjects brushed according to a randomised 4-tailed splitmouth protocol. Pre- and postbrushing plaque was compared and the percentage plaque reduction was taken as cleaning efficacy. **Results:** Overall plaque was reduced from 3.35±0.58 to 2.11±0.54 (A), from 3.32±0.57 to 2.03±0.64 (B), from 3.35±0.57 to 2.07±0.54 (C), and from 3.27±0.47 to 2.06±0.52 (D). At proximal surfaces plaque was reduced from 3.51±0.59 to 2.41±0.60 (A), from 3.56±0.63 to 2.32±0.56 (B), from 3.57±0.56 to 2.41±0.57 (C), and from 3.51±0.51 to 2.39±0.62 (D; Wilcoxon test for paired samples;  $p<0.001$  all). Compared to A, C and D, B showed a statistically significant better plaque reduction proximally (Friedman test;  $p=0.039$ ). **Conclusion:** All brushes removed a significant amount of plaque. In proximal areas, the hard toothbrush with the oblique tuft surface design was slightly superior to the other toothbrushes tested.

## 4

**Effect of repeated study participation on the 48-hours plaque regrowth**

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**Introduction:** During the development of new toothbrush designs it might be favourable to test different versions with the same individuals to reduce inter-individual variation. However, repeated abstinence from oral hygiene measures might influence the plaque accumulation. As the baseline plaque is the most important confounder for the amount of plaque reduction those changes would significantly influence the outcome of the study. **Aim:** To investigate whether or not repeated study participation would influence the 48-hours plaque regrowth. **Methods:** Three versions of a toothbrush were tested in 3 different clinical studies (T1, T2 and T3) with the same 37 healthy adult non-dental professionals. Time between the studies was 6 and 8 weeks, respectively. The participants abstained from all oral hygiene procedures for 48-hours prior to the test. Plaque accumulation was measured by one calibrated examiner using the Turesky modification of the Quigley & Hein Index. The plaque accumulation at the 3 timepoints was tested for statistically significant differences using the non-parametric multisample Friedman test ( $p=0.05$ ). **Results:** The overall 48-hours plaque regrowth resulted in scores of 3.09±0.37 (T1), 3.16±0.38 (T2) and 3.17±0.45 (T3), respectively (n.s.). At proximal sites, plaque was scored for 3.20±0.38 (T1), 3.26±0.40 (T2) and 3.26±0.47 (T3, n.s.). **Conclusions:** Repeating plaque regrowth studies with the same participants after 6 to 8 weeks does not influence the amount of accumulated plaque.

## 5

### Salivary and plaque fluoride levels after consumption of fluoridated salt-containing meals

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The aim of this study was to determine the salivary and plaque fluoride (F) levels after consuming of 3 different meals prepared with F salt (250 ppm), drinking F water (1 ppm) and using F toothpaste (1000 ppm). Study involved 15 volunteers (age 18-65 years) who consumed on 5 separate days spaghetti (1), rice (2), mashed potatoes (3), F water (4) or used F toothpaste (5). Volunteers had refrained from toothbrushing for 24 hours prior each examination. Samples of unstimulated saliva and interdental plaque were collected at baseline and 1, 5 (only saliva), 30, 60, 90 and 120 min after each application. F concentrations were measured using an ion-specific electrode and expressed as F/saliva (ppm), F/plaque (ppm) and F/protein (ppm). Baseline values were 0.03±0.002 ppm F (saliva), 5.01±0.03 ppm F (plaque), 196.88±3.67 ppm F (protein). After an initial rapid increase the F concentration exponentially returned to the basic values after 60 min. In saliva F values 1min after brushing were 7.79±0.209 ppm F and after eating and drinking between 0.27±0.002 ppm F and 0.24±0.003 ppm F (4,1,2,3). In plaque samples 31.12±0.81 ppm F (5) and between 15.74±0.27 ppm F and 14.51±0.03 ppm F (1,4,2,3) were measured and in protein the F concentrations were 1373.71±35.54 ppm F (5) and between 611.73±10.12 ppm F and 601.23±4.79 ppm F (1,2,4,3). Differences between the F concentrations after brushing (5) and after eating/drinking (1,2,3,4) were statistically significant (p<0.05). To summarize, also consumption of fluoridated salt-containing meals provides elevated F levels in plaque and saliva.

## 6

### Correlation between Clinpro<sup>TM</sup>Cario Diagnosis and Clinical Parameters

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The aim of this pilot study was to assess the correlation of the new test, Clinpro<sup>TM</sup>Cario Diagnosis (3M ESPE, Seefeld, Germany) with current usual clinical parameters. Clinpro<sup>TM</sup>Cario Diagnosis is an impression material containing a diagnostic additive which is able to show a site specific metabolic activity of lactic acid producing bacteria in a color reaction. 31 children were examined in this study. They were between 11-13 years old and had at least one erupted permanent second molar. The status of oral hygiene (TÜRESKY modification of the QUIGLEY and HEIN plaque index (QHI) and approximal plaque index (API)), gingivitis index (papillary bleeding index (PBI)), the caries status (DMFS/dmfs), and the results of the Clinpro<sup>TM</sup> test were recorded. Data analysis was accomplished using a Kappa test (SPSS 10.0). There was a low correlation between Clinpro<sup>TM</sup>Cario Diagnosis and oral hygiene indices ( $\Delta=0.3$  (fair) for QHI;  $\Delta=0.15$  (poor) for API), and between Clinpro<sup>TM</sup>Cario Diagnosis and caries lesions ( $\Delta=0.013$  (poor)). These results show that Clinpro<sup>TM</sup>Cario Diagnosis is not suitable for identification of current caries and that it did not correlate with common oral hygiene indices. The prognostic power of the new test has to be determined in a longitudinal study.

This study was supported by 3M ESPE.

## 7

### Effects of fissure sealants on laser fluorescence measurements

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The aim of the present study was to assess the influence of fissure sealants on caries diagnostic with laser fluorescence. 35 freshly extracted human teeth with 105 initial carious lesions were stored in physiological saline solution. After cleaning of the surface, carious lesions were randomly divided into seven groups. Teeth were fixed on a mechanical scope. Each group, containing 15 lesions, was sealed with a clear and a white version of the sealants Delton<sup>TM</sup> (Dentsply, Konstanz, Germany), Fissurit<sup>TM</sup> (Voco, Cuxhaven, Germany) and Helioseal<sup>TM</sup> (Vivadent, Schaan, Liechtenstein). Another group was sealed with an experimental nanofilled clear material. The reflected fluorescence was measured using the Diagnodent<sup>TM</sup>-system (Kavo, Biberach, Germany) at the occlusal surface both before and after acid etching as well as after application of the sealants. Measurements were repeated after 1 week. For statistical analysis a non parametric test was used (Kruskal-Wallis). Values were considered as statistically different at p<0.05. In all cases the reflected laser fluorescence values significantly increased after acid etching (p<0.05). Compared to the measurements before sealing values decreased after sealing with the white materials (p<0.05). There was no difference between values before and after sealing with the clear and the experimental materials (p>0.05). After 1 week all values were reproducible (p>0.05). The present study indicates that it is possible to control caries activity under clear, unfilled or nanofilled fissure sealants by means of laser fluorescence measurements.

## 8

### Association between cariogenic bacteria FCU in specific site plaque and saliva.

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Levels of cariogenic bacteria in saliva are not the best caries predictor because there are other related factors involved in the process, nevertheless could be useful to follow high risk patients or patients having a chemical plaque treatment. The goal of this study is to evaluate the association between levels of cariogenic bacteria in saliva and in several plaque locations with caries in the same sites. We have evaluated the level of FCU of mutans streptococci (MS) and lactobacilli (LB) in occlusal, approximal and buccal dental plaque as well as in stimulated saliva, using the CRT Bacteria system, and we established DMF-S index, all in 241 14–15-years-old students. Those individuals treated with antibiotics or rinsing with some kind of antiseptic were excluded. MS and LB in saliva and DMF-S index and his components were compared between U of Man Whitney non parametric test; MS and LB in specific sites and their caries experience, and MS and LB in saliva and specific sites plaque were compared between X<sup>2</sup> test. We founded a significant association between DMF-S index and it O component with MS levels in saliva. LB were significantly high in occlusal and buccal surfaces that had had caries experience. We conclude that SM and LB in plaque and saliva levels showed significant association with every approximal, occlusal and buccal surfaces. High levels of MS and LB in saliva correlates with high levels in plaque of specific sites, but MS levels in specific sites plaque does not correlate with caries experience in the same sites.

### In vivo evaluation of four methods of occlusal caries detection at discoloured fissures

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The present investigation deals with the ability of four diagnostic methods to detect occlusal dentine caries at teeth with discoloured fissures. A total of 550 sites were examined in vivo by two dentists using magnifying glasses, DIAGNOdent, ECM III and Cariometer CRM 800. If two or more methods indicated dentine caries, a minimal-invasive opening of this site was performed. Lesion depth was determined visually and dentine softening as an indicator for caries activity was assessed with a dental probe. This way validated data were collected at 108 sites that were opened in the fissures of 60 teeth from 37 patients aged 5 to 30 years. Diagnostic performance for dentine caries detection was evaluated using the parameters sensitivity and specificity as well as area under the ROC curve. Inter-examiner reproducibility was estimated by Cohen's Kappa. ECM showed the best predictive values concerning dentine caries followed by CRM, DIAGNOdent and visual inspection (sensitivity/specificity/AUC 0.88/0.85/0.88, 0.75/0.76/0.85, 0.72/0.69/0.71 and 0.45/0.76/0.61). The prediction of active caries was less accurate (sensitivity/specificity/AUC 0.54/0.87/0.75, 0.54/0.77/0.76, 0.57/0.72/0.65 and 0.38/0.80/0.59). In older patients (17–30 years) diagnostic performance of all methods decreased greatly (AUC 0.66, 0.53, 0.57 and 0.51 for dentine caries). Inter-examiner reproducibility was 0.93, 0.69, 0.78 and 0.62. In conclusion, among the four methods used, ECM demonstrated the best suitability for treatment decisions at non-cavitated, discoloured occlusal fissures.

### 10

#### TEM analysis of dentine after caries removal by an Er:YAG laser with fluorescent feedback

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The following investigation evaluated the dentine morphology after caries treatment with an Er:YAG laser supplemented with a novel laser fluorescence feedback device. Twenty permanent teeth with dental caries were treated as follows: enamel was removed by diamond burs and water-cooling until access to the caries lesion was achieved. The dentine surface was lased with beam pulses of 250 mJ energy and 4 Hz frequency (KEY Laser 3, Kavo). The endpoint of caries removal by laser irradiation was indicated by the integrated fluorescence feedback system (655 nm diode-laser). Subsequently, the laser irradiated dentine surface was scanned by the Diagnodent system (Kavo) (n=15) and stained by Caries detector (Voco) (n=5). The teeth were demineralised, dehydrated and embedded in epoxy resin. Ultra-thin sections (800 Å) were examined in a Philips EM 201 electron microscope after being stained with uranyl acetate and lead citrate. The TEM analysis of the lased dentine revealed that superficial aspects of the dentinal tubules were opened, devoid of any residual materials, odontoblast processes or bacteria. Within the superficial collagen network collagen cross-banding was an inconsistent finding, while it was generally apparent in deep dentine layers. In conclusion, the present investigation showed that the new Er:YAG laser supplemented with a feedback device was capable of a complete removal of bacterial infected dentine. The inconsistent collagen cross-banding of superficial dentine layers may indicate only minimal over-extension of caries removal within the demineralised layer. In accordance with REM investigations dentinal tubules remained open and empty after laser treatment.

### 11

#### SEM analysis of dentine after caries removal by an Er:YAG laser with fluorescent feedback

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The following investigation evaluated the caries removal and surface morphology of the dentine after caries treatment with an Er:YAG laser supplemented with a novel laser fluorescence feedback device (KEY Laser 3, Kavo). Twenty permanent teeth with dental caries were treated as follows: enamel was removed with diamond burs until access to the caries lesion was achieved. The dentine surface was lased at a radiation energy of 250 mJ and 4 Hz frequency until the endpoint of caries removal was indicated by the integrated fluorescence feedback system (655 nm). Subsequently, the laser irradiated dentine surface was scanned by the Diagnodent system (Kavo) (n=10) or stained by Caries detector (Voco) (n=5). Following impressions, epoxy resin replica models from all treated dentine surfaces were produced and examined by scanning electron microscopy (SEM) using different magnifications. In a control group of 5 teeth dental caries was treated by conventional means with a steel bur and caries detector. The Diagnodent system and staining with Caries detector revealed no residual dentine caries after laser treatment. Er:YAG laser irradiated dentine surfaces appeared scaly or flaky, often accompanied by open dentinal tubules with flat craters, however no dentine cracking was observed. The bur treatment resulted in a flat dentine surface covered with a smear layer. The investigation showed that the new Er:YAG laser supplemented with a fluorescence feedback was capable of a complete removal of dentine caries with respect to Diagnodent and Caries detector comparisons. The SEM examination revealed open dentinal tubules of the lased dentine surfaces that may have clinical implications.

### 12

#### The Influence of the calibration mode on laser fluorescence caries detection

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The aim of the present study was to assess the influence of calibration of the measurement device on laser fluorescence caries detection. 30 freshly extracted human teeth with initial occlusal carious lesions were examined. Tooth surfaces were visually intact and cleaned with a polishing paste. While positioning probe A of the Diagnodent™ system (KaVo) on a carious lesion, the whole occlusal surface of each tooth was covered with a light body silicone impression material (Voco) to facilitate a reproducible probe position. Measurements of laser fluorescence values took place after standard calibration on the touchstone of the probe container and after individual calibration at four non-carious areas of the buccal surface of each tooth. A second series of measurements was performed after one week. Mean laser fluorescence readings after standard calibration were significantly higher compared to values after individual calibration (mean difference: 3.8±1.4 units; p<0.05, Mann-Whitney). Readings after both standard and individual calibration were not different after one week (p>0.05, Mann-Whitney). During individual calibration, a mean difference of 2.0±1.0 units could be observed when comparing the values at the four different areas of each buccal surface. The present study indicates that laser fluorescence readings are dependent on the mode of calibration. Moreover, when using individual calibration, the probe position has to be recorded carefully. Employing laser fluorescence measurements for longitudinal caries monitoring, always the same mode of calibration should be used.

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### Protection of enamel from demineralisation by calcium, phosphate and fluoride applications

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Aim of the study was to evaluate different regimes for creating an acid-resistant layer on dental enamel by pre-treatment with calcium, phosphate and fluoride. In one series, the crowns of bovine teeth were stored in pooled human saliva for creating an acquired pellicle. In another series, no acquired pellicle was formed. The specimens were exposed to a 3-component system with varying concentrations of calcium chloride (1.67 mol CaCl<sub>2</sub>), sodium hydrogen phosphate (1.0 mol NaH<sub>2</sub>PO<sub>4</sub>) and fluoride (0.1-0.33 mol Olaflur or sodium fluoride). Afterwards the samples were submitted to 1% citric acid for 20 min and examined under a scanning electron microscope at 200-fold magnification. The single use of fluoride did not lead to formation of a protective coating on the enamel surfaces. However, combination of either Olaflur or NaF with NaH<sub>2</sub>PO<sub>4</sub> and CaCl<sub>2</sub> resulted in formation of a partially protective layer on the tooth surfaces. A typical etching pattern of the enamel surface was not observed in these specimens. This finding was true irrespective of the presence of the acquired pellicle prior to treatment. It is concluded that 3-component systems consisting of either amine fluoride or sodium fluoride, and phosphate and calcium are able to form a layer on enamel surfaces which is able to protect the underlying enamel from acid dissolution.

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### The effect of a combination of various dentifrices and mucin on *in vitro* remineralization

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The aim of this study was to evaluate the effect of combining various fluoridated dentifrices with mucin on *in vitro* remineralization of bovine enamel. From 40 incisors 160 samples were prepared. The specimens were embedded in epoxy resin and polished up to 4000 grit. Subsequently, the specimens' surfaces were partly covered with nail varnish (control of sound enamel) and demineralized in Buskes solution (pH 5.0, 14 days). The specimens were partly covered with nail varnish again. Half of the samples was exposed to a mucin-containing (2.7 g/l); the other half was remineralized in a mucin-free solution for 30 days. In each group the specimens were subdivided into four groups and brushed twice a day for three minutes with a toothpaste containing either sodium fluoride (Signal<sup>®</sup>), stannous fluoride (Meridol<sup>®</sup>), or amine fluoride (Elmex<sup>®</sup>). The specimens of the fourth subgroup were not brushed but exposed to their according solution. Mineral loss and lesion depth were evaluated from microradiographs of thin sections by a dedicated software package (TMR 1.24). No significant differences were found for the lesion depths between the eight groups ( $p > 0.05$ ; ANOVA). However, mineral gain was significantly increased for those specimens stored in the mucin-containing remineralizing solution that were brushed with each of the dentifrices ( $p < 0.05$ ; Kruskal-Wallis, Bonferroni). Within the limitations of an *in vitro* study, the present investigation indicates that mucin in

combination with various flourides seems to affect enamel remineralization significantly. Thus, these proteins should be considered as an additive to saliva substitutes or mouthwashes in patients with hyposalivation.

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### Patterns of Resistance or Sensitivity to Antimicrobial Agents in Strains of Oral Bacteria

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Several antimicrobial agents, including tetracyclines and metronidazole, are presently used in dentistry for systemic or local treatment of oral diseases. Possible resistance of the target organisms is an important factor to be considered when choosing an agent for the treatment. The aim of the present study was to determine the resistance to antimicrobial agents in wild-type (WT) strains of oral bacteria and compare it with strains resistant to tetracycline, doxycycline or metronidazole. In the agar diffusion test, paper discs, containing one of the 3 agents plus 11 other antibiotics were placed on top agar containing a bacterial strain. *S. oralis* H1, *A. naeslundii* A65, *A. actinomycetemcomitans* DSM 8324, *M. micros* ATCC 33270 were susceptible to tetracycline and doxycycline, while only *A. actinomycetemcomitans* DSM 8324 and *M. micros* ATCC 33270 were susceptible to metronidazole or to the commercially available product Elyzol<sup>®</sup>. Three resistant strains (*S. oralis* PK1317 tet res., *A. a.* Y4 metronidazole res., and *A. naeslundii* A65 doxycycline res.) were then used in the agar diffusion test, and the inhibition zones were compared with those of the susceptible WT strains. Y4 was in addition resistant to amoxicillin and spiramycin, and was in general less sensitive to almost all antibiotics. As expected, PK1317 was less sensitive to doxycycline, minocycline, and demeclocycline. However, it was more sensitive to the beta-lactam antibiotics and to rifamycin. In A65 doxycycline res. similar effects were seen. This study shows that resistance to an antibiotic can not only lead to multidrug-resistance, but can also cause new or higher sensitivity to a different class of antibiotics.

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### Efficacy of PDT in reducing periodontopathogenic bacteria in a beagle dog model

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**Objective:** The photodynamic therapy (PDT) may support the present therapy strategies of periodontitis. Furthermore PDT could have a preventive effect and may stabilise the therapy results. **Methods:** The PDT procedure was performed with the photosensitizer BLC2003 on 7 beagle dogs (14 sites, 35 sites controls). All dogs were infected with *P. gingivalis* (P.g.) and *F. nucleatum* (F.n.). The infection included all subgingival areas, the tongue and the vestibulum oris. The PDT procedure was not started before a steady state of infection had been established. We documented clinically distinct signs of redness and of bleeding on probing (BOP). Microbiological checks of the bacteria causing gingival inflammation were made by the method of colony forming units (CFU). The PDT procedure was conducted with a Ceralas diode laser 532 nm (CeramOptec, Bonn). The PDT procedure was applied to the crevicular region, the tongue and the vestibulum for 6 min twice a day over a period of 5 days. **Results:** The photosensitizer BLC2003 caused an evident reduction of clinical inflammation signs (redness, BOP) after PDT and an evident reduction of bacteria popula-

tion in the CFU test in comparison to both control groups. After PDT the CFU test showed an evident decrease of the mixed bacteria population of P.g. and F.n. Control group 1 (BLC2003 only) showed a slight decrease while the bacterium settlement in control group 2 (no PDT component) even increased. **Conclusion:** The evaluated data indicate that PDT has the potential to be a supplementary method for eradicating periodontopathogenic bacteria in the presence of gingival inflammation and periodontitis.

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### Influence of bleaching agents on subsurface enamel and dentin

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Aim of the study was to evaluate the influence of various bleaching systems on subsurface microhardness of enamel and dentin. Moreover colour change of enamel and subsurface dentin was assessed. For hardness determination 30 bovine crowns were distributed among six groups (A: Opalescence Boost, B: Opalescence Quick, C: Rapid White, D: Whitestrips, E: Opalescence 10%, F: Opalescence 15%). The crowns were sectioned and baseline hardness (Knoop) of enamel and dentin was assessed on the sectioned surface at various distances from the enamel surface. The sectioned surface was covered with wax and the enamel was treated with the bleaching agents (10 d). Finally hardness was re-assessed. For colour determination 90 bovine crowns were allocated to the six bleaching regimes described above, 15 specimens served as controls. Two enamel-dentin specimens (ED) were prepared from the labial aspect of each tooth. In one of the specimens enamel was removed resulting in a dentin cylinder (D). Before and after bleaching of the ED specimens Lab-values of ED and D were evaluated. Then enamel of ED was removed and the colour of the exposed dentin was assessed. Data were statistically analysed ( $p < 0.05$ ). In C hardness was significantly reduced in enamel and dentin. In the remaining groups significant reduction of hardness was observed up to the following depths [ $\mu\text{m}$ ] in enamel; A: 250, B: 750, D: 350, E: 150, F: 150. For all bleaching agents significant colour changes were evaluated for enamel and subsurface dentin compared to controls. **Conclusion:** Bleaching with the tested systems results in hardness reduction of superficial enamel layers and in colour change of both enamel and subsurface dentin.

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### Certain HLA-antigens predict a higher caries risk in patients undergoing transplantation

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Caries is probably the least lethal but most frequent long term complication after hematopoietic stem cell transplantation (HSCT). It is associated with substantial morbidity, high costs and impaired quality of life. It can occur despite effective preventive regimens, including careful dental hygiene, chlorhexidin mouthwashes and fluoridation. Better knowledge of risk factors is warranted to allow targeted approach. Associations of HLA-antigens with certain forms of periodontitis and with high levels of *S. mutans* have been postulated. We made use of our longstanding caries prevention program in HSCT recipients to compare oral data with recipient HLA-antigens. 267 patients were transplanted at our institution between March 1987 and March 2002 of which 214 were included. Standardized

oral examinations were undertaken at fixed time points, pre-HSCT and at 6 and 12 months post HSCT. Evaluation did include loss of radiologic attachment level, DMFT index, salivary flow rate and saliva pH. For 241 patients (120 male, 121 female) baseline values of these parameters were compared with recipient HLA-A, -B, -C and -DR-antigens. Most pronounced was a significant correlation between increased DMFT and HLA-A9 ( $p=0.045$ ), -B5 ( $p=0.011$ ), -A32 ( $p=0.04$ ) and -DR2 ( $p=0.001$ ) as well as decreased DMFT with HLA-B35 ( $p=0.024$ ) and -C4 ( $p=0.044$ ). Significant associations were also found for loss of radiologic attachment level and saliva flow. These data illustrate the link between caries, other oral parameters and HLA in patients at HSCT. They provide a basis for targeted strategies in oral maintenance for patients at high risk.

## 19

### Retention of tin and fluoride after application of $\text{SnF}_2/\text{AmF}$ containing mouthrinse in enamel

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Stannous fluoride has been proven as a prophylactic agent against caries and gingivitis and as a therapeutic agent against dental hypersensitivity. It is well known that  $\text{SnF}_2$  preparations are susceptible to oxidation. The current study aimed to evaluate the influence of oxidation on the uptake and retention of tin and fluoride on enamel. 72 enamel samples were etched with 37 % phosphoric acid. They were treated twice a day for 1 minute on 5 consecutive days with the original Meridol mouthrinse (Sn(II) content 402 ppm) or the oxidised Meridol mouthrinse (Sn(IV), Sn(II) content 0 ppm). 12 enamel samples were treated with distilled water and served as control. During the experimental period the samples were stored in artificial saliva. 12 samples each were analysed directly and at 6- and 24-hour intervals after the last application. The Sn-content (wt%) was measured by electron microprobe (EDX). KOH-soluble fluoride ( $\mu\text{g}/\text{cm}^2$ ) was determined by method of Caslavská et al. (1975). After the experimental period the content of tin and KOH-soluble fluoride was significantly higher in all test samples compared with the controls (controls:  $0.4 \pm 0.1$  wt% tin;  $2.1 \pm 0.5$   $\mu\text{g}/\text{cm}^2$  F<sup>-</sup>). Directly after the last application of the Sn(II) mouthrinse the tin content was significantly higher ( $28 \pm 4$  wt%) than after the application of the Sn(IV) mouthrinse ( $11 \pm 1$  wt%). Throughout the whole experimental period, the tin content remained constant. The content of KOH-soluble fluoride was significantly higher directly ( $138 \pm 30$   $\mu\text{g}/\text{cm}^2$ ) and 6 hours after the last application ( $54 \pm 7$   $\mu\text{g}/\text{cm}^2$ ) of the Sn(II) mouthrinse than after the application of the Sn(IV) mouthrinse ( $49 \pm 7$   $\mu\text{g}/\text{cm}^2$  directly and  $24 \pm 2$   $\mu\text{g}/\text{cm}^2$  after 6 hours). After 24 hours no significant difference was found ( $33 \pm 6$   $\mu\text{g}/\text{cm}^2$  after Sn(II)/ $27 \pm 9$   $\mu\text{g}/\text{cm}^2$  after Sn(IV)). The results show that the oxidised  $\text{SnF}_2/\text{AmF}$  mouthrinse is less effective in accumulating tin and fluoride on enamel. The need of sufficient stabilisation of Sn(II) in stannous fluoride containing formulations is emphasized. Supported by GABA International AG.

## 20

### Microbiology and clinical parameters due to a recall systems in periodontitis patients

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This follow-up study investigates if scaling and root planing is able to change the spectrum of periodontopathogenic bacteria and the clinical parameters during the observation period of 1 year. 24

periodontitis patients had been divided into 2 groups: 12 subjects enrolled for a recall system (test group), 12 subjects without recall serving as controls. After an initial treatment, (both groups) API, PBI and probing depth were raised for all subjects. Microbiological saliva and subgingival samples (8 sites) were obtained. The recall group visited the dental office every three months. The microbiological analysis was based on PCR with specific primers. Testing was done for: *Porphyromonas gingivalis* (P.g.), *Actinobacillus actinomycetemcomitans* (A.a.), *Fusobacterium nucleatum* (F.n.), *Bacteroides forsythus* (B.f.), *Treponema denticola* (T.d.), *Prevotella intermedia* (P.i.). After 1 year API, PBI and probing depth were changed in both groups comparing to the baseline [BL] value. In the recall group the API (58,6% [BL] and 48,6% mean) was lower than in the control group (56,6% [BL] and 70% mean). In the average, probing depth increased by 20% in both groups. The microbiological samples showed a significantly decrease of A.a., P.i. and F.n. in the recall group ( $p < 0,05$ ). Furthermore we could observe a significantly decrease of positive samples for A.a., for P.i. and for F.n. in the recall group. Unfortunately we did not see changes for P.g., B.f. and the clinical parameters PBI and PPD. Scaling and root planing in a recall system alone is not able to reduce the clinical and microbiological signs of periodontitis.

## 21

### Effect of the intrapulpar pressure on the adhesive sealing ability and microporability.

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**Objectives:** To evaluate the influence of the intrapulpar pressure on the class V microleakage and adhesive microporability. Materials and method: 16 molars were used and two class V cavities per molar were prepared. The adhesive system used was Prime&Bond NT. 10 cavities were restored under intrapulpar pressure (30 cm H<sub>2</sub>O) and 10 cavities without intrapulpar pressure. Specimens were processed and fuchsine penetration was measured. The other 6 specimens were prepared with the intrapulpar device but only 3 were restored under intrapulpar pressure, the other 3 were restored without intrapulpar pressure. Adhesive was previously labelled with rhodamine. After restoring, fluid was fluorescein labelled and the intrapulpar pressure device of the 6 specimens was activated for 24 hours. Then, specimens were processed and axial wall was observed under confocal laser scanning microscope.

### Results:

#### Mean microleakage (SD)

	Oclusal wall (mm)	Gingival wall (mm)
Without intrapulpar pressure	0.11(0.09)a	0.63(0.12)b
With intrapulpar pressure	0.06(0.05)a	1.44(0.26)c

Data with different letter were statistically different ( $p < 0,05$ )

Under intrapulpar pressure, the CLSM revealed a dilution of the adhesive layer and a complete penetration of the fluorescein inside the adhesive layer. However, when specimens were restored without intrapulpar pressure, no dilution of the adhesive was promoted. In addition, microporability was observed but the fluorescein penetrated not more than 50% of the adhesive layer. Conclusion: The intrapulpar pressure affects the sealing ability of the adhesive and increases the adhesive microporability.

## 22

### Variables affecting transmittance of LED curing light through restorative materials

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The purpose of this study was to determine the spectral transmittance of curing light through resin-based (Tetric™) and ceramic (Empress™/Vita blocs Mark II™) restorative materials. The effects of selected properties of the samples (type, shade and thickness) were investigated using a halogen source and 2 LED units. The samples were cut to discs of 1, 2, 3, 4, 5 and 6 mm thickness. These discs were irradiated with a halogen source (Bluelight™, Mectron) and 2 LED units (Epilar Freelight™, Espe/Ultra Lume 2™, Ultradent) under standardised conditions. The transmitted light was analysed using a spectrometer, the light intensity was determined in mW/cm<sup>2</sup> and in lux. The thickness of the restorative materials had the greatest influence on light transmission. After 2mm the energy power decreased to about 50% of the output power. The restorative material type and the shade of the samples had a significant but minor effect. The porcelain samples had a greater light transmission than the composite resin, regardless of shade. The spectral properties of the curing light were not influenced by the different restorative materials. The transmission effects were not significantly influenced by the individual spectral characteristics of the used light sources (halogen or LED) ( $p > 0,05$ ,  $\chi^2$ ). When considering the ability of restorative materials to transmit light for curing of photo-activated resin cements, the thickness of the restorations is much more influential than the type of light sources, the choice of the material or the shade. Therefore restorations greater than 2 mm in thickness should be photobounded using a dual cure resin.

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### The Effects of Curing Method and Water Storage on Surface Hardness

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**Objective:** The aim of this study was to evaluate the effect of different polymerization type and water storage on surface hardness of resin-based restorative materials. Methods: Three different dental composite materials; Ecusit (DMG), EsthetX (Dentsply), Venüs (IvoclarVivadent), were evaluated in this study. Standardized composite blocks (dimensions 3x2 mm, height 2mm) were polymerized by 5 different curing methods. Curing methods were as follows: (1) heat and light curing for 30 sec. by Dentocolor (Ivoclar-Vivadent); (2) halogen light , 40 sec. by Trilight (3M Espe); (3) halogen light, 40 sec. soft-start polymerization by Trilight (3M Espe); (4) halogen light, 20 sec. by Trilight (3M Espe); (5) LED light for 20 sec. by Freelight (3M Espe). Vicker's hardness values were measured by Dentocolor (Ivoclar-Vivadent); 1. immediately after polymerization, 2. after 24 hours, 3. after 10 days. Polymerized samples were stored in distilled water 37<sup>0</sup> C until measurement. Obtained data were statistically analyzed by One-way ANOVA and Tukey Multiple Comparison Test. **Results:** The superior mean values were revealed with immediately evaluation by cured Dentocolor for EsthetX (92,30±16,25), for Ecusit (89,82±3,81) and for Venus (85,85±8,17). The lowest mean values were obtained after 10 days stored in water for Ecusit (58,97±24,77) and for Venus (67,68±3,95) cured by LED while for EsthetX (77,44±11,15) cured by halogen light for 20 sec. **Conclusion:** It may be concluded that polymerization types affect the surface hardness of resin composites. Also water storage after 10 days may result in a decrease of surface hardness.

### Three-body wear resistance of resin composites

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**Objective:** The wear of dental restorative materials is still one of the most important factors contributing to clinical success. The purpose of this in-vitro study was to evaluate the ACTA-three-body wear resistance of twenty-one different resin composites. **Methods:** Samples of 21 composite (each composite: n=8) having dimensions 7 mm×10 mm to 5 mm height were prepared and polymerised with Dentocolor (Ivoclar-Vivadent) for 3 minutes. Cured samples were placed in a sample-holding wheel having 20 compartments, and subjected to the three-body wear test using the ACTA Wear Machine. Both, antagonist and sample-holding wheel, were run in the millet slurries (220 g distilled water and 150 g millet seeds) during the test. A total of 200,000 cycling were run for each wheel by changing the millet suspension every 50,00 cycling. The amount of wear was determined with a 3D laser scanning device (Laserscan 3D Pro, Willytec). One-way ANOVA and Post-Hoc Tests were used for statistical analysis. Results: The mean wear (µm) (±SD) of tested materials was as follows (same coefficients belong to the same homogenous subset): Grandio (Voco)<sup>a</sup> 32,5 ± 9,7; Filtek Supreme (3M-Espe)<sup>a</sup> 35,1±5,8; Clearfil AP-X (Kuraray)<sup>a,b</sup> 36,8±7,3; Palfique Estelite (Tokuyama)<sup>a,b</sup> 37,2±3,3; Surefil (Dentsply)<sup>a,b</sup> 37,6±4,8; Clearfil Photo Posterior<sup>a,b,c</sup> (Kuraray) 38,4±10,5; Palfique Toughwell<sup>a,b,c</sup> (Tokuyama) 39,2±6,6; Esthet X (Dentsply)<sup>a,b,c,d</sup> 46,4±7,7; Adamant (Ivoclar-Vivadent)<sup>a,b,c,d</sup> 48,1±9,4; Point4 (Kerr)<sup>a,b,c,d,e</sup> 49,6±7,7; Charisma (Heraus Kulzer)<sup>a,b,c,d,e</sup> 50,2±10,9; Ecusit (DMG)<sup>a,b,c,d,e,f</sup> 51,9±10,8; Miris (Coltene) 53, 1±15,6<sup>a,b,c,d,e,f</sup>; Admira (Voco)<sup>a,b,c,d,e,f</sup> 55,2±8,0; Venus (Heraus Kulzer)<sup>b,c,d,e,f</sup> 55,6±10,7; Tetric Ceram (Ivoclar-Vivadent)<sup>c,d,e,f</sup> 58,0±8,6; Beautifil (Shofu)<sup>c,d,e,f</sup> 58,6±11,6; Intense S (Ivoclar-Vivadent)<sup>d,e,f</sup> 68,4±17,3; Dyract AP (Dentsply)<sup>e,f</sup> 69,2±9,1; Heliomolar RO (Ivoclar-Vivadent)<sup>e,f</sup> 69,5±15,2; Heliomolar HB (Ivoclar-Vivadent)<sup>f</sup> 75,4±15,4. Conclusion: Modern composite materials exhibit a very similar three-body-wear-behaviour.

### Effect of Resin Based Material Combination on the Compressive and Flexural Strength

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**Objective:** This in-vitro study was objected to evaluate the changes in the compressive and flexural strength of tooth-coloured resin-based dental restorations placed on flowable, luting and masking materials. **Methods:** Samples in control group were produced in a cylindrical (diameter 4 mm×6 mm) form for testing compressive strength and in a quadrangular prism form (2 mm×2 mm×25 mm) for flexural strength test using Surefil (SU), DyractAP (DY) (Dentsply), Charisma (CH) (Heraus Kulzer), Admira (AD) (Voco), Clearfil Photo Posterior (as inley) (CPP) (Kuraray), EstetixBody (EXB), TetricCeram (TC), Tetric Ceram Inley (TCL), CompoglassF (CG). In each test group samples were fabricated by placing the control materials on different liners. The thickness of liners in cylindrical and quadrangular prism samples ranged from 0,8 mm to 1,2 mm and from 0,4 mm to 0,6 mm, respectively. The material combinations were as follows: DyractFlow (DYF)-SU, DYF-DY, Flowline (FL)-CH, AdmiraFlow (ADF)-AD, Twinlook (TW)-CPP, EstetixOpaque (EXO)-EXB, TetricFlow (TF)-TC, TetricColor (TCL)-TC, CompoglasFlow (CGF)-TC, CGF-CG, Variolink (VL)-TCL. All samples were stored for 24 hours in distilled water at 37°C before testing. Compressive strength values were

measured at the Instron Testing Machine with a cross head speed of 10mm/min while flexural strength were determined in 3-point bending with a cross-head speed of 1mm/min. One way ANOVA and Tukey's Multiple Comparison tests were performed for the statistical analysis. Results: The combination of DYF -DY (199±9,8), EXO-EXB (257,6±12,0) and CGF-TC (266,0±3,7) showed significant increase in compressive strength (p<0,001) while DYF-SU (175,1±10,1), TW-CP (177,1±7,0) and TCL-TC (76,9±4,2) showed significant decrease in compressive strength values (p<0,01). An increased flexural strength was observed in combination of FL-CPP (120,4±5,6), TCF-TC (135,9±3,2), CGF-TC (133,3±7,6) and CGF-CG (108,2±5,2) while decreased in flexural strength was revealed in combination of DYF-DY (56,9±3,2), TW-CPP (106,1±6,04) and TCL-TC (92,4±5,9). Conclusion: Hence we concluded that material combination as liner and restorative materials may cause changes in compressive and flexural strength.

### Effect of hydrofluoric acid etched composite bonded to composite

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**Introduction:** Intra-oral repair is promoted by modern trends in restorative dentistry, which postulate a minimally invasive restorative treatment implementing need-, damage-, and risk-balanced dental care. Some manufacturers recommend hydrofluoric acid (HF) as a conditioning agent for composite repair. **Purpose:** The purpose of this study was to examine the bond strength and interface characteristics of composite bonded to composite. **Materials and Methods:** 10 HF-etched (9.5%, 15 s) and non-HF-etched specimens were inspected under SEM. 48 composite specimens (Herculite XRV) with plane surfaces were sandblasted (CoJet, 20 s) and randomly divided into 3 groups. Group 1 was left as control. In group 2 the composite surface was primed with silane, in group 3 the composite was first etched with HF, rinsed with water and then primed with silane. Composite cylinders (d=3mm) were bonded with OptiBond Solo. 11 specimens from each group were used for shear bond testing. For 5 specimen of each group the bonding agent was labeled with a fluorescent dye, sectioned and used for morphological inspection with a confocal laser scanning microscope (CLSM). Results: Shear bond values were: 15.3±5.7 MPa (group 1), 17.9±6.3 MPa (group 2) and 10.3±3.9 MPa (group 3). SEM demonstrated that filler particles were removed from the composite surface after HF-etching. CLSM cross-sections showed that bonding resin penetrated into the surface pores of the HF-etched composite. The use of HF decreased statistically significant (p<0.05, ANOVA) bond strength of composite bonded to composite although the surface porosity is increased. Conclusion: Beside possible risks with the intraoral use of HF, we dissuade from the use of HF for composite repair because bond strength is reduced.

### Clinical evaluation of QuiXfil in stress-bearing posterior teeth after 3 and 6 months.

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To determine the clinical performance of a new low-shrinkage posterior composite in an ongoing controlled clinical trial. 46 QuiXfil+Xeno III (QF; Dentsply) and 50 Tetric Ceram+Syntac

(TC; Vivadent; control) restorations were placed according to manufacturers' instructions by 3 dentists in class I and II cavities of 40 adult patients each. Clinical assessment at baseline and after 3 and 6 months was performed by 2 independent dentists using mod. USPHS criteria (surface texture ST; color match CM; anatomic form surface AS; anatomic form marginal step AM; marginal integrity MI; marginal discoloration MD; tooth integrity TI; restoration integrity RI; occlusion OC; sensitivity SE; postop. symptoms PS; patient's compliance PC; secondary caries SC; swelling of material SM) and statistically analyzed with Mann-Whitney U-test ( $p < 0.05$ ). At 3 m all restorations could be rated, at 6 m 35 QF and 40 TC restorations were rated up to now. All restorations showed excellent or acceptable clinical results (Alpha and Bravo scores), no restoration failed (Charlie or Delta). Results are listed in the table [(alpha/bravo) in %].

QF	ST	CM	AS	AM	MI	MD	TI	RI	OC	SE	PS	PC	SC	SM
3 m	98/2	100/-	98/2	98/2	100/-	100/-	100/-	100/-	98/2	100/-	98/2	96/4	100/-	100/-
6 m	97/3	100/-	100/-	97/3	100/-	97/3	100/-	97/3	97/3	100/-	97/3	97/3	100/-	100/-

  

TC	ST	CM	AS	AM	MI	MD	TI	RI	OC	SE	PS	PC	SC	SM
3 m	98/2	96/4	98/2	98/2	100/-	100/-	100/-	100/-	100/-	100/-	100/-	98/2	100/-	100/-
6 m	100/-	100/-	100/-	98/2	100/-	95/5	98/2	100/-	100/-	100/-	100/-	100/-	100/-	100/-

No significant differences between QF and TC could be detected for all evaluated criteria at 3 and 6 m, respectively. Up to 6 m, the clinical performance of QuiXfil in combination with the self-etching adhesive Xeno III exhibited excellent results. Sponsored by Dentsply DeTrey, Germany.

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**Clinical evaluation of Dyract eXtra in stress-bearing posterior teeth after 3 and 6 months.**

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To determine the clinical performance of a new compomer restorative in posterior teeth in an ongoing controlled clinical trial. 46 Dyract eXtra+Xeno III (DE; Dentsply) and 50 Tetric Ceram+Syn-tac (TC; Vivadent; control) restorations were placed according to manufacturers' instructions by 3 dentists in class I and II cavities of 41 and 40 adult patients each. Clinical assessment at baseline and after 3 and 6 months was performed by 2 independent dentists using mod. USPHS criteria (surface texture ST; color match CM; anatomic form surface AS; anatomic form marginal step AM; marginal integrity MI; marginal discoloration MD; tooth integrity TI; restoration integrity RI; occlusion OC; sensitivity SE; postop. symptoms PS; patient's compliance PC; secondary caries SC; swelling of material SM) and statistically analyzed with Mann-Whitney U-test ( $p < 0.05$ ). At 3 m all restorations could be rated, at 6 m 35 DE and 40 TC restorations were rated up to now. All restorations showed excellent or acceptable clinical results (Alpha and Bravo scores), no restoration failed (Charlie or Delta). Results are listed in the table [(alpha/bravo) in %].

DE	ST	CM	AS	AM	MI	MD	TI	RI	OC	SE	PS	PC	SC	SM
3 m	100/-	100/-	98/2	96/4	98/2	100/-	100/-	100/-	100/-	100/-	98/2	96/4	100/-	100/-
6 m	97/3	100/-	100/-	100/-	100/-	94/6	100/-	100/-	100/-	100/-	97/3	100/-	100/-	100/-

  

TC	ST	CM	AS	AM	MI	MD	TI	RI	OC	SE	PS	PC	SC	SM
3 m	98/2	96/4	98/2	98/2	100/-	100/-	100/-	100/-	100/-	100/-	100/-	98/2	100/-	100/-
6 m	100/-	100/-	100/-	98/2	100/-	95/5	98/2	100/-	100/-	100/-	100/-	100/-	100/-	100/-

No significant differences between DE and TC could be detected for all evaluated criteria at 3 and 6 m, respectively. Up to 6 m, the

clinical performance of Dyract eXtra in combination with the self-etching adhesive Xeno III exhibited excellent results. Sponsored by Dentsply DeTrey, Germany.

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**Study on particle-size distribution and volume loss of wear-abraded resin-based materials.**

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Resin-based restorative materials consist mostly of dimethacrylate resins such as Bis-GMA, UDMA, and TEGDMA. Silane coated inorganic filler particles stiffen the organic matrix and greatly improve material properties. In the mouth, these resin-based materials are subjected to chemical attacks and thermal and mechanical loads that degrade material integrity. Aim of the study was to determine the particle-size distribution of wear debris of several composite materials after simulation of mechanical loading. Materials were processed and light-cured as suggested by the manufacturers and subsequently mechanically loaded and abraded in an artificial oral environment (86400 wear cycles @ 50 N vertical load). Abraded particles were accumulated and purified using filter systems. The particles were analyzed in a SEM and size was measured using image analysis software. All analyzed materials yielded particle sizes (range: 0.08 to 4.38  $\mu\text{m}$ ) that were able to reach the deep lung alveoles after inhalation and possibly can enter the lung epithelium. Furthermore, the volume loss of the materials was measured with a 3D-laser sensor. Mean values of volume loss and mean wear rates (MWR; volume loss per cycle) are listed in the table. Wear data were analyzed with ANOVA and post hoc Tukey test. Superscript letters indicate statistically homogeneous subsets.

Material	Type of material	Wear [ $\text{mm}^3$ ]	MWR [ $\mu\text{m}^3/\text{cycle}$ ]	Particle range [ $\mu\text{m}$ ]
Arabesk	Composite	0,25 <sup>a</sup>	2843 <sup>a</sup>	0.08–3.46
Tetric Ceram	Composite	0,44 <sup>a</sup>	5097 <sup>a</sup>	0.08–4.38
Surefil	Packable composite	0,14 <sup>a</sup>	1637 <sup>a</sup>	0.14–3.65
Hytac	Compomer	1,90 <sup>b</sup>	21741 <sup>b</sup>	0.11–3.59

The abraded particles are swallowed or inhaled, respectively, and are a potential reservoir for resorption processes in the gastro-enteric tract or in the lung tissue. Funded by the FöFoLe-Project (Dekanat der Medizinischen Fakultät der LMU).

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**Stress Analysis of Class II Ceramic and Composite Inlays Using the Three-Dimensional Finite Element Method**

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**PURPOSE:** The aim of this study was to evaluate and to compare the stress distribution under a vertical loading condition within posterior ceramic and composite class II MOD inlay restorations adhesively luted. **MATERIALS AND METHODS:** A three-dimensional finite element model of a class II MOD restoration that consisted of 18,244 nodes and 27,140 elements for a total solid elements number of 24,818, representing a maxillary first premolar was constructed. In particular, in order to investigate the stress status of the total adhesive interface (bonding+resin cement) under

an occlusal vertical loading simulation, 1160 *shell* elements (Ansys 6.0) were used to create the two different layers. Variations of the model included inlays of a resin composite (E=50 GPa) and of a glass ceramic (E= 96 GPa), respectively cemented with a low modulus resin cement (E=6 GPa) alone and a high (10 GPa) and low (6 GPa) modulus resin cement. All the resin cement layers were 70 micron thick. A dentine resin bonding system was also considered (E=4 GPa), 10 micron thick. A load of 400 N, simulating maximum bite-force was applied vertically to the restored teeth, in correspondence of the sound cusp tips of the premolar. Vertical and horizontal stress distribution was evaluated. RESULTS: The stress distribution in both types of glass ceramic inlay restorations were similar, independently from the rigidity (E-modulus) of the resin cement used, and it was greatly concentrated in correspondence of the cavity walls with an higher stress level (reported by means of von Mises equivalent stress) when compared with the composite inlay model stress distribution, in which the same low modulus cement and adhesive system were considered. CONCLUSION: The resin cement and the resin bonding layers did not perform well in terms of shock absorbing of the ceramic rigidity (having higher elastic modulus than composite materials) which stressed the adhesive interface differently from the composite one. In this case stress distribution was differently oriented and the adhesive interface better absorbed and released stresses.

### 31

#### Evidence on chemisorption of maleic acid to enamel and hydroxyapatite by XPS, FTIR and XRD

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**Background:** Maleic acid (MA) has been used as an etchant in recent adhesive dentistry. However, only few data have been reported on the chemical reaction of MA with hydroxyapatite (HA) or enamel. Aim: To investigate the reaction products of HA with MA and provide evidence for chemisorption of MA onto HA and enamel. Methods: HA particles (800 mg) were dissolved in 24.648 ml 15 w/v% aqueous solution of MA (pH=0.98) for 24 h. Half of the solution was dried, and analyzed by X-ray diffraction (XRD). HA, MA and a standard calcium maleate were also detected by XRD. The other solution was added with acetone up to 11.5 ml for 0.5 ml each time until no more precipitate appeared. After the suspension solution was centrifuged, the supernatant solution was decanted to get the precipitate. The precipitate was purified for 4 times as mentioned above. The precipitate, HA and MA were analyzed by Fourier transformed infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). An unetched enamel disk and a MA-etched enamel disk were investigated with XPS. The precipitate was also analyzed by <sup>1</sup>H NMR (nuclear magnetic resonance). **Results:** A new binding energy was detected by XPS after enamel etching with MA, and after MA reacted with HA. FTIR spectra of the precipitate indicated the stretching bands of a conjugated double bond, the carboxylate and the phosphoric groups. XRD data indicated the formation of calcium maleate and calcium hydrogen phosphate after the reaction of MA with HA. NMR data indicated that one carboxylic group of MA had reacted with the calcium of HA. **Conclusion:** MA can decalcify and chemically adhere to HA and the enamel surface.

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#### Influence of disinfectants on dentin bond strength of adhesive systems

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Aim of the study was to evaluate the influence of water disinfectants of dental units on dentin bonding of different adhesive systems. 160 human molars were sectioned resulting in a dentin disk of 2.2 mm thickness. The samples were evenly allocated to four groups (A-D). Tapered cavities were prepared under standardized conditions. Preparation and application of the adhesives were performed utilizing the water supply of a dental unit. Different water disinfectants were used: A (control, pure water), B (Alpron neutral), C (Alpron mint), D (Dentosept P). Each 10 cavities of each group were filled with direct composite restorations using the following combinations of dentin bonding adhesives and composites: Syntac classic/Tetric, Clearfil Liner Bond 2V/Luxacore, Optibond FL/Prodigy, Prime & Bond NT/Spectrum. The samples were stored in water for 180 d (37°C) and subsequently thermocycled (2000 x, 5°/55°). Push-out tests were performed in a universal testing machine. The following loads [MPa] required for push-out were recorded (mean±stand. dev.) and statistically analyzed (p<0.01):

	A	B	C	D
Syn	27.6±4.3	24.2±3.1	28.0±1.8	30.1±2.0
Clear	26.3±4.3	26.9±4.0	25.8±4.3	24.5±3.9
Opti	27.5±3.1	28.1±4.6	30.8±4.7	27.5±3.0
P&B	19.2±3.5	13.3±2.8	13.0±2.4	13.8±2.8

The disinfectants did not show a significant influence on the loads required for debonding for Syntac classic, Clearfil Liner Bond 2 V and Optibond FL. However, use of the disinfectants in the water supply decreased dentin bond strength in the samples filled with Prime & Bond NT/Spectrum. It is concluded that disinfectants in the water of dental units may have an influence on dentin bonding depending on the adhesive used.

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#### Factors that influence tooth traumatism epidemiology

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Injury to dental hard tissue is different from traumatogenic damage to any other hard and/or soft tissue since mineralized dental tissue has no or only limited inherent healing ability. Within this retrospective clinical study the impact of various epidemiologic factors on the prevalence and severity of dental injuries was assessed. The study sample comprised a total of 360 individuals with dental injuries. The dental trauma in each individual occurred between 1982 and 1998. All data as used herein were provided by standardized protocols which had been completed at the time of the injury. Statistical analysis was performed using different tests, i.e. Pearson's Chi-square, non parametric Mann-Whitney-U, and non parametric Kruskal-Wallis. Tooth traumatism was considerably more frequent in males than in females (69.2% vs. 30.8%). The medium age of patients suffering from dental injuries was 14.2 (±8.5) years (male) and 12.6 (±7.7) years (females), respectively. Damage to dental tissue occurs most frequently at the central maxillary incisors. Non-complicated crown fractures was the most prevalent kind of dental injury. In cases with dental trauma-

tism the lips and the chin were most frequently affected by extra-oral injuries. Overall, dental injuries are more prevalent in winter than in summer. In conclusion, this study revealed that several epidemiologic factors have significant influence on the risk for tooth traumatism.

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#### Internal fit and gapformation of CAD/CAM-manufactured ceramic inlays

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The purpose of this study was to evaluate the marginal and internal fit and microleakage of CAD/CAM manufactured CEREC 3™ ceramic inlays in vitro. 50 extracted caries free human teeth were prepared with a class II MOD cavity design. One proximal box ended on enamel, the other on root dentin. The preparations and inlays were made according to the manufactures' instructions. After acid-etching (enamel) and treatment with a dentin bonding system (Syntac™ Classic), the inlays (Vitablocs Mark II™) were cemented with a microfilled hybrid posterior composite (Tetric™ Cavifil) and thermocycled. For light microscopic investigation undecalcified slices (20 µm) were cut. The marginal discrepancy, the thickness of the luting cement, inhomogeneity and crack formation in the ceramic texture were recorded. The location of internal gap formations was determined at 10 key points. The marginal fit of 48% of the restorations was sufficient, 38% showed an excess and 14% a deficiency. The average thickness of the luting cement was 334 µm (min: 0 µm, max: 2000 µm). The variation of the dimensions of the interfacial luting space could be correlated to the geometry of the cavity outline. The width of the luting space at the inner axial walls and at the occlusal cavosurface was found to be larger than at the proximal boxes. In 68% of the samples some internal gap formation could be recorded after luting. The majority (94%) was located at the dentinal interface. The quality of the ceramic texture was good. Signs of infracture appeared in 5% of the investigated sites only. Histologically, the CEREC 3™ inlay system showed satisfactory results to be used clinically.

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#### Bond Strength of Two Dentin Adhesive Systems Applied on Different Bonding Area Sizes.

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**Objectives:** The aim of the present investigation was to evaluate tensile bond strength of a new self-conditioning dentin adhesive system (Adhes) compared to a established dentin bonding agent (Excite) used on four different bonding area sizes. **Methods:** One hundred and twenty freshly extracted third molars were included. All teeth were specially prepared allowing the simulation of dentin perfusion. The specimens were randomly assigned to eight experimental groups: group A1- A4: Adhes (bonding area diameter 1 mm–4 mm); group E1–E4: Excite (∅ 1 mm–4 mm) Tensile bond strength of the above mentioned adhesive agents was measured 15 minutes after application and light curing of the composite material (Tetric, colour A2) using an universal testing machine. **Results:** For the eight test series following tensile bond strengths were evaluated (mean value and standard deviation in MPa): group A1 4.85 (+/-4.1), group A2 8.59 (+/-3.07), group A3 4.02 (+/-1.06) and group A4 2.37 (+/-0.69); group E1 13.28 (+/-9.26) group E2: 9.10 (+/-4.33); group E3: 6.59 (+/-1.35); group E4 3.92 (+/-1.36). Statistical analysis showed a significant influence of the

used dentin bonding agent and bonding area width on tensile bond strength ( $p < 0.001$ , ANOVA). In both groups used on 1 mm bonding area, bond strengths of Excite (E1) was significantly higher compared to Adhes (A1). Between the other diameters no significant differences could be detected ( $p < 0.05$ , Tukey's test). **Conclusions:** Regarding the limitations of an in vitro study it can be concluded that different bonding area sizes have an influence on the results of both adhesive systems tested.

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#### Mechanical characteristics of hybrid and micro-filled Composites

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The aim of this study was to evaluate eight hybrid and micro-filled Composites (Z100, Filtek supreme (3M ESPE), Charisma, Durafill (Heraeus Kulzer), Tetric, InTenS (Vivadent), Enamel plus (GDF) and Estelite Low flow (Tokuyama)) by determination of the fracture toughness, strength and modulus of elasticity in a flexural, compression and diametral tensile test, as well as modulus of elasticity, Vickers hardness, elastically behaviours, plastic hardness and creep measured in a universal hardness test. For all attempts the same test conditions were kept. The samples (n=8) were polymerized on both sides for 40 s in a light-curing oven (Dentacolor XS, Kulzer, Wehrheim) and stored for 24 hours in dest. water. Strength and modulus of elasticity were tested with a universal test equipment (MCE 2000ST, quick test, Langenfeld, D., crosshead speed 0.5 mm/min). The measurement of the universal hardness was accomplished in accordance with DIN 50 359; draft DIN 55 676 and Technical report ISO TR 14 577. For the evaluation of the data, a one-factorial ANOVA with a post hoc Tukey HSD test ( $\alpha = 0.05$ ) and Weibull statistics were used.

	Flexural				D-Tensile			Compressive		
	E	m	$\sigma_0$	K <sub>1C</sub>	E	m	$\sigma_0$	E	m	$\sigma_0$
Z100™	11,3±0,5	7,7	139,1	1,8 <sup>b,c,d</sup> ±0,2	0,8±0,1	7,0	36,0	8,5±0,6	8,4	271,5
Charisma®	7,1±0,5	10,0	107,6	1,9 <sup>b,c,d</sup> ±0,2	0,8±0,1	10,7	28,6	4,7±0,5	19,9	270,1
Tetric®	9,9±0,7	11,1	146,2	2,0 <sup>d</sup> ±0,2	0,3±0,0	9,2	32,3	6,3±0,5	10,3	273,9
Durafill	3,0±0,2	9,6	80,3	0,8 <sup>a</sup> ±0,01	0,5±0,2	10,4	22,5	2,3±0,1	9,2	305,5
Enamel plus	8,5±1,7	15,6	142,9	2,4 <sup>c</sup> ±0,5	0,8±0,1	9,5	35,0	5,1±0,7	4,8	217,5
InTen-S	5,5±1,9	9,5	97,6	1,9 <sup>b,c,d</sup> ±0,3	1±0,2	9,9	38,6	2,9±1,8	6,7	210,2
Estelite (LF)	2,3±0,3	7,8	108,2	1,1 <sup>a,b</sup> ±0,3	0,6±0,1	3,4	40,0	4,7±0,7	4,5	262,1
Filtek-Supreme	5,2±0,5	9,7	128,3	1,5 <sup>b,c</sup> ±0,3	0,7±0,3	6,3	44,9	4,0±1,0	5,6	112,4

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#### In Vitro Comparison of Polymerization Outcomes in Terms of Hardness Profiles.

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In addition to halogen and plasma lamps, LED lamps claimed to be suitable for polymerizing composite are commercially available. The aim of the study was to compare the hardness profiles of test specimens made of composite. 23 test specimens (6×6×6 mm) made of Herculite XRV and 23 made of Filtek Supreme were polymerized with a halogen lamp (Elipar™ II, Espe, Seefeld, Germany), and 23 of each type with a LED lamp (Elipar™ FreeLight, Espe), for a period of 40 sec. The Barcol hardness was measured directly after polymerization and after 24h storage in Ringer solution at 37°C in the dark. The measuring points (MP) were 1 mm,

1.5 mm, 2 mm, 2.5 mm and 3 mm below the point at which light impacted the test specimen. Immediately after polymerization, the specimens of both composites polymerized with the halogen lamp (HL) displayed a significantly ( $p < 0.01$ ) to highly significantly ( $p < 0.001$ ) higher Barcol hardness than those polymerized with the LED lamp (LED). One day after polymerization, the Filtec composite displayed a very significantly to highly significantly greater surface hardness for the HL. With the Herculite composite, the HL induced a significant increase in Barcol hardness only at the first two measuring points. No significant difference between HL and LED was observed at MPs 2mm and 2.5 mm, while the LED displayed a significantly higher hardness at MP 3 mm. Comparison of hardness profiles between a conventional HL and a LED showed that the hardness values achieved with the LED were not up to those achieved with the HL. LED lamps should not be used for clinical applications until polymerization similar with that accomplished with halogen lamps is possible.

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#### Solubility of root canal sealers in water and artificial saliva.

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The purpose of a root canal filling is the complete and fluid- and bacteria-tight obturation of the root canal system. The physical properties necessary for this function include insolubility or at least low solubility of the root canal sealer. Low solubility of sealers has been introduced as a requirement in the International Standard for root canal sealing materials. The aim of this study was to apply the method proposed in the ISO standard to compare the solubility of 8 different sealers in water and artificial saliva over a period of 28 days. For standardized samples ( $n=12$  per group) ring molds were filled with the following sealers: AH26, AHPlus, Apexit, Aptal-Harz, Diaket, Ketac Endo, RSA RoekoSeal, and Sealapex. The samples were immersed in distilled water or artificial saliva with different pH values (7.0, 5.7, 4.5) for 30 s, 1 min, 2 min, 5 min, 10 min, 20 min, 1 h, 2 h, 10 h, 24 h, 48 h, 72 h, 14 d and 28 d. Mean loss of weight was determined and statistically analyzed. Most sealers were of low solubility, while especially Sealapex, Aptal-Harz, and Ketac Endo showed a marked weight loss in all liquids. Even after 28 days of storage in water, AH26, AHPlus, RSA RoekoSeal, and Diaket showed less than 3% weight loss. At exposure times greater than 14 days, Sealapex showed the significantly greatest weight loss of all sealers ( $P < 0.05$ ). Aptal-Harz and Ketac Endo were significantly more soluble in saliva pH 4.5 than in water ( $P < 0.05$ ). Conclusions: Sealapex, Aptal-Harz, and Ketac Endo were of high solubility. With regard to the solubility mediums tested, the use of distilled water as proposed by the ISO should be supplemented by the use of acidic test mediums.

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#### Histological study of the morphology and location of the apical constriction

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The apical constriction is generally accepted as apical endpoint of root canal preparations. Aim of the study was to scrutinize the morphology and location of the apical constriction in a total of 286 root canals. The teeth were histologically prepared by grinding the root dentin until the root canal was visible. The apical areas of the teeth were examined under a light microscope (32x

magnification). The morphology of the apical constriction was categorized as single (point) constriction or parallel (line) constriction. Moreover the distance between the anatomical apex and the apical foramen was determined. In case of having parallel constrictions the length of the constriction was measured. The distances between the most coronal part of the constriction and both the apical foramen and the anatomical apex were determined. In case of having a single constriction the distance between the narrowest position of the constriction and the apical foramen was measured. 145 of the canals showed a single constriction, in 141 canals a parallel constriction was found. The distance between the anatomical apex and the apical foramen varied in a range of 0-1.5 mm (mean:  $0.21 \pm 0.26$ ). The lengths of the parallel constrictions amounted to 0-1.875 mm ( $0.35 \pm 0.5$ ). The distance between the most coronal parts of the constrictions and the apical foramen ranged between 0-4.5 mm ( $1.11 \pm 0.71$ ). The most coronal parts of the constrictions were located in a distance of  $1.32 \pm 0.77$  mm (0-4.5) from the anatomical apex. It is concluded, that the location and morphology of the apical constriction shows a great variety rendering it difficult to determine the end point of a root canal preparation arbitrarily.

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#### Comparison of three rotary NiTi-systems in the retreatment of gutta-percha root canal fillings with and without use of a solvent

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**Aim of the study:** Comparison of three rotary NiTi-systems in the retreatment of gutta-percha root canal fillings with and without use of a solvent. **Materials and methods:** 80 extracted single rooted teeth were prepared with rotary NiTi instruments to size 35 and obturated with laterally condensed gutta-percha and AH plus. The teeth were stored at  $37^\circ\text{C}$  in a hygostat for one month. The length of the root fillings was limited to 15 mm so that a standardized volume of the root canal fillings was achieved. The teeth were randomly divided into eight groups and retreated using the following instruments: 1. FlexMaster (VDW) 2. GT Rotary (Dentsply), 3. ProTaper (Dentsply), 4. Hedstroemfiles (HF) (VDW). Ten root canals in each group were treated without a solvent, 10 were treated using eucalyptol (E) as a solvent. The NiTi instruments were used with a torque controlled motor (ITcontrol, VDW). Instruments in Group 4 were used manually in a filing motion. The following data were recorded: Time to reach working length (TWL) and to remove the gutta-percha (TGR). Cleanliness of the root canal walls (RCC) was evaluated after longitudinal splitting of the roots using photographs under a 70x magnification. **Results:** TWL: The sequence of techniques was as follows: ProTaper/E, FlexMaster/E, ProTaper, FlexMaster, HF/E, GT Rotary/E, HF, GT Rotary. ProTaper and FlexMaster with solvent performed significantly faster than the other techniques. TGR: The sequence of techniques was as follows: ProTaper/E, FlexMaster/E, ProTaper, FlexMaster, GT Rotary/E, HF/E, HF, GT Rotary. Again, ProTaper and FlexMaster performed significantly faster than the other techniques. RCC: FlexMaster and HF each with use of eucalyptol showed the best results, leaving only small amounts of residual gutta-percha or sealer. **Conclusion:** Rotary NiTi instruments may be used for safe and fast removal of gutta-percha in endodontic retreatment. The additional use of a solvent is recommended.

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### Torque-controlled handpiece versus endodontic step-motor using rotary NiTi files

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Nickel-titanium engine-driven rotary instruments are increasingly used in endodontic practice. The main problem of this procedure is the fracture of instruments. Therefore, torque-control is required. The purpose of this study was to compare the frequency of instrument fracture and deformation comparing a low-torque step-motor (M) with auto-reverse function and a newly developed torque-controlled endodontic handpiece (H) (SIRONiTi, Sirona). Motor and handpiece were adjusted to the instrument-specific limit-torque according to the manufacturers' instruction. ProFile®, ProTaper™, FlexMaster® and SystemGT® instruments were used to shape simulated resin root canals (A-ETE, frasaco) with various angles of curvature (0°, 10°, 20°, 30°). A total of 192 root canals were evaluated using the two engine driven systems. The number of deformed and separated instruments, the preparation time and aberrations were recorded for the various experimental groups. In this study in 7 of 104 cases instrument fracture occurs when shaping the simulated canals. No correlation could be found to the used parameters. Aberrations were recorded in 14 samples, no differences could be found comparing the step-motor and the handpiece. Even in canals with a 30°-curvature the NiTi files produced appropriate canal shapes. Canal preparation using the handpiece was significantly less time consuming as compared to the step-motor, regardless of the type of the file systems (H: 6.08±2.95min, M: 11.65±3.93min, p<0.05, Mann-Whitney-test). The results suggested that the use of both torque-limiting endodontic systems is safe. The new handpiece is favourable due to the easy handling and the reduced preparation time.

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### Comparison of root canal preparation using GT and ProFile .04 rotary NiTi instruments

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The aim of this study was to compare various parameters of root canal preparation using two nickel-titanium instruments: GT and ProFile .04 rotary files (Dentsply/Maillefer, Ballaigues, Switzerland). Fifty extracted mandibular molars with root canal curvatures between 20° and 40° were embedded in a muffle system as described by Bramante et al. (1987) and modified by Hülsmann et al. (1999). All root canals were prepared using GT or ProFile rotary files to size 45. The following parameters were analysed: straightening of curved root canals, postoperative root canal cross-sections, cleaning ability, safety issues, and working time. Both NiTi systems maintained curvature well; the mean degree of straightening was less than 1°. 84% (GT) respectively 80.9% (ProFile) of the postoperative cross-sections were acceptable (round or oval diameter). For debris removal, both systems achieved acceptable results (GT: 71.6% scores 1 and 2, ProFile: 67.1%). With none of the two systems a completely satisfying elimination of the smear layer could be obtained (GT: 25.3% scores 1 and 2, ProFile: 23.3%). Ten procedural incidents occurred with ProFile instruments (2 fractures, 4 apical blockages, 4 working length losses), GT preparation resulted in 3 apical blockages and 2 working length losses. Perforations did not occur with either system. Mean working time was shorter for ProFile (132 s) than for GT (144 s). Differences between the two systems were not significant for any of the parameters investigated. It is concluded that both systems respect original root canal curvature well and are safe to use. Due to the insufficient cleaning ability an effective root canal irrigation is recommended.

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### Influence of post length in the biomechanical behaviour of endodontically treated root.

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Intraradicular posts are used in devitalised teeth for the retention of the later restoration. They do not reinforce the dental structure but may weaken it. The aim of this study is to investigate on the influence of the post length selected on the final restored tooth strength, for both esthetic posts of glass fibre (Para-Post Fiber-White) and steel posts (Para-Post) with a similar design. In order to achieve this goal, a finite element model has been used to simulate and compare three different lengths: an optimal one (3/4 of the root length), and two other a 50% greater and smaller than the optimal one. The model has been developed using MSC/PATRAN-NASTRAN software, having considered continuity between the elements in contact. The model has been experimentally validated using a universal assay device with compression strength until root fracture. Good agreement has been found between the model estimations and the experimental results, which indicate that the model is able to reproduce real conditions. The virtual model predicts significantly (ANOVA, P<0.01) different tensional states for a given post length depending on the post material: steel post restorations show tensional concentrations in the interface between the post and the rest of elements in contact, in contrast with glass fibre post restorations. A significant influence of the length on the root biomechanics was observed being more affected the metallic posts than the glass fibre ones. This effect was also predicted by the virtual model, with an approximated increase of the maximal von Mises stress with length of 145% for steel posts and 110% for glass fibre posts.

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### Determination of the long term pH-value of four different endodontic sealer materials

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The antibacterial activity of root canal sealers is strongly dependent upon the pH-value within the material. It was aim of this study to compare the long term pH-value of an experimental calcium peroxide(CaO<sub>2</sub>)-base paste with that of three different conventional sealer materials. Subject of the study were three different types of endodontic sealer materials (group A: Apexit, Ivoclar Vivadent; group B: AH Plus, Dentsply DeTrey; group C: Sealapex, Kerr) and an experimental calcium peroxide(CaO<sub>2</sub>)-base paste (group D). Following to activation according to the manufacturers' instructions 10 specimens of each material were placed into plastic molds. Each sample was stored in 0.5 ml of pH 6.86 buffer solution at 100% humidity and 37° C. The control group contained buffer solution only. The pH-value on the surface of each sample was determined using a digital pH measuring device at different time intervals after setting, particularly at 1 h, 24 h, 7 d, 2 wk, and 4 wk. The mean value and standard deviation of the pH-value was calculated separately for each material. The differences among the experimental groups regarding the pH-value were then tested with ANOVA at a level of significance of 5% (p<0.05). The pH value at 4 weeks was 11.40 (±0.13) (Sealapex), 11.04 (±0.31) (Apexit), 8.20 (±0.12) (AH Plus), and 10.97 (±0.14) for the experimental calcium peroxide(CaO<sub>2</sub>)-base paste, respectively. On basis of the

results obtained herein, it is concluded that the alkaline activity of the experimental calcium peroxide( $\text{CaO}_2$ )-base paste is equal as compared to two conventional sealer materials. In contrast to the conventional materials the pH-value was constant over time for the calcium peroxide( $\text{CaO}_2$ )-base.

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##### The influence of clinical experience on the quality of root canal fillings.

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**Objective:** Investigation of correlation between clinical experience and success of root canal treatment. **Methods:** From 10/1999 to 02/2003 2293 teeth (T) with 4957 root canals (C) were endodontically treated. Diagnostical, clinical and therapeutical parameters were recorded in a data base. The quality of root canal fillings (RCF) was radiographically analysed considering the clinical experience of the operators (undergraduates first (U1), second (U2) clinical course or exam (U3), dentists up to 2 (D1), 5 (D2), or more (D3) years after exam). Radiographs were assessed as to RCF appearance (homogeneously, inhomogeneously, correct-, under-, over-filled). Additionally, tooth morphology (1, 2, or  $\geq 3$  C/T), adverse canal condition (obliterations, curvatures) and treatment complications were recorded. Results: undergraduates: 931 T with 2022 C: U1: 1C/T 36%, 2C/T 14%, 3C/T 50%; U2: 1C/T 35%, 2C/T 14%, 3C/T 51%; U3: 1C/T 61%, 2C/T 19%, 3C/T 20%, dentists 1362 T with 2935 C: D1: 1C/T 49%, 2C/T 7%, 3C/T 32%; D2: 1C/T 35%, 2C/T 15%, 3C/T 50%; D3: 1C/T 39%, 2C/T 16%, 3C/T 45%; correct and homogeneous RCF: U1: 59%, U2: 53%, U3 65%, D1: 66%, D2: 63% and, D3: 69%. More adverse canals were treated with increasing experience (U: 25%, D: 40%). The complication rate was increased for U2 and D1 (10% and 8% vs. ~5%). Conclusions: Clinical experience led to higher RCF quality regardless of tooth morphology and root canal condition. More training and supervision is necessary to increase the treatment quality of inexperienced operators. A longitudinal analysis of endodontic treatment seems to be imperative to monitor and control its efficacy to meet our responsibility for the public we treat.

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##### Seven Year Results With Direct, Single-visit, Ceramic Inlays (*Cerana*)

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The results over 7 years of a prospective longitudinal study of 33 *Cerana* (Nordiska Dental, Sweden) prefabricated leucite ceramic restorations (25 CI I, 8 class II) are presented. Restorations were placed in single appointments by one clinician and assessed by two examiners using modified USPHS criteria and graded A, B, C or D for anatomical form (AF), marginal adaptation (MA), surface roughness (SR), marginal discoloration (MD), colour match (CM), discomfort (DT). The aim of the study was to assess the performance of *Cerana* inlays. The % of A scores for AF, MA, SR, MD, CM and DT at baseline (n=33) were: 100, 100, 79, 100, 21, 100; after 2 years (n=24) 100, 83, 38, 100, 13, 100 and after 4 years (n=17) 94, 71, 23, 94, 23, 100. At 6 years (n=10) 100, 70, 20, 90, 10, 100 and at 7 years (n=4) 100, 75, 0, 75, 0, 100. AF of the inlay was maintained but composite was lost where exposed in 75% restorations. SR increased to a B score for all inserts by 7 years. MD at B grade was observed in 25% between composite and

tooth, none between insert and composite. The inlay colour was stable and the colour match was acceptable in all cases. DT was nil throughout the study. There were no scores less than B and so all restorations remain clinically acceptable and in function. The results suggest that these restorations can be expected to perform well. Over the seven year period there was a slight loss of marginal adaptation due to loss of marginal resin but no loss of ceramic and a slight increase in surface roughness. In conclusion, the results were promising in terms of aesthetics, patient acceptance, occlusal wear and ease of use.

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##### Temperature rises in pulp, bone and gingivae after electrosurgery and laser gingivoplasty

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Both electrosurgery and lasers can be used for soft tissue surgery in order to facilitate routine restorative procedures. They have several advantages over conventional surgery with a scalpel, including haemostasis and ease of use. However, there is some concern over the possible temperature rises in the tissues that may result during electrosurgery and laser procedures. The aim of this study was to evaluate the temperature rises seen in hard and soft tissues when using electrosurgery and lasers for soft tissue removal. A gingivoplasty procedure was carried out by the same operator around the teeth of fresh juvenile pig maxillae. Two different electrosurgery machines and three different laser wavelengths ( $\text{CO}_2$ , 830 nm diode and 980 nm diode) were used. The temperature rises were recorded using thermocouples located in the bone, pulp and gingivae associated with the tooth around which a gingivoplasty procedure was carried out. The mean temperature rises in  $^{\circ}\text{C}$  recorded for the two electrosurgery machines were:  $1.6 \pm 0.8$  and  $1.9 \pm 1.1$  for pulp,  $3.9 \pm 1.9$  and  $2.3 \pm 1.5$  for bone,  $1.7 \pm 1.2$  and  $1.7 \pm 2.0$  for gingivae; for the  $\text{CO}_2$  laser:  $0.47 \pm 0.27$  for pulp,  $0.64 \pm 0.87$  for bone,  $15.6 \pm 13.71$  for gingivae; for the two diode lasers:  $1.69 \pm 0.70$  and  $1.18 \pm 0.64$  for pulp,  $1.68 \pm 1.69$  and  $1.63 \pm 1.38$  for bone,  $7.73 \pm 4.48$  and  $2.88 \pm 1.95$  for gingivae. The results suggest that there is little concern for damaging temperature rises when using electrosurgery or lasers correctly. The temperature rises were recorded in dead tissue. These temperature rises would be less in vital tissue due to the presence of a blood supply.

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##### Adhesion to cariously affected dentin

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Nowadays, there exists a considerable amount of experience on the chemical mechanism of restorative adhesion to both, enamel and dentin. However, the adhesion to dentin still appears rather challenging due to its organic component and the production of liquor which both might have significant impact on the quality of adhesion. Habitually, almost all previous studies on the adhesion to dentin were performed using healthy, carious free teeth which do not reflect the real clinical situation. Commonly, teeth are restored following the removal of cariously affected dentin. Therefore, in the present study the adhesion of a composite to cariously affected dentin was tested on 45 extracted teeth with carious lesions. The samples were randomly assigned to three equally sized groups of 15 teeth each. Caries removal was performed as follows: group 1: chemical caries removal (Carisolv); group 2: mechanical caries removal using microabrasion; group 3: mechanical caries

removal using burs. Specimens were restored with a conventional adhesive (Excite-Vivadent), and a hybrid composite (Tetric Ceram-Vivadent). After this, all samples were subjected to a shear strength test using the Instron machine (44–11 model) with a load cell of 100 Newton. The results were analysed with a parametric tests (Mann-Whitney). Arithmetic mean of our results are the following: carisolv caries removal: 7.97 Mpa; microabrasion caries removal: 11.04 Mpa; burs caries removal: 6.42 Mpa, so we can see numeric differences, but there is no statistically significant differences. The present data revealed a tendency for different bond strength to cariously affected dentin as compared to non affected dentin but no statistical significant difference was found. Hence, further studies with a higher number of samples have to be performed to draw more definite conclusions.

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### A two-week evaluation of two novel, topically applied, tooth whitening systems

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Tooth whitening offers a non-interventive way of improving the appearance of anterior teeth. Typically the whitening agent is applied using a tray but recently whitening agents suitable for topical application have been developed. The aim of this study was to investigate the tooth whitening efficacy of two novel, topically applied, tooth whitening systems (TATWS) containing either 18% (Group 1) or 16.4% (Group 2) Carbamide Peroxide. 95 subjects, aged 18–70, who had anterior teeth that were A3 or darker were recruited and randomly allocated to either group. The subjects were instructed to apply the formulation to all maxillary anterior teeth after brushing in the morning and evening. At baseline and two weeks later the subjects had the shade of the upper six anterior teeth measured using the Vita shade guide tab system. In addition, the gingival health of the labial surfaces of the upper six front teeth was assessed using the Loe and Silness Gingival index. The mean (s.d.) reduction in shade guide scores was 4.1 (2.4) shade guide tabs for subjects in Group 1 compared to 3.7 (2.6) shades for those in Group 2 and this difference was not statistically significant ( $p=0.5$ ). During the course of the study there were significant improvements in gingival health with gingivitis scores reducing from a mean (s.d.) of 0.91 (0.62) at baseline to 0.44 (0.55) at the final examination (48% reduction). It is concluded that the TATWS tested in this study resulted in improvements in whiteness of the upper anterior teeth of approximately 4 shades over a two-week period.

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### Efficacy of two home-bleaching systems: Whitestrips vs. Vivastyle

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Aim of the study was to evaluate the tooth-whitening efficacy of a two-week treatment with Crest Whitestrips® (WS) (6% H<sub>2</sub>O<sub>2</sub>-gel) and Vivadent Vivastyle® (VS) (10% carbamide peroxide gel) six months after completion of bleaching.

Forty-two subjects were included in this single blind, randomized, clinical study. The subjects were evenly distributed among two groups of 21 subjects each according to L-values determined at baseline before starting bleaching therapy. Stratified random sampling was applied, so that the average L-value in the two groups was nearly equal at baseline. Application of WS was per-

formed twice a day for 30 minutes. Trays filled with VS were worn for 60 minutes once a day. Whitening efficacy was evaluated by measuring Lab-values using digital images of the facial surfaces of the maxillary incisors and cuspids. The digital images were captured with a high resolution digital colour camera connected to a computer. Images were taken at baseline, after two weeks, two months and six months. Finally,  $\Delta b$  (initial b-value minus reading after six month) and  $\Delta L$ -values were statistically analysed in order to compare efficacy of the bleaching agents. After six month for both WS and VS, positive  $\Delta L$ -values (=increase in brightness and negative  $\Delta b$ -values (=reduction in yellow) were recorded. The following values [mean (90% CI)] were obtained for  $\Delta L$  (WS [2.12 (1.67, 2.57)], VS [2.26 (1.79, 2.72)]) and for  $\Delta b$  (WS [-2.11 (-2.63, -1.58)], VS [-1.52 (-2.05, -0.98)]). No statistically significant difference was observed in  $\Delta L$ - and  $\Delta b$ - values for the two systems. It is concluded that bleaching efficacy of Whitestrips and Vivastyle after 6 months is not different.

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### Influence of bleaching on fracture toughness of enamel

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Aim of the study was to evaluate the influence of different bleaching procedures on the fracture toughness (FT) of enamel. The labial aspects of 72 bovine incisors were prepared for microhardness determination. FT of the enamel was assessed with the method described by Seghi & Denry (J Dent Res 71:1340-4, 1992) performing Vickers hardness indentations with a load of 9.8 N. Length of indentations and enamel cracks were recorded and used for calculation of FT. The samples were divided among six (A-F) groups ( $n=12$ ) and then sectioned resulting in a control and experimental half. Samples were stored in artificial saliva for ten days. The experimental halves were removed from the saliva and subjected to bleaching according to manufacturers' instructions (A: Opalescence Xtra, B: Opalescence Quick, C: Rapid White, D: Whitestrips, E: Opalescence 10%, F: Opalescence 15%). Bleaching with C-D was conducted each day, systems A-B were applied on first and fifth day. Finally, FT was assessed and statistically compared to baseline values using Wilcoxon-tests ( $p<0.05$ ). Due to severe surface softening FT could not be determined for the samples of group C. FT of the controls remained stable during storage in the saliva. Percentage changes (mean±standard error of means) of FT in the experimental specimens were as follows: A: 3.9±9.5%, B: 0.1±4.7%; D: -8.2±7.19%, E: -18.9±4.7%, F: -12.0±4.7%. Application of Opalescence 10% resulted in a significant reduction of FT compared to baseline. In the remaining groups changes of FT were not statistically significant. It is concluded that depending on the applied bleaching system fracture toughness of enamel may be reduced.

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### In vitro evaluation of toothbrushing abrasion of differently bleached bovine enamel

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The aim of the present in vitro study was to evaluate the effect of different external bleaching agents on the susceptibility of enamel against toothbrushing abrasion. 96 bovine enamel specimens were embedded in acrylic resin, polished and covered with tape except for a 1.4x10 mm window. The samples were divided into eight

groups (A-H). 12 specimens each (A-G) were treated with seven different home-bleaching (A: Whitestrips, B: Rapid White, C: Opalescence 10%, D: Opalescence PF 15%) and in-office-bleaching (E: Opalescence Extra, F: Opalescence Quick, G: Opalescence Extra Boost) agents according to manufacturers' instruction. Before and after each individual bleaching treatment the samples were brushed 40 times in an automatic brushing machine using a slurry containing artificial saliva and fluoridated toothpaste. The control group (group H) was not bleached, but also brushed. After each cycle the specimens were stored in artificial saliva for 24 h. After 20 cycles loss of enamel was determined by profilometry, resulting in the following values (mean±standard deviation) which were statistically analysed: group A: (0.169  $\mu\text{m}\pm 0.035$ ), group B (11.108  $\mu\text{m}\pm 0.655$ ), group C (0.207  $\mu\text{m}\pm 0.042$ ), group D (0.154  $\mu\text{m}\pm 0.028$ ), group E (0.081  $\mu\text{m}\pm 0.015$ ), group F (0.084  $\mu\text{m}\pm 0.018$ ), group G (0.087  $\mu\text{m}\pm 0.014$ ), group H (0.076  $\mu\text{m}\pm 0.012$ ). Group B containing sodium chloride as active substance showed a significant difference compared to the controls. The other agents did not differ significantly from the controls. Nevertheless, it could be proved that toothbrushing abrasion of bleached enamel increases with increasing time of bleaching and depends on pH-value and concentration of  $\text{H}_2\text{O}_2$ .

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#### Peroxide release into saliva from different home bleaching systems in vivo

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Aim of the study was to determine kinetics of peroxide release into saliva during different bleaching procedures. Stable and specific determination of peroxides in saliva was performed with peroxidase, phenol and 4-aminoantipyrin in a photometric method. Upper jaws incisors were bleached with individual trays charged with 350 mg Opalescence 10% (OP), Opalescence 15% and Vivastyle (V). Additionally, Whitestrips (WS) designed for upper and lower jaw were used. All systems were adopted by 5 subjects for 30 min on different days. Whole saliva was collected during bleaching at various intervals (2–5 min) by disgorging. Results are depicted in the table (average±SD).

	bleaching system				
	OP 10%	OP 15%	V	WS, upper	WS, lower
applied amount of $\text{H}_2\text{O}_2$ [mg]	12.5	18.9	12.1	10.7	7.6
remnants in tray after 30 min [mg]	6.68±0.932	8.23±2.243	3.94±0.962	0.55±0.459	0.03±0.040
released into saliva during 30 min [mg]	0.78±0.450	1.52±0.439	2.67±1.031	3.25±0.565	2.09±0.344

Less peroxides were released into saliva from OP compared to V and WS. Higher amounts of peroxides remained in the trays charged with OP and V compared to WS.

All applied bleaching systems led to release of small amounts of peroxides into saliva. A smaller fraction of the charged peroxides was released into saliva from individual trays than from Whitestrips.

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#### Scanning Electron Microscopic Evaluation of two different techniques for luting glass fibre post.

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**Objectives:** Different techniques are available for luting fiber posts into root canals. This study evaluated the ability of two luting procedures for bonding translucent fiber posts in forming resin tags (RT), adhesive lateral branches (ALB), and resin dentin interdiffusion zone (RDIZ). **Methods:** Forty root canal treated teeth, extracted for periodontal reasons, were selected for this study. The samples were randomly divided into 4 groups of 10 samples each. Group 1: One Step (OS) (Bisco, Schaumburg, IL, USA), light-cured (LC) 20 sec+DuoLink (DL) resin cement (LC 20 sec), Group 2: OS, not light-cured (NLC)+DL resin cement (LC 30 sec), Group 3: OS (NLC)+DL resin cement (LC 60 sec), Group 4: OS (NLC)+DL resin cement (LC 90 sec). Forty translucent fiber posts (DT posts, RTD, St Egrève, France) were inserted. Then, root specimens were processed for SEM observations. One-Way ANOVA and Newman-Keuls Multiple Comparisons Test were applied as statistical analyses, setting the level of significance at  $p<0.05$ . **Results:** In all the luting procedures the formation of a RDIZ, RT and ALB occurred. However, the microscopic examination of adhesive interfaces revealed that the percentage of RDIZ was higher in Group 1 than in the other three Groups. Group 4 showed a higher percentage of RDIZ than Group 3, which in turn exhibited a greater percentage than Group 2, but these differences were not statistically significant. Resin tags formation was evident in all the four Groups. The characteristic reverse cone shape of resin tags was always noted in the coronal and middle third of all Groups, and in the apical third of Group 1. In the apical third a shorter length and a less uniform appearance of resin tags were noted in Group 2, 3 and 4. **Conclusions:** When bonding a translucent fiber post into a root canal, the luting procedure including light curing of the adhesive solution before the placement of the cement performs more satisfactorily than the procedure which involves the simultaneous curing of adhesive and cement (one-shot technique).

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#### Clinical behaviour of translucent fibre posts and luting and restorative materials: a 2-year report.

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**Objectives:** The clinical performance of three types of translucent posts was evaluated over a follow-up period between two and three years. **Methods:** 225 patients were selected for having one bicuspid in need of endodontic treatment, followed by restoration with a fiber post and a porcelain crown. The sample was randomly divided into three groups of 75 patients each. The same type of post was used on all of the patients within a group: Group 1: Aesthetic Plus Posts (RTD); Group 2: DT Posts (RTD); Group 3: FRC Postec (Kerr). For bonding the post, a light-cure adhesive (One-Step, Bisco) and a dual-cure resin cement (Duo-Link, Bisco) were applied in Groups 1 and 2 roots, whereas self-curing materials (Excite DSC as adhesive and MultiLink as resin cement, Ivoclar-Vivadent) were utilized in Group 3. Six, twelve, and twenty-four months after, patients were recalled and a clinical and radiographic examination was performed. For some patients, also thirty month follow-up data were collected. **Results:** A failure of the post was recorded for 14 patients (6%). In 8 cas-

es failure was due to debonding of the post, in 6 cases to the recurrence of a periapical lesion. The statistical analysis did not reveal any significant difference in the survival rate of the tested posts, suggesting that all of them are equally and sufficiently reliable for clinical use.

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### Huge Canals Filled with Composite Resins and FRC Posts

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The aim of this study was to determine the degree of polymerization of the cement and the quality of marginal adaptation of adhesively luted root canal posts in oversized canals. Two kinds of fiber reinforced composite posts (FRC: LuscentAnchor, LA; DentinPost, DP), approximately 1 mm in diameter, were luted in 3×10 mm canals in bovine roots. Composite resins used were TetricCeram (TC), TetricFlow (TF), both with ExciteDSC, and Panavia21/ED-Primer (PA) and ClearFilCore/NewBond (CL). After thermocycling, specimens were cut horizontally at the level of 1 mm and 9 mm below the canal orifices. Knoop microhardness of the polymerized composite resins was measured on each surface at three points: close to the post (P), in the middle (M) and close to the dentin (D). Gap formation was measured along the post/composite interface (P/C) and the composite/dentin interface (C/D) by SEM. Results: Means of the percentage of gap formation and microhardness:

		LA					DP				
		P	M	D	P/C	C/D	P	M	D	P/C	C/D
TC	1 mm	68	71	68	0	54	82	78	71	5	78
	9 mm	41	32	16	32	80	21	17	10	25	86
TF	1 mm	48	50	45	17	74	47	48	43	0	59
	9 mm	35	29	12	16	86	7	8	6	13	85
CL	1 mm	118	111	117	0	51	125	166	110	30	63
	9 mm	111	104	96	0	70	103	108	102	0	69
PA	1 mm	107	104	101	10	27	77	79	76	8	47
	9 mm	105	102	108	6	65	78	81	74	1	71

**Conclusions:** For both posts microhardness of TC and TF depends significantly on the depth in the canal and the distance to the post. Due to incomplete polymerization in the depth, light cured composite resins are not recommended for luting in root canals. While posts influence microhardness significantly, they do not affect gap formation. For all experimental groups gaps occurred significantly more at C/D interface. Due to very high gap rates, indication for this kind of restoration seems to be rather doubtful.

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### Crown and restoration conditions prior to endodontic treatment.

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Over the last decades there has been a high increase in the number of endodontic treatments, and there are many factors, which might be responsible for pulp disease. Aside from carious lesions, as main causal factor, trauma and malocclusion could play an important role. The aim of this clinical study was to investigate the crown condition of a tooth before root canal treatment.

A total of 503 teeth from 357 patients (51% male, 49% female, mean age: 49 years), coming to our dental school for endodontic treatment, were included in the study. Patient assessment included a medical history and x-ray diagnose. Of special interest was the clinical condition of the crowns of the teeth at baseline: healthy crowns, carious lesions, composite, amalgam, gold or ceramic restorations. The results showed that 302 teeth were located in the maxilla and 201 teeth in the mandible. 49% of the teeth were molars, 37% premolars, and 14% were anteriors. In most cases the teeth had a ceramic restoration (35%), gold restorations were found in 20%, composites in 15% and amalgams in 11%. Carious lesions were detected in 12% and other type of fillings (temporary, cements) in 7%. 8.3% of the maxillary anteriors, 14% of the premolars and 12% molars (12%); and 2.5% of the mandibular anteriors, 16.4% premolars and 17% molars had a ceramic restoration. Unrestored carious lesions were found in the maxilla in anteriors (2.4%), premolars (5%) or molars (5.3%), and in the mandible in anteriors (0.5%), premolars (3%) and molars (7.5%). This study documents a high percentage of ceramic restorations prior to root canal treatment. Aside from carious lesions as main causal factor of endodontic treatment, also the effect of a hard occlusion, like in the case of ceramic restorations, needs to be taken into consideration.

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### Effect of professional tooth cleansing on plaque and gingivitis in elderly persons.

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Demographic alterations and outcome of dentistry result in increasing numbers of elderly people with own teeth. Some people will not be able to perform adequate oral self care, so the importance of professionally applied measures will rise. The aim of this 6-month-study was to examine the effect of professional tooth cleansing on plaque and gingivitis in elderly persons. 53 healthy persons older than 54 years were assigned to 2 study groups. At baseline all persons received a professional tooth cleansing to remove debris as well as supragingival and easily accessible subgingival calculus. While subjects of one group did not receive further measures, subjects of the other group received a second professional tooth cleansing after 3 months. Plaque and gingivitis were scored at baseline and after 3 weeks and 6 months. The Wilcoxon-test was used to compare the findings. Subjects of both groups were corresponding with respect to mean age, number of teeth, DMFT, QHI (1.21±0.52 vs. 1.42±0.67) and PBI (1.10±0.70 vs. 1.10±0.60) at baseline. After 3 weeks, subjects of both groups exhibited statistically significant improvements. After 6 months, QHI-scores of 0.88±0.48 vs. 0.70±0.53 and PBI-scores of 0.72±0.59 vs. 0.58±0.34 were determined. In comparison to baseline this means a significant improvement in both groups. Yet, the PBI-score in group 1 exhibited a significant worsening after the 3-week-examination, while the PBI in group 2 was statistically stable. The study shows that in elderly persons professional tooth cleansing is an effective regimen to improve oral health, and that gingivitis is controlled better by performing this intervention quarterly than semi-annually.

### Thickness and Bacterial Distribution of *in situ* formed dental biofilms during a three day growth

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It was the aim of this study to examine the vitality distribution and thickness of one, two and three days old *in situ* biofilms. Twelve volunteers had to wear acrylic appliances in their upper jaw provided with three glass slabs (diameter: 3 mm) on each site. During wearing, no oral hygiene measures were allowed. During the meals and toothbrushing the splints were stored in saline. After 1, 2, and 3 days 2 specimens each were removed and stained without delay by the vital fluorescence technique. By means of fluorescent dyes living bacteria are selectively stained green (fluoresceindiacetate) and dead bacteria red (ethidiumbromide). The confocal laser scanning microscopy (CLSM) allows analysing the vitality of the biofilm bacteria in different layers. Starting from the highest point of each specimen optical sections of 1 µm each were recorded. By means of an automatic image analysis program the percentage of vital bacteria (vitality) within these layers was calculated. Additionally the thickness of the biofilm was determined by the number of layers. The statistical analysis was performed with ANOVA and paired t-test. During the three days of the experiment, the volunteers developed biofilm thicknesses of 46.2±13.4 µm, 93.3±492 µm, and 123.7±40.5 µm, which differed significantly. The biofilms showed a mean vitality of 60.8±18.0%, 53.6±15.0%, and 83.9±5.1%. It can be concluded that the thickness of the biofilm increases continuously while the vitality of the bacteria at the first two days decreased and increased significantly on the last day.

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### Effect of soft drink modifications on dental enamel erosion

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Aim of the study was to evaluate the erosive potential of modified acidic drinks under controlled conditions in an artificial mouth. From each of 144 bovine incisors one enamel sample was prepared. Labial surfaces of the samples were ground flat, polished and covered with adhesive tape, leaving an exposed area. The samples were distributed among four (A-D) groups (n=36; with A: Coca-Cola, B: Sprite; C: Sprite light, D: orange juice). Either 1.0 mmol calcium (Ca) or a combination (comb.) of 0.5 mol calcium plus 0.5 mmol phosphate plus 0.031 mmol fluoride was admixed to the beverages. Samples of each group were subdivided into 3 subgroups (-pure; -Ca and -comb.). For demineralisation the specimens were rinsed with the respective solution for 1 min, immediately followed by remineralisation with artificial saliva (1 min). The specimens were cycled through this alternating procedure five times within 10 min with a flow rate of the solutions of 3.0 ml/min. After cycling through this de- and remineralisation procedure, the specimens were rinsed for 8 h with artificial saliva at a flow rate of 0.3 ml/min. The de- and remineralisation cycle was repeated three times interrupted by the 8 h-remineralisation periods. After the experiment, surface loss of the specimens was determined using profilometry. In all subgroups, loss of enamel was observed. With exception of Coca-Cola, demineralisation

with the modified beverages led to significantly lower loss compared to the respective pure solutions. It is concluded that modification of soft drinks with calcium or a combination of calcium, phosphate and fluoride may exert a significant protective potential with respect to dental erosion.

### Comparison of clinical plaque recording and a novel impression-based lactate-sensitive diagnostic device.

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The aim of this study was to get information about corresponding or non-corresponding values of clinical plaque scoring and the lactate-sensitive signal of an experimental impression-based diagnostic device (3M Espe, D-Seefeld). Dental plaque in 31 adult volunteers (mean age 33 yrs.) was scored using a disclosing solution according to the Quigley/Hein plaque index (QHI). Then, the diagnostic impression was taken and evaluated on buccal and oral impression surfaces for lactate signals (LS) in a 6-point-scale (grade 0-5), which was equivalent to the Quigley/Hein scale. The results of both methods were compared statistically with respect to means, correlations and site-specific findings. Although the mean index values of both methods showed significant correlation (Person's correlation coeff.,  $p \leq 0.001$ ), the means (QHI  $0.87 \pm 0.56$ , LS  $1.09 \pm 0.54$ ) differed statistically significant (Wilcoxon-test for related samples,  $p=0.001$ ). In a further site-specific approach the findings were compared per tooth for each person, and the Spearman rank correlation coefficient was calculated. Results showed an excellent correlation in about one quarter of all subjects (correlation coeff.  $>0.9$ ), a moderate correlation in about half the subjects (coeff.  $0.5-0.75$ ), and no correlation in the remaining subjects. This means that plaque disclosing solutions and the lactate sensitive impression method can identify the same sites at risk, but this is not necessarily the case. So far, it can be concluded that both methods should not be used alternatively. Clinical studies have to evaluate the meaning of the new diagnostic impression method.

### Prevalence of Lactobacilli species in active dentine caries

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Aim of the present study was to investigate the prevalence of lactobacilli in samples taken from active, deep dentine caries and secondly to assess the isolation frequency of different species within these samples. Dentine was sampled with a sterile round bur from 50 deep posterior carious lesions. Decimally diluted aliquots were plated on Rogosa (lactobacilli) and blood agar (total counts) and incubated anaerobically for 7 days at 37°C prior to quantitative assessment and biochemical identification. The genus lactobacillus was verified evaluating the colonies' morphology on Rogosa agar, their Gram staining reaction, catalase activity and resistance against vancomycin. Species identification was performed evaluating the fermentation of 14 carbohydrates. In cases of uncertainty 16S rRNA nucleotide sequencing (MicroSeq 500, Applied Biosystems, USA) was performed in addition to classical taxonomy. Quantitative analysis revealed a mean total anaerobic count on blood agar of 5.03 (1.44)  $\log_{10}$ cfu. Lactobacilli species were isolated from every sample in relatively high numbers (mean: 3.34 (1.24); min.: 1.48; max.: 7.0  $\log_{10}$ cfu). Subsequently, 52 isolates

were identified. Classical taxonomy proved *L. rhamnosus* (isolation frequency 60%) and *L. casei* (29%) to be predominant in the microflora of carious dentine. Other species including *L. buchneri*, *L. delbrueckii ss lactis*, *L. plantarum*, *L. salivarius* and *L. viridescens* were found in very low numbers. 16S rRNA sequence analysis of selected 23 species confirmed these results. In conclusion the microflora of advanced active carious lesions is characterised by high numbers of lactobacilli dominated by *L. rhamnosus* and *L. casei*.

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### Effect of Etching and Rinsing Time on Shear Bond Strength between Composite and Enamel.

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This study compared shear bond strength of composite bonded to enamel in 12 groups of 192 extracted third molars. The buccal enamel of the molars was ground flat. Half of the specimens were etched for 20s, half for 40s with 37% phosphoric acid gel. The gel was rinsed with an air/water spray for varying amounts of time (5s, 20s and 40s) and dried. Then a composite cylinder (-2.4 mm) was polymerized to the flattened surface: in half of the specimens with Prime & Bond NT and Esthet-X (Dentsply, Germany) and in the other half with Excite and Tetric Ceram (Vivadent, Germany). Specimens were thermocycled (500x, 5∞-55∞C), and shear bond strength was measured in an universal testing machine. Fracture mode was analysed. Shear bond strength between composite and enamel was not significantly influenced by the composite system used. Specimens with 5s and 20s rinsing time resulted in significantly lower bond strength (127N) than with 40s rinsing time (140N, p=0.0236). Etching for 40s decreased bond strength compared to 20s (128N and 139N, resp.) significantly (p=0.0349). Highest bond strength was reached with 20s etching and 40s rinsing of the specimens (152N). Shear bond strength is significantly influenced by the etching and rinsing procedure during processing composite systems.

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### Histological evaluation of long-term reactions of pulp tissue to three dentin adhesives

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The aim of this in-vivo study was to evaluate histologically the reactions of rat pulp tissue to three dentin adhesives (DA) (Resulcin AquaPrime+MonoBond [RAPMB], Scotchbond 1 [SB 1] and Gluma Comfort Bond [GCB]) in comparison to calcium hydroxide (CH) after 7 d and 70 d. According to ISO 7405 10 teeth per DA and period were treated. In 60 cariesfree left and right upper molars (30 Wistar rats) an occlusal cavity was prepared with an cylindrical diamond (ISO 008). Then the pulp chambers were perforated with a sharp probe. The DA were placed onto the exposed pulp tissue according to manufacturers' instructions and the cavities were filled with composite (Tetric flow), successively. Eight molars per period served as controls: their exposed pulps were capped with CH. The cavities were filled with RAPMB and Tetric flow. 7 d and 70 d after pulp capping the animals were sacrificed. Crown pulp, root pulp and apical periodontal ligament were histologically evaluated and separately recorded according to following

scores: bacterial infection, inflammatory cells, necrosis, reparative dentin. The extent of the observed alterations were scored with 1=absent, 2=slight, 3=moderate, 4=profound. Using the Wilcoxon-test the comparison of DA to CH showed no statistical significant differences after 7 d. After 70 d the scores for bacterial infection and necrosis in the crown pulp of RAPMB and SB 1 and in the root pulp of SB 1 were significantly higher than those of CH. All fillings were estimated to be tight. In long-term evaluation of direct pulp capping CH seems to be superior to some tested DA concerning histological results.

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### In vitro study on solvent volatilization procedure of two self-etching adhesives.

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**Objective:** Aim of this investigation was to evaluate the influence of different solvent volatilization procedures when using the self-etching adhesives iBond (Heraeus Kulzer) and Prompt L-Pop (3M-Espe) by determination of the bond strength to human dentin. **Method:** After application of the adhesives solvent volatilization prior to halogen light curing (600 mW/cm<sup>2</sup>) was achieved by waiting for different time periods without using any air-stream, and by using an air-stream for different time periods. The adhesives were combined with Charisma/Heraeus Kulzer composite, bulk applied in cylindrical split Teflon molds (3.5 mm in diameter, 2 mm in depth) and 20 s halogen light cured. Shear bond strength (SBS) was determined on flat proximal dentinal surfaces (n=8) prepared on SiC paper grit 80 through 500 after 24 h storage of specimens in 37° C tap water. Statistical analysis were done by ANOVA (p<0.05). Results: SBS (MPa) after drying without using any air-stream: 7.1 (5 s), 9.0 (10 s), 11.9 (20 s) for iBond and 5.4 (5 s) for Prompt L-Pop. SBS after drying by using an air-stream: 22.5 (5 s), 23.3 (10 s), 25.6 (20 s) for iBond and 7.4 (5 s), 17.5 (10 s) for Prompt L-Pop. Conclusions: For both adhesives a relationship was found between SBS to dentin and solvent volatilization. Evaporation of solvent by waiting for a short time without any air-stream, and short evaporation times in spite of using an air-stream lead to significant lower SBS values compared to longer evaporation times and using an air-stream.

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### A randomised controlled trial of a giomer for the restoration of non-carious cervical lesions – initial findings.

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The efficacy of different materials for the restoration of non-carious cervical lesions (NCCL's) remains to be determined. The present randomised controlled trial to evaluate the giomer Reactmer (Shofu) with the compomer Dyract AP (Dentsply) as control for the restoration of NCCL's forms part of a three-centre international evaluation of Reactmer. Thirty-three adult patients requiring the restoration of two or possibly four NCCL's in canine or premolar teeth were recruited to the study. Each pair of NCCL's was restored, one with Reactmer and the other with Dyract AP, according to manufacturer's directions and a scheme for randomisation. A total of 55 pairs of restorations were placed. Baseline and six-month reviews were completed, the restorations having been assessed using modified USPHS criteria. Forty-five pairs of restorations were reviewed at six months. At six months 8 (18%) of the Dyract AP and 1 (2%) of the Reactmer restorations had been lost, with a further three restorations (one of Dyract and two of React-

mer) having suffered partial loss. Based on the assessment of 45 pairs of restorations at six months, the initial clinical performance of the restorations of both Reactmer and Dyract AP was variable in terms of marginal adaptation and micro-leakage as diagnosed clinically. No secondary caries was found to be associated with the restorations assessed. It is concluded that the six-month performance of the restorations of Reactmer was superior to that of the restorations of Dyract AP in terms of retention.

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### Buffering effects of toothpastes and fluoride gels on abrasion of eroded enamel

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Aim of the study was to evaluate the abrasion resistance of eroded enamel brushed with experimental toothpastes and fluoride gels of varying buffering capacities. Specimens were prepared from 50 extracted human molars and cycled through 3 alternating de- and remineralizations including brushing abrasion in an automatic brushing machine (2000 strokes, 2.7 N load; between cycles storage of specimens in artificial saliva for 8 h). Demineralization was accomplished by immersing the specimens in 1% citric acid (5 min), remineralization was performed by storing the samples in artificial saliva for 1 min. Groups of 10 samples were brushed with either one of the toothpaste (A-C) or one of the flouridated gels (D-E). Toothpastes were produced on basis of elmex<sup>®</sup> toothpaste (1250 ppm F<sup>-</sup>), gels on basis of elmex-gele<sup>®</sup> (12500 ppm F<sup>-</sup>, GABA, Lörrach, Germany). Amount of titratable acid was defined as amount of 1N KOH needed for neutralization of 1 g toothpaste or gel (A: 6 mg, B: 12 mg, C: 24 mg, D: 3,1 mg, E: 10 mg KOH). The following abrasion values (mean ± S.D. [µm]) were obtained profilometrically and statistically analyzed by Tukey analysis of variance (p<0.01); A: 6.76±2.05, B: 6.84±1.19, C: 8.28±2.89, D: 4.19±1.09 and E: 0.83±0.61. No significant difference in abrasion between the toothpastes was found. In contrast, the fluoride gel with the higher buffering capacity (E) exhibited significantly less abrasion than the gel with the lower buffering capacity (D). It is concluded that in eroded enamel buffering capacity of the tested flouridated toothpastes has no effect on abrasion, whereas use of fluoride gel with a higher buffering capacity leads to reduced abrasion values.

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### Effects of Different Preparation Techniques On the Microleakage of Sealants.

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The aim of this study was to evaluate microleakage of a compomer and resin pit and fissure sealants after using two different surface preparation techniques:(1) traditional pumice prophylaxis and acid etching,(2) AlO<sub>2</sub> air abrasion . 125 intact third molars were randomly divided into five groups of 25 in each. A compomer (Dyract seal) and a resin sealant (Helioseal F) were used.The materials and the surface preparation techniques were; Gr 1; Phosphoric Acid (37%) + Resin Sealant, Gr 2; AlO<sub>2</sub> air abrasion + Resin Sealant, Gr 3; Non Rinse Conditioner (NRC) + Prime&Bond + Compomer Sealant, Gr 4; Phosphoric acid + Compomer Sealant, Gr 5; AlO<sub>2</sub> air abrasion + Compomer Seal-

ant. After the treatments teeth were submitted to thermocycling, sealed apically and coated within 1 mm of the sealant margin with nail varnish and immersed in a photographic developer solution under the fluorescent light for staining.After sectioning the assessment of the microleakage were performed by a stereomicroscope and scored zero to three. Statistical investigations were performed with Kruskal Wallis 1 – way ANOVA test and the comparisons by Mann- Whitney U and Wilcoxon Rank Sum W test.The range of microleakage was found as ; Gr 1; 34.3%, Gr 2; 89%, Gr 3; 64.8%, Gr 4; 25.6%, Gr 5; 83.4%. In conclusion pretreatment with phosphoric acid produced the lowest microleakage scores when applied with both fissure sealants but there was no statistical difference (p>0.05). Compomer sealant used with NRC was not successful without Air Abrasion pretreatment or phosphoric acid etching, whereas Air Abrasion pretreatment was ineffective in preventing microleakage in both sealants.

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### Depth of cure of new high power LED versus QTH light curing devices at a clinically relevant distance.

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The aim of this study was to determine the depth of cure of new high power blue LED curing devices (Elipar FreeLight 2, 3M Espe; LEDemetron 1, Kerr; Ultralum 2, Ultradent) compared to a high power QTH curing device (Optilux 501, Kerr). Method: Surface hardness was measured (Zwick Z2.5/TS1S) 5 min post exposure at the top-and bottom surface of resin samples (Tetric Ceram, Vivadent, 1–5 mm; 0.5 mm increment, Ø 5mm, n=9), cured within 7mm distance from the bottom of the sample to the light guide tip to simulate a class II-curing situation. A reference sample was cured under direct contact with the light guide. The reference-sample with the highest top-surface hardness of all devices measured served as the overall control. A bottom/top-surface hardness ratio of 80% of the reference sample was defined as clinically acceptable for safe curing. A descriptive statistical analysis was carried out. **Results:** The mean maximum resin composite sample thickness cured sufficiently (relative surface ratio of 80%) was: 3 mm for Optilux 501 (40 s, 10/10 mm), 2.5 mm for the Elipar FreeLight 2 (40 s), Ultralum 2 (40 s), and LEDemetron (40 s, 13/11 mm), 2.0mm for the LEDemetron (20 s, 13/8 mm), 1.5 mm for LEDemetron (20 s, 13/11 mm), and Ultralum 2 (20s) The Elipar FreeLight 2 and the Optilux 501 (10/10 and 13/8 mm) were not able to cure a 1 mm thick resin sample within a 7 mm distance sufficiently, given 20 s exposure time. **Conclusion:** Application of the new high power LED curing devices ensure clinically sufficient depths of cure, comparable to the Optilux 501. In contrast to QTH curing, depth of cure benefits from the use of a focusing lightguide with high power LED curing devices.

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### Second opinion by radiography, ECM or DIAGNOdent in detecting questionable occlusal caries

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The purpose of this study was to evaluate the detection of occlusal caries with radiographs, electric conductance and laser fluorescence readings on sites of clinical uncertainty. 72 unrestored, non-cavitated occlusal surfaces of posterior teeth visually scored as questionable by 3 readers, were examined by 10 observers. Caries detection was supported by conventional radiographs (RX;

Ektaspeed plus, Kodak, USA), by electrical conductance (ECM; ECM III, Lode, NL) and by laser fluorescence readings (DD; DIAGNodont, KaVo, Germany) or the sites were visually scored (VI; Ekstrand et al., 1998). Histological lesion depth evaluated from serial sections using polarising light microscopy served as validation standard (19 sound, 44 enamel and 9 dentinal lesions). Accuracy was defined by areas under ROC curves that were calculated for two disease cut-offs: enamel and dentine lesion. The factors "diagnostic test" ( $p < 0.0001$ ), and "disease cut-off" ( $p = 0.24$ ) were analysed by repeated measures ANOVA. ROC areas for the detection of all carious lesions were 0.59 (RX), 0.49 (ECM), 0.62 (DD), 0.62 (VI) and at disease cut-off II 0.59 (RX), 0.46 (ECM), 0.60 (DD) and 0.55 (VI). Overall, ECM yielded significantly the lowest ROC areas ( $p < 0.0001$ ), whereas DD and VI showed comparable accuracy. The difference between RX and DD was significant ( $p = 0.04$ ). Correlation to histology expressed by Spearman rank coefficients was: 0.18 (RX), -0.05 (ECM), 0.15 (DD), 0.17 (VI). The highest caries detection rates for questionably carious occlusal sites were seen with visual inspection and DIAGNodont. However, discriminating ability at the enamel and dentinal level was unsatisfactory for all diagnostic tests.

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### Are Compomers Suitable for Direct Posterior Restorations?

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The aim of this study was to evaluate the clinical behavior of two polyacid-modified resin composites (Hytac [3M-Espe] and Dyract AP [Dentsply]) in class I and II cavities.

In a controlled prospective clinical study, 71 cavities (21 occlusal, 41 mo/od, 9 mod) in 30 patients (age 31.7 years) were filled with compomers by three dentists. 38 fillings were inserted with the combination OSB/Hytac with selective enamel etching and total bonding. The same patients received 33 restorations with Prime&Bond 2.1/Dyract AP (selective enamel etching). At baseline, after 24, and 48 months the restorations were examined by two investigators according to modified USPHS-criteria.

Twenty restorations were not investigated at the four year recall (dropout). After 48 months, 11 restorations (Hytac: N=8, Dyract AP: N=3) had to be replaced due to tooth fracture (N=4), gap formation (N=5), and adhesive failure (N=2). Forty fillings were in good condition (failure rate 16% [Hytac: 21%; Dyract: 9%] Kaplan-Meier algorithm). Between the recalls (A baseline, B 2 years, C 4 years) statistically significant differences were detected for the criteria [alpha/bravo/charlie in %] marginal integrity A 76/24/0 B 37/58/6 C 35/58/7 and integrity filling A 99/1/0 B 81/19/0 C 42/58/0 (Friedman test;  $p < 0.05$ ). No differences were found for color match, proximal contact, and hypersensitivities ( $p > 0.05$ ). For the criterion surface roughness, a significant difference between the materials was evident in favor of Dyract AP (Mann-Whitney-U test;  $p < 0.05$ ).

Although enamel margins were etched, the clinical results with compomers after four years were not favorable.

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### Dentin Bonding of Light- and Self-curing Composite Resins using Simplified Total- and Self-etch Adhesives

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**Purpose:** It was the purpose of this study to evaluate the influence of (i) the curing mode of the composite and (ii) activators for dual-curing of the bonding system on dentin bond strength.

**Materials and methods:** The light-curing (LC) resin composite Brilliant (B) and the self-curing resin composite Brilliant MH (MH) were bonded to human dentin with the following total-etch (TE) or self-etch (SE) adhesives (n=10): OptiBond FL (OFL), Excite (EX), Prime&Bond NT (PB), OptiBond Solo plus (OS), Adper Prompt L-Pop (LP), Clearfil SE Bond (CSE), Xeno III (XE) and AdheSE (AD). EX, PB and OS were also used in combination with activators for dual-curing (DC). Tensile bond strengths were measured after 24 h water storage (37°C), and fractured surfaces were analyzed in the SEM. Statistics: ANOVA, t-test ( $p = 0.05$ ).

### Results:

Mean bond strengths ( $\pm$ Std.Dev); p: t-test

	OFL	EX	PB		OS				LP	CSE	XE	AD	
	TE/ LC	TE/ LC	TE/ DC	TE/ LC	TE/ DC	TE/ LC	TE/ DC	SE/ LC	SE/ DC	SE/ LC	SE/ LC	SE/ LC	
B	19,6	18,2	13,9	10,2	3,7	17,9	10,9	13,8	10,0	6,3	32,6	16,7	17,0
MH	14,2	1,5	13,0	0,3	2,4	3,9	4,6	4,2	3,0	0,4	5,5	0,1	0,4
p	0,01	0,000	n.s.	0,000	n.s.	0,000	0,001	0,000	0,000	0,003	0,000	0,000	0,000

**Conclusions:** This study confirms the incompatibility between self-curing resin composites and simplified bonding systems containing acidic components. Activators designed for dual-curing the bonding were able to eliminate this chemical incompatibility only in two out of three bonding systems. Self-curing composites should not be used in combination with simplified, especially with self-etching adhesive systems.

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### Comparative evaluation of handling properties and color concepts of universal composites

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**Objectives:** The development of a viscosity measuring method (VMM) for the description of the handling behaviour of some universal restoratives and the analysis of the coloring systems in connexion with the development of a new universal microhybrid (Venus). **Methods:** – An amplitude sweep oscillation method for the viscosity measurement of storage modulus (SM) and loss factor (LF) depending on controlled shear stress (CSS). – A color measurement unit for the determination of lightness (L), chroma (C), hue (h) and transparency (T). **Results:** – VMM: linear range: EsthetX:  $2.7 \times 10^6$  Pa (SM)/0.1 (LF), Z 250:  $1.4 \times 10^4$  Pa/1.0, Point 4:  $1.5 \times 10^4$  Pa/0.2 Charisma:  $1.4 \times 10^3$  Pa/1.3, Venus:  $4 \times 10^4$  Pa/0.5. Products behave similar at high shear stress. At low stress the CSS-method differentiates between the firmness, packability and flow properties of the examined composites and shows a good correlation to handling tests done by dentists. – **Color measurements:** L, C, and h of the Vita Classic shade guide develop almost linear between light and dark colors of the A, B, C and D shade groups. L, C, h and T differ significantly between the products Point 4, Vitalescence, Charisma and Venus. Among these composites only the Venus shading system is approximately linear. To-

gether with the corresponding layered shade guide, this concept allows the dentist to easily select the appropriate shades for the best color match of the restoration with the surrounding tooth.

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#### 4-Year Efficiency of a Adhesive System for Posterior Teeth.

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**Objectives:** To do a longitudinal clinical study to assess the efficiency of an adhesive system to be composed of a primer adhesive (Syntac SC®) and hybrid composite (Tetric Ceram®). **Methods:** 48 Class I and II cavities on molars were restored. Inclusion criteria: informed consent, pulp sensitivity positive, at least one proximal and antagonistic contact to natural teeth, moisture control by rubber dam. The treatment was carried out by 4 clinical operators according to manufacturer's directions (Vivadent, G). 20 out of 25 Class I (80%) and 21 out of 23 Class II fillings (91,3%) were placed applying partial bonding. The trials were rated as to modified USPHS Criteria (at baseline, 6, 24 and 48 months). The 4 year evaluation was done by a clinical operator who had not placed the trial. Cumulative failure rate was analysed for each restoration and criteria at any given recall interval. **Results:** At 4-years 35 of 48 trials were reassessed (rate 72,9%). All in all 4 trials failed (1 of them was unacceptable as to the criteria marginal integrity, marginal discoloration, recurrent caries, and anatomic form). Failures were only restricted to partial bonding. No adverse effects were observed. **Conclusions:** As to ADA Guidelines for Composite Resins for Posterior Restorations and within the limitations of this study (e.g. the portion of Class II restorations was less than 75%), the adhesive system exceeded with 11.1% after 4 years the failure limit of no more than 10% Charlie for unrestricted use (including the categories of marginal integrity, caries, anatomic form, and restoration replaced). The study was supported by Vivadent.

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#### Changes in proximal contact strengths after direct reconstruction with composite

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**Introduction:** Adequate proximal contacts are difficult to achieve after the reconstruction with directly inserted posterior composites. **Aim:** To test the hypothesis that direct composite restorations reduce the proximal contact strengths. **Methods:** 61 consecutive patients of our department without periodontitis, who needed a direct posterior composite restoration including at least one proximal contact participated in this study. The proximal contact strengths (PCS) were electronically evaluated by measuring the frictional forces during the removal of a 50±5 µm thick straight metal band. PCS were measured at the site next to the restoration (R) and at the corresponding contact of the contra-lateral quadrant (C), which was taken as control. Measurements were taken at baseline (R0/C0), after finishing the restoration (R1/C1) and after one week (R2/C2). Differences over time were tested by ANOVA followed by the post hoc Scheffé-test and differences between test and control side by the Wilcoxon-test for paired samples (p=0.05). **Results:** PCS changed from 2.21±1.47N (R0) to 1.51±0.81N (R1) and 2.28±1.23N (R2; p<0.001). At the corresponding contact of the contra-lateral quadrant the PCS changed from 2.27±1.45N (C0) to 2.22±1.41N (C1) and 2.24±1.45N (C2; n.s.). PCS differed statistically significant after finishing the composite restoration (R1 versus C1; p<0.001). **Conclusions:** After reconstruction

with direct composite proximal contacts are weaker compared to baseline and to the contra-lateral quadrant. However, after one week these differences have been disappeared.

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#### Adaptation Of A Composite In A Proximal Slot Preparation

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This laboratory study aimed to examine the adaptation of resin composite materials to the margins and prepared enamel and dentine surfaces of ultraconservative Class II preparations. Uniform proximal slot preparations were completed mesially and distally in each of 20 upper first premolars. The teeth were restored with Z250 (3M ESPE, St. Paul, MN, USA). Five teeth were selected randomly, impressions taken and epoxy resin replicas produced. The replicas were tested by SEM to assess marginal adaptation, cavosurface margin damage, restoration marginal fracture and marginal openings. The restored teeth were embedded in epoxy resin and sectioned mesiodistally. Following 60s immersion in a 0.5% basic fuchsin, the sections were rinsed, dried and examined (X10) by light-reflecting microscopy. Digital micrographs were recorded and computerised for image analysis (SigmaScan Pro 5). The tooth/restoration interface was examined and the percentage tooth/restoration interface length occupied by voids calculated. Data were analysed by Paired-sample T-test and Mann-Whitney. The enamel/restoration interface had significantly less percentage length occupied by voids than the dentine/restoration interface (P<0.001). There were significantly less overfilled margins occlusally than proximally under SEM (P<0.001). The findings indicate that resin composites have significantly enhanced marginal adaptation to cervical and occlusal enamel than to dentine. Moreover, occlusal margins are better adapted in comparison to proximal margins.

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#### Stress Relaxation of Resin Composites by Means of Water Sorption

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**Introduction:** Resin composites show a certain polymerization shrinkage stress which remains on a certain level, when samples are stored dry. A compensation of this polymerization shrinkage stress by means of a certain water sorption is discussed, when those samples would be stored wet, compared to the environment in the oral cavity. **Objective:** Aim of this study was to evaluate the polymerization shrinkage stress of hybrid resin composite samples (Tetric Ceram, Vivadent) and compomer samples (Dyract AP, Dentsply/DeTrey) stored wet and dry by means of a photo-elastic investigation. **Methods:** Cylindrical cavities (Ø 5 mm) in Araldit B epoxide resin plates (40×40×3 mm) were pretreated with the Rocatec system to ensure a bonding of the resin composite. 20 composite resin specimens of each material, embedded in the Araldit-plates, were exposed for 60s (Elipar Trilight), 10 samples stored dry and dark while 10 samples each were stored in water (37 °C). 4 min, 24 h and weekly up to 12 weeks post exposure, polymerization shrinkage stress data (MPa) were calculated from the diameter of the isochromatic rings of first order of the Araldit-plates. The initial polymerization stress obtained 4 min after exposure was defined as 100%. **Results:** Tetric Ceram (stored dry) reached a mean polymerization shrinkage stress of 125%±2% after one day which almost remained at this level after 12 weeks

(120%±2%); when stored wet, the mean polymerization shrinkage stress of Tetric Ceram was reduced from 126%±4% after 24 h to 35%±1% after 12 weeks. The mean polymerization shrinkage stress of Dyract AP rose to 130%±4% after 24 h when stored dry and to 134%±2% when stored wet. The dry stored samples showed 122%±4% remaining mean polymerization shrinkage stress after 12 weeks while the samples stored wet showed no remaining polymerization shrinkage stress from the 5th week on. **Conclusion:** Dyract AP and Tetric Ceram showed a reduction in polymerization shrinkage stress when stored wet. The higher reduction in Dyract AP might be due to the higher water sorption of this compomer material.

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### Depth of Cure of Differently Irradiated Resin Based Composites

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The study determines the depth of cure of resin based composites photo-activated using different light curing units. Specimens (4 mm diameter, 8 mm height) of a fine hybrid and a nano-particle resin composite (Filtek Z250, Filtek Supreme, shade

A2, 3M ESPE) were fabricated using a PTFE mould. Irradiation was performed by a quartz tungsten halogen [QTH] light of standard [std] (Elipar Trilight, 3M ESPE) or high [hi] intensity (Optilux 501, Kerr) or by LED units (std: Ultralume, Ultradent; hi: Elipar Freelight 2, 3M ESPE). Activation times were 20s (std) or 10s (hi), respectively. Specimens were stored dry for 7d at 37°C in the dark. Longitudinal cross-sections were prepared by wet grinding. Knoop hardness (0.5 kp, 30 s) was measured at depths of 0.2, 0.5, 1, 1.5 mm at the centre of each specimen and 1mm to either side. At each depth, the 3 hardness readings were averaged. Depth of cure was defined as the interpolated depth, where 80% of the maximum hardness of each specimen was observed. Statistical analysis (n=6) was performed by 2-way ANOVA and Tukey's post-hoc test.

Mean±SD	QTH std <sup>a</sup>	QTH hi <sup>c</sup>	LED std <sup>b</sup>	LED hi <sup>b, c</sup>
Z250	5.9±0.2	5.0±0.2	5.5±0.5	5.2±0.4
Supreme	4.8±0.2	3.6±0.4	4.1±0.2	4.0±0.1

Z250 featured a higher depth of cure than Supreme (p<0.001). The highest depth of cure was observed for QTH std, the lowest by QTH hi, with LED units ranging in between (p<0.001). The interaction was not significant. The high intensity QTH unit was not strong enough to produce an equivalent depth of cure in half the activation time compared to the standard QTH unit. In contrast, the depths of cure produced by the two LED units were not significantly different.

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