

## A SCOPING REVIEW ON THE APPLICATIONS OF TRIBOLOGY CONCEPT IN DENTAL COMPOSITES RESEARCH

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**Aim:** a growing interest has developed in tribology application in medical biomaterials, such as resin composites used in restorative dentistry. Yet, the keywords “tribology” and “biotribology” are little applied in the pertinent publications. The aim of this scoping review is to provide an overview of tribology applications in dental composites research and to identify knowledge gaps and address future research.

**Methods:** this scoping review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews and answered to the research question: “What is the application of tribology concept in dental resin composites research?”. A literature search was conducted on PubMed and Scopus databases and the *in vitro*, animal and human studies investigating the tribological behavior of resin composites were included for qualitative synthesis. Two independent reviewers performed the studies’ selection and data extraction.

**Results:** the search identified 163 potentially relevant studies. After removal of duplicates and articles not fulfilling the inclusion criteria, 17 laboratory studies met the eligibility criteria. No human/animal studies were identified. The majority of studies on dental tribology were published in the research areas of mechanical engineering/nanotechnology and differed in several methodological aspects, including macroscopic and microscopic techniques to investigate tribological and mechanical properties of the tested materials.

**Conclusions:** the preponderant engineering approach and the lack of standardized testing make the laboratory findings poorly informative for clinicians. Future research should focus on the tribological behavior of dental materials composites by means of an integrated approach, i.e., engineering and clinical, for improving development and advancement in this field of research.

## INFLUENCE OF A CHLORHEXIDINE-BASED GEL ON CHROMATIC VARIATIONS OF TWO COMPOSITE RESINS

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**Aim:** the aim of this *in vitro* study is to evaluate the discoloration induced by a Chlorhexidine (CHX)-containing gel of two different composites: paste and flow.

**Methods:** twenty composite samples (8x6x5 mm) were prepared through a silicon stamp in order to obtain reproducible specimens. Samples were divided in 2 groups (n = 10): paste composite (PC-Premise, Kerr) and flowable composite (FC-Premise Flow, Kerr).

After polymerization, and polishing and finishing procedures, samples were incubated in distilled water (dH<sub>2</sub>O) for 24 hours, and then the initial color (L\*, a\*, b\*, C, h) was measured through a spectrophotometer (VITA Easyshade V). Specimens underwent the CHX/tea coloration model cycle based on immer-

sion in human saliva for 2', covered by a layer of 0.50% CHX gel for 2', and immersion in black tea for 1h.

These procedures were repeated 6 times. After rinsing and drying, sample color values (L\*, a\*, b\*, C\*, h°) were measured, and color variation was calculated using both CIELAB ( $\Delta E_{ab}$ ) and CIEDE2000 ( $\Delta E_{00}$ ).

**Results:**  $\Delta E_{ab}$  and  $\Delta E_{00}$  were calculated using the respective formulas. FC showed a higher  $\Delta E_{ab}$  and  $\Delta E_{00}$  (2.95+-1.3/1.53+-0.6), than PC samples (1.84±0.7/1.34±0.5). This difference was not statistically significant (p >0.05).

**Conclusions:** based on the results of this preliminary study, it can be concluded that flowable composites are more subject to discoloration after CHX-gel use.

## EFFECTS OF CYCLING LOADING ON SURFACE ROUGHNESS OF HIGHLY-FILLED FLOWABLE COMPOSITE

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**Aim:** the aim of this study is to evaluate the difference in surface roughness, before and after occlusal wear, between traditional composites and highly-filled flowable.

**Methods:** eighty samples were divided in 4 groups (n = 20): CMF (Clearfil Majesty ES flow superlow, Kuraray), GUF (Gaenial Universal Injectable, GC), CM (Clearfil Majesty ES-2, Kuraray), and GA (Gaenial A'CHORD, GC). Samples (8x6x5 mm) were created through several 2 mm-layers of composite, each of them polymerized for 10".

Specimens were stored at 37°C for 24 hours to ensure polymerization, were polished and ultrasonically cleaned for 3' in dH<sub>2</sub>O, and then preserved in a without-light box. Surface roughness was measured with a roughness tester (SJ-201, Mitutoyo) placed 3 times randomly on the specimens surface, be-

fore and after cyclic loading (Chewing Stimulator CS4.4, Mechatronik).

**Results:** the initial average value was: 0.27μ(±0.13) for CMF, 0.25μ(±0.14) for GUF, 0.5μ(±0.29) for CM, and 0.47μ(±0.25) for GA. The final average value was: 0.66μ(±0.12) for CMF, 0.6μ(±0.12) for GUF, 0.79μ(±0.15) for CM, and 0.8μ(±0.14) for GA. The average differences between initial e final values were: 0.4μ(±0.19) for CMF, 0.36μ(±0.18) for GUF, 0.29μ(±0.2) for CM, and 0.33μ(±0.27) for GA. No statistically significant differences were found between CMF-CM (p = 0.1), GUF-GA (p = 0.71), CMF-GA (p = 0.37) and GUF-CM (p = 0.3).

**Conclusions:** the surface roughness of highly-filled flowable composites seems to be comparable to traditional paste composites.

## FLUORIDE AND CALCIUM RELEASE FROM ALKASITE AND GLASS IONOMER RESTORATIVE DENTAL MATERIALS

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**Aim:** the aim of this investigation was to evaluate the effect of pH and temperature on the ion (F<sup>-</sup> and Ca<sup>2+</sup>) release of a resin-based material containing alkaline fillers (*Cention N Forte* - CN) and a self-setting high-viscous glass ionomer cement (*Equia Forte HT* - EF).

**Methods:** dental materials specimens, prepared according to manufacturers' instructions, by light curing for CN and self-reaction modalities for EF, were immersed in 3 different pH environments (4.8, 6.8, and 8.8), stored at 4 temperatures (0, 18, 37, 44 °C) and analyzed after 24 hours, 7 and 28 days. Cumulative F<sup>-</sup> and Ca<sup>2+</sup> releases were analyzed by ion chromatography, mass spectrometry with inductively coupled plasma. Statistical analyses were performed by Stata 14.0 program and the level of significance was set to 0.05.

**Results:** in both materials, for all three pH values, the highest release was recorded after 28 days. F<sup>-</sup> concentrations ranged from 0.15 to 10.08 mg/L and from 0.11 to 32.56 mg/L, for CN and EF, respectively. Ca<sup>2+</sup> concentrations were in range 0.13-14.31 mg/L for CN and 0.27-29.57 mg/L for EF. Significant difference by temperature in F<sup>-</sup> and Ca<sup>2+</sup> release (p < 0.05) was detected for both materials, with higher amount at 44°C and 37°C. Therefore, the temperature storage influenced ion release and the high-viscous glass ionomer showed the maximum values.

**Conclusions:** both materials efficiently behave as F<sup>-</sup> and Ca<sup>2+</sup> releasing dental filling materials. Moreover, they showed different but stable bioactivity, so they can contribute to the dental remineralization process and secondary caries prevention.

## INFLUENCE OF CURING TECHNIQUE ON CHEMICAL AND AESTHETIC PROPERTIES OF RESIN CEMENTS

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**Aim:** this study aims to evaluate the effect of two curing techniques on degree of conversion (DC), translucency (TR), color (C) and C stability of different resin-based luting agents (RLA).

**Methods:** light-cure Nexus Third Generation (NX3L), dual-cure Nexus Third Generation (NX3D), light cure RelyX Veneers (RXL), dual cured RelyX Ultimate (RXU), and Enamel Plus Flow (MF) were evaluated. For each tested material, 30 samples were made and divided into two groups: Group P1, cured for 40 sec; Group P2, initially cured for 5 sec. and, after 20 sec., cured for additional 40 sec. Then, samples of each group were randomly assigned to 3 groups (n = 5), according to the following chosen analyses: DC for assessing chemical properties at 5 min., 1 and 2 days after curing; TR and C after immersion in distilled water

at 1 and 7 days; moreover, color stability was assessed after exposure to a coffee solution for 7 days. Data were analysed by two-way ANOVA and Tukey's HSD test (p = 0.05).

**Results:** P1 and P2 reported no differences in DC at each time points (p <0.05). However, the two curing techniques influenced the color of RXD since it showed a perceptible difference in both TR and C (p <0.05). The curing technique also influenced the color stability of RXL and RXD making them more susceptible to coffee staining (p <0.05).

**Conclusions:** although P1 and P2 did not change the DC, they influenced the colorimetric properties of the tested RLAs, in particular of RXL and RXD. For this reason, P1 can be recommended when using RXL and RXD.

## REMINERALIZATION POTENTIAL OF THREE FLUORIDE TOOTHPASTES ON WSLs: A MICROANALYTIC APPROACH

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**Aim:** this *in vitro* study aims assessing the remineralization potential of three fluoride-based toothpastes in permanent teeth with white spot lesions (WSLs). A multidisciplinary approach based on Raman Microspectroscopy, Computed X-Ray Microtomography, Scanning Electron Microscopy, Energy-Dispersive X-ray Spectroscopy and Vickers Microhardness was exploited.

**Methods:** N = 12 permanent molars with natural WSLs in the proximal-vestibular zone were divided into 4 groups (n = 3), treated with toothpastes 1450 ppm F<sup>-</sup> coupled with different active ingredients: HAF (hydroxyapatite with fluoride); SMF (sodium monofluorophosphate with arginine); SF (sodium fluoride); and CTRL (untreated group). Samples were submitted for 7 days to a pH cycling, with two daily treatment exposures (2 min each time). Surface micromorphology, chemical/elemental composition, mineral density (MD), and micro-

hardness were evaluated. Statistical analysis was performed (One-way ANOVA, followed by t-Test; Graphpad Software).

**Results:** a significant remineralization of WSLs was observed in all treated groups respect to CTRL (p <0.05). HAF and SF displayed higher microhardness than SMF and CTRL, higher phosphates amounts, higher crystallinity, and lower C/P. Ca/P pinpointed significant differences (p <0.05) between treated groups and CTRL, while no differences were found among treated groups (p >0.05). The highest MD and the smoothest surface morphology were found in SF.

**Conclusions:** SF and HAF toothpastes have comparable capability in hardness recovery, showing a good remineralizing potential according to both micromorphological and chemical/elemental analyses. The use of these toothpastes could represent a preventive, therapeutical and effective treatment for WSLs, especially in young and un-cooperative subjects.

## A TEACHING TECHNIQUE FOR DIRECT POSTERIOR RESTORATIONS: ESSENTIAL LINES

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**Aim:** traditional methods able to replicate dental anatomy in composite direct posterior restorations usually need a long learning time. As an alternative to the classic layering method using traditional composites, Essential Lines technique has been recently introduced. It consists of various steps, including the use of bulk-fill composites and simple occlusal drawn lines that facilitate the restoration's execution also reducing its timing. This study is aimed to validate the simplicity of Essential Lines technique by administering a questionnaire to record the opinion of young practitioners who have been taught this technique.

**Methods:** an anonymous questionnaire entitled "Technical evaluation of Essential Lines" was created, consisting of 10 multiple choice questions, with an evaluation score from 1 to 5, where 1 is the minimum and 5 the maximum. For the assessment, the questionnaire was administered via Google Form

platform to the students of the Dental School of Università Politecnica de Marche and to recently graduated dentists that learned this technique during their degree course.

**Results:** 77.4% of the interviewed people found the Essential lines steps extremely reproducible; 3.2% of them did not find the technique useful and would not recommend it to a colleague; 54.8% were extremely satisfied with the training and confirmed the easiness of reproducing the occlusal anatomy in posterior regions. Most of the questions about the utility of bulk-fill composites and the practice-kit received a score of 4, demonstrating how helpful and fast they were in learning the Essential Lines technique. Only 3.2% of participants did not complete the restoration in 15 minutes.

**Conclusions:** the Essential lines technique can be considered a valid method to teach a feasible and reproducible way to perform direct posterior restorations.

## COMPARISON OF THREE DIFFERENT CURING STRATEGIES ON THE COLOR STABILITY OF COMPOSITE RESINS

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**Aim:** the objective of this study was to evaluate the effects of 3 different curing methods on the colour stability of composite resins using a coffee pigment solution.

**Methods:** three different composites were used placed on 8 x 2 mm Plexiglas cylinders. The 120 samples were divided into 4 groups according to the polymerization strategy: control group, in which a single photopolymerization was performed for 40s; group 1 in which a polishing procedure was added; group 2 in which an additional photopolymerization was performed after the polishing procedure; group 3, photopolymerization was performed using glycerin and then the polishing maneuvers were performed. The samples were soaked for 7 days in coffee solution. After the 7 days in the solution: A first color measurement

was taken immediately after polymerization, the measurement was performed using a dental spectrophotometer, the second measurement was taken after 7 days in the coffee solution. Three parameters (L,a,b) were evaluated and used to derive the  $\Delta E$ . A descriptive statistic of the different groups and a one-way ANOVA was performed for comparison between the different groups and the control. The p-value was set <0.05.

**Results:** a descriptive statistic of the different groups and a one-way ANOVA was performed for comparison between the different groups and the control. The p value was set <0.05.

**Conclusions:** finishing and polishing should be performed in order to maintain aesthetic properties by providing less discoloration in composite resins.

## MEETING POINTS BETWEEN CONSERVATIVE AND ORTHODONTICS IN THE AGENESIS OF LATERAL INCISORS

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**Aim:** agenesis of the maxillary lateral incisors is the third most frequent one after that of the eighth and second lower premolars. The upper lateral incisor is directly involved in smile aesthetics and its mono or bilateral absence requires a multidisciplinary dental intervention. The two treatment options are orthodontic opening or closing of the spaces.

The aim of the study is to analyse not only the tip and the torque positions but also the rotation of the canine crown replacing the missing teeth in case of bilateral agenesis considering the greater convexity of the buccal surface compared to that of the central incisor, in anticipation of conservative camouflage.

**Methods:** literature review and *in vitro* reconstructions on moulded models were performed.

**Results:** it is evident from the literature review that there is little attention paid to canine crown rotation in replacement cases. Through the *in vitro* reconstructions on printed models, it was possible to demonstrate that the positioning of the canine in the best rotation, compared to the traditional one, allows a greater preservation of the patient's dental tissue, respecting the principle of Minimal Invasive Dentistry.

**Conclusions:** this work proves to be an *in vitro* evaluation from which becomes apparent the need for new studies to obtain more precise indications.

## BONDING PERFORMANCES OF DUAL-CURE ADHESIVE RESIN CEMENTS

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**Aim:** to evaluate the shear bond strength (SBS) of two adhesive dual-cure resin cements to dentin and composite substrates.

**Methods:** two resin cements (EP, Estecem II Plus, Tokuyama and VAR, Variolink, Ivoclar Vivadent) with dual-cure (DC) or self-cure (SC) polymerization mode and their respective universal adhesives (UB, Universal Bond II and ADH, Adhese universal DC) were used for the study. Regarding the bonding substrates, human molars were cut in half longitudinally to expose dentin, while composite overlays (Estelite Posterior, Tokuyama, 4x4x3 mm) were created in two 2mm-incremental layers using a silicone mold. Dentin blocks (D) and composite overlays<sup>®</sup> were embedded in acrylic resin, leaving one of the surfaces available for bonding. The following adhesive/resin

cement combination were used for luting purposes (n = 20): 1) UB/DC EP; 2) UB/SC EP; 3) ADH/DC VAR; 4) ADH/SC VAR. Specimens were submitted to SBS test until detachment. Data were statistically analyzed (p <0.05).

**Results:** cement (ER >VAR), polymerization (DC >SC), substrate (D >C) and the interaction between factors significantly influenced the results. When DC, ER resulted in higher SBS compared to VAR (p <0.05), while no differences were observed between the two cements in SC mode (p = 0.81).

**Conclusions:** ER cement combined with the recent SC universal adhesive showed better bonding performance in DC cementation mode, compared to a conventional adhesive cement.

## EFFECT OF IMMEDIATE AND DELAYED DENTINAL SEALING ON CORONAL BOND STRENGTH: 5-YEAR OUTCOME

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**Aim:** to investigate the effects of immediate (IDS) and delayed (DDS) dentinal sealing on coronal dentin bond strength at baseline and after 5 years of storage in artificial saliva.

**Methods:** molar coronal dentin surfaces were selected and divided in groups (N = 10) according to the following adhesive procedures:

G1: 3-step etch-and-rinse (ER) adhesive.

G2: Universal adhesive with MDP in ER mode.

G3: Universal adhesive with MDP in self-etch (SE) mode.

G4: Universal adhesive without MDP in ER mode.

G5: Universal adhesive without MDP in SE mode.

After adhesive application resin composite buildups of 4 mm were made and specimens were sectioned to obtain 1-mm-thick sticks in accordance with the  $\mu$ TBS protocol. Sticks were stressed to failure at baseline and after 5 years. Each speci-

men was observed under a stereomicroscope to determine the failure mode: adhesive (A), cohesive (C) or mixed (M).

Data were statistically analyzed using analysis of variance (ANOVA) and Tukey post-hoc test. Chi square test was used for failure mode analysis. Statistical significance was set for  $p < .05$ .

**Results:** all the investigated factors (adhesive system, treatment, sealing and storage) significantly influenced  $\mu$ TBS, with the ER performing better than SE, IDS giving higher bond strength values than DDS and storage over time significantly affecting  $\mu$ TBS.

**Conclusions:** based on the obtained data, immediate dentinal sealing of the coronal surface achieved higher bond strength results both immediately and over time. Further studies are needed to confirm the obtained outcomes.

## ACCELERATED FATIGUE RESISTANCE OF 3D PRINTED VS MILLED OCCLUSAL VENEERS

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**Aim:** to evaluate the biomechanics of the cement layer and different restorative materials (3D printed and milled) through accelerated fatigue.

**Methods:** a human second mandibular molar was prepared with anatomical reduction for an occlusal veneer restoration. After digitalization, 8 identical models of the prepared tooth were 3D printed (SolFlex 170, V-Print Model 2.0, Voco). All the obtained casts were individually scanned (Cerec Primescan, Dentsply Sirona), and restorations were designed with identical occlusal surfaces and uniform 1mm-thickness. Four restorations were 3D printed (Irix Plus, DFAB, DWS), four were milled (Grandio Blocks, Voco) with a chairside milling unit (Cerec MC X, Dentsply Sirona).

Surface pretreatment was performed as follows, for both restorations and casts: sandblasting (30  $\mu$ m Cojet Sand, 3M), Silane (Porcelain Silane, BJM LAB), Universal adhesive (Universal Bond Quick, Kuraray Noritake). Then a dual curing self adhesive cement was used to cement all restorations with standardized

pressure (Panavia SA, Kuraray Noritake). Cement excesses were removed before 3 min light-curing (VALO 1400mW/cm<sup>2</sup>). Accelerated fatigue was performed with Instron Machine, MTS, as follows: 200N-5000 cycles, 400N-5000 cycles, 400N-5000 cycles, 600N-5000 cycles, 600N-5000 cycles, 800N-5000 cycles. Samples were tested up to fracture and n° of cycles were recorded, as well as fracture pattern.

**Results:** Kaplan-Meier survival estimates showed that the 3D printed material performed significantly better than the milled material. Fracture pattern showed that 3D printed samples were more prone to wear and failure due to complete consumption of the material. On the other hand, milled material had more catastrophic failures with complete fracture of both the restoration and the substrate.

**Conclusions:** tested 3D printed material showed promising performances both on fatigue resistance and failure patterns. Further studies are necessary to confirm the results obtained and evaluate their interfacial behavior.

## ANTERIOR TEETH SHAPE MODIFICATION AFTER ORTHO TREATMENT THROUGH 3D-PRINTING TECHNOLOGIES

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**Aim:** the aim of this case report is to demonstrate the use of a digital workflow in achieving an aesthetically pleasing outcome for a patient who underwent orthodontic treatment and has lateral incisor agenesis.

**Methods:** a 20-year-old male patient visited the Restorative Department of the Dental School Lingotto, University of Turin, after receiving a two-year-long orthodontic treatment to correct malocclusion, microdontia, and lateral incisor agenesis. Due to the altered Bolton Index, multiple diastemas were present, and the canines were positioned as lateral incisors. As a result, indirect hybrid ceramic adhesive restorations were planned after Digital Smile Design (DSD) evaluation. After minimal preparation of teeth 1.3, 1.1, 2.1, and 2.3 to remove enamel undercuts, an intraoral scan was performed using Trios 3. The CAD fabrication

of minimal veneer restorations was performed in cut-back mode, followed by importing the stl file to NAUTA software, which was used to set up the procedure for 3D printing. The restorations were printed using a hybrid ceramic (IrisMax, DWS) with a D-Fab 3D printer (DWS). The veneers were then luted, and enamel layers with characterization were completed directly.

**Results:** the all-digital workflow employed in this case proved to be effective in achieving morpho-functional restoration using minimal thicknesses. The artifact was optimally fitted and anatomically adapted.

**Conclusions:** the use of 3D printing technologies in indirect restorative care represents the future, and the digital workflow can assist multidisciplinary approaches in orthodontic patients with altered Bolton indices or requiring shape modifications.

## EFFECT OF OCCLUSAL CORRECTIONS ON LITHIUM DISILICATE WEAR RATE

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**Aim:** analyze the effect of different surface treatments on wear rate under cyclic fatigue in lithium disilicate glass-ceramic crowns. The null hypothesis tested is that there will be no difference between the different surface treatments on volume loss.

**Methods:** initial LiSi Block was selected for milling flat-surfaced identical single-crown restorations which were cemented onto the replicated acrylic preparations. Thirty samples were randomly assigned to 3 different groups: No Intervention (group 1), Fine grit Shaped Diamond Bur (group 2), and Fine Grit Shaped Diamond Bur + Polish (group 3). A chewing simulator (SD Mechatronik) was used for fatigue cycle mechanical

aging of the specimens under wet conditions. After every fatigue cycle, for a total of two cycles, the evolution of the volume loss was analyzed with a 3D laser profilometer (LAS-20). SEM analysis of worn scars were done. Data obtained were statistically analyzed with a one-way ANOVA test and Bonferroni post-hoc test.

**Results:** statistical analysis showed that group 2 and group 3 had a significantly higher wear rate than group 1 ( $p = 0.00001$ ).

**Conclusions:** the initial null hypothesis was rejected since any kind of occlusal correction increases the wear rate of lithium disilicate.

## ACCELERATED FATIGUE RESISTANCE OF ENDOCROWNS VS OVERLAYS IN NON VITAL MOLARS

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**Aim:** the aim of this *in vitro* study was to evaluate the effect of different adhesive restorative solutions with and without the support of intraradicular retention on the fatigue strength of endodontically treated molars. The null hypothesis is that the core restoration and the restorative material do not influence the accelerated fatigue strength.

**Methods:** intact molars extracted were selected and endodontically treated. A standardized MOD cavity was prepared. Specimens were then divided into 2 groups (n = 20 each):  
group A: core build-up with composite supported by 1 fiber post (FP1) and adhesive overlay;  
group B: pulpal chamber seal with flowable composite for endocrown (EDC).

After scanning with an intraoral scanner, restorations were milled using two different materials: hybrid ceramic (HC, n = 10) and lithium disilicate (LD, n = 10). After luting with an adhesive standardized procedure, accelerated fatigue was tested through a Universal Machine. After fracture, representative samples were analyzed with an optical microscope and SEM. Data were statistically evaluated with a Kaplan-Meier survival test (p <0.05)

**Results:** the worst fatigue resistance was obtained with HC endocrowns, while the other tested solutions performed similarly.

**Conclusions:** based on the obtained results, the null hypothesis was rejected since both the core restoration and the materials significantly influenced the survival rate of indirect adhesive solutions to restore non-vital molars.

## EVALUATION OF FLOWABLE VS COMPOSITE IN DEEP MARGIN ELEVATION: A RETROSPECTIVE STUDY

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**Aim:** to retrospectively evaluate the periodontal response when different composite materials were employed in deep cervical margin relocation (DMR) to restore class 2 cavities. The null hypothesis tested was that there are no differences between flowable and non-flowable materials.

**Methods:** 42 patients, with at least one deep interproximal caries in posterior teeth, were selected. Initial periodontal records (PPD, REC, PI, and BoP) were recorded. In all patients, after caries debridement, a gingivectomy without osteoplasty was performed to expose the cervical margin. Since the distance between the alveolar ridges and cervical margins was 2 mm, sutures were done and rubber dam was positioned again. After bonding procedures (enamel pre-etching for 15 sec; two-step self-etch application), patients were randomly divided in-

to 2 groups: according to the material employed for the relocation: Group 1 with a high-viscosity flowable composite, Group 2 with a nanofilled composite. Restorations were completed through a centripetal build-up technique. Two independent, blinded, and calibrated operators performed follow-up visits after mean 5 years of clinical function. Data were analyzed with a chi-square test and Kaplan-Meier (p <0.05).

**Results:** a statistically significant difference between the two groups was observed, with nanofilled composites performing better than a flowable composite, which showed higher BoP and PPD.

**Conclusions:** since 5 years after the DMR, flowable composite showed a worse periodontal response than nanofilled resin, thus the null hypothesis was rejected.

## COLOR MATCHING OF ONE-SHADE COMPOSITES: AN *IN VIVO* STUDY

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**Aim:** to compare optical integration of one-shade composites (Venus Pearl One, Kulzer; Omnichroma, Tokuyama; Clearfill U, Kuraray) when restoring NCCL. The null hypothesis is that there are chromatic differences one-shade and conventional composites.

**Methods:** patients who need direct composite restorations in NCCL were enrolled for this study. An initial Lab measurement (t0) with Easy Shade was performed. Once the cavity has been created after rubber dam placement, the adhesive procedures were carried out and the restorations were randomly performed with 4 different materials according to the composite selected: Venus Pearl One, Kulzer; Omnichroma, Tokuyama; Clearfill Majesty ES-2, Venus Pearl A3. Patients

were recalled after 14 days (t14), to calculate Lab of the restored tooth and a Delta t14-t0 was performed. Data obtained are statistically evaluated with One-way ANOVA and Bonferroni post-hoc test.

**Results:** 10 patients per group were treated. The obtained results showed that Venus Pearl had a significantly better chromatic integration than other materials tested ( $p = 0.0001$ ). Any materials showed a clinically satisfying chromatic integration.

**Conclusions:** based on the obtained results the initial null hypothesis was rejected since one-shade composites had different chromatic behavior when restoring NCCL cavities. An increased number of patients should be treated to confirm these results.

## 3-BODY WEAR OF 3D PRINTED VS MILLED COMPOSITES: AN *IN VITRO* STUDY

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**Aim:** to evaluate the 3-body wear behavior of 3D printed vs milled materials in an acidic medium. The tested null hypothesis will be that the different materials are not able to equally resist to abrasive wear independently of the acidic medium.

**Methods:** the analyzed materials are 2 CAD/CAM milled composite (Cerasmart, GC; Grandio Block, Voco), a PICN (Vita Enamic, Vita) and a 3D printed composite (Iris Max, DWS). Square-shaped specimens of 2 mm thickness are obtained by using a cutting machine (Micromet, Remet) under water cooling or printed using a 3D printing machine (D-Fab, DWS). Once the specimen surface is finished with abrasive papers at sequential grit, they are fixed on the rotative wheel of the ACTA machine with a resin-based support. The wear test are

performed with specimens continuously immersed in different mediums: pH 5.8 (distilled water), pH 3.3 (Redbull) and SEM analysis were performed.

After the wear test the volumetric loss are evaluated through a 3D laser scanner. The obtained data are statistically analyzed through a 2-way ANOVA test and Tukey post-hoc test.

**Results:** after 3 body-wear test IrisMax showed significantly lower volume loss than other materials ( $p = 0.00001$ ), while acidic medium induced an increased wear ( $p = 0.0007$ ).

**Conclusions:** since 3D printed material had a lower wear rate than CAD/CAM ones independently of the acid medium, the initial null hypothesis was rejected.

## CEMENT GAP WITH 3D PRINTED VS MILLED OCCLUSAL VENEERS: A MICROCT STUDY

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**Aim:** to evaluate the cement layer thicknesses in different manufacturing techniques through the use of the microCT.

**Methods:** a second mandibular molar was prepared with anatomical reduction for an occlusal veneer restoration. After digitalization, 16 identical models of the prepared tooth were 3D printed (SolFlex 170, V-Print Model 2.0, Voco). All the casts were scanned (Cerec Primescan, Dentsply Sirona) and restorations were designed with identical occlusal surfaces and uniform 1mm-thickness. Half of the restorations (n = 8) were 3D printed (Irix Plus; DFAB, DWS) and half were milled (Grandio Blocks, Voco) with a chairside milling unit (Cerec MC X, Dentsply Sirona). Surface pretreatment was performed as follows, for both restorations and casts: sandblasting (30 µm Cojet Sand, 3M), silane (Porcelain Silane, BJM LAB), Universal adhesive (Universal Bond Quick, Kuraray Noritake). After that, a dual curing self

adhesive cement was used to cement all restorations, with standardized pressure (Panavia SA, Kuraray Noritake) and 3 min light-curing (VALO, 1400mW/cm<sup>2</sup>). Micro-CT scans were taken to obtain high-quality 3D images (15 µm resolution), that were linearly analyzed to collect data of internal (24 points per sample) and marginal (16 points per sample) adaptation.

**Results:** no significant differences were found for marginal adaptation (p = 0.154), with an average of 0.11±0.067 in the 3D-printed group and 0.098±0.063 in the milled group. However, a significant difference was reported for internal adaptation (p <0.01), with the 3D-printed group performing better.

**Conclusions:** the study showed that different manufacturing techniques have a significant influence on cement layer thickness in internal adaptation of different restorative materials.

## RANDOMIZED CLINICAL TRIAL ON CAD-CAM CHAIRSIDE ADHESIVE CROWNS: 3 YEARS REPORT

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**Aim:** to evaluate the clinical performance of full-crown adhesive indirect restorations made with different materials obtained with a CAD/CAM chairside system.

**Methods:** following inclusion and exclusion criteria, patients who needed an indirect adhesive restoration were recruited and treated following a standardized procedure. After cavity debriement, a coronal build-up with a bulk material was performed after adhesive system application. The adhesive full-crown preparations were performed, considering a uniform thickness of 1.5 mm, except of the margins and an intraoral scan was performed. Patients were randomly divided in 3 groups, according to the CAD/CAM material employed: Grandio Blocks (G1); Cera-smart (G2); E-Max CAD (G3). Indirect crowns were milled using CEREC MCXL. Standardized luting procedures were performed

following the study protocol. Patients were recalled after 12, 24 and 36 months and restorations were evaluated following USPHS criteria. 101 patients with 109 restorations totally (G1 = 38; G2 = 38; G3 = 33), with a mean follow-up of 37,6 months were evaluated after 3-years. Kaplan-Meier curves were plotted to show each variable differences on the restoration survival.

**Results:** USHPS scores showed a satisfying clinical behavior of all performed full-crown adhesive restorations, independently of the material employed. The Kaplan-Meier plot showed a comparable clinical performance between the 3 tested materials.

**Conclusions:** the present study results showed a good clinical behavior of CAD/CAM resin-based materials when employed as full crowns.

## RADICULAR BOND STRENGTH PRESERVATION WITH UNIVERSAL CEMENTS: 5 YEARS OUTCOME

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**Aim:** the aim of this *in vitro* study was to evaluate the stability of radicular bond strength with simplified adhesive approaches. The null hypothesis is that bond strength is not affected by adhesive technique, root portion and aging.

**Methods:** similar single-rooted teeth were selected and endodontically treated after anatomical crown removal. Fiber posts were then luted through different adhesive techniques (n = 20 each): universal adhesive (UA) in etch-and-rinse mode (Group 1), UA in self-etch mode (Group 2), self-adhesive cement (Group 3). After light-curing, specimens were sectioned in 1 mm thick slices, and the bond strength was measured through push-out test immediately (n = 10 per group) and after 5 years

of storage in artificial saliva (n = 10 per group). Data were statistically analyzed with Three-way ANOVA test and Tukey post-hoc (p < 0.05).

**Results:** ANOVA test showed a significant difference between aged and non-aged specimens (p = 0.0009), independently of the adhesive technique employed. Nor the adhesive approach or the root portion statistically influenced the radicular bond strength.

**Conclusions:** the null hypothesis was partially rejected since the aging process significantly reduce the radicular bond strength. Simplified adhesive techniques similarly perform in term of fiber post bond strength.

## SPECTROPHOTOMETRIC EVALUATION OF RESIN INFILTRATION IN WSLs: 3 YEARS FOLLOW UP

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**Aim:** white spots are defined as areas of demineralized enamel that are white, opaque and clearly distinguishable from the surrounding healthy enamel. Treatment for WSLs is important for both aesthetic and clinical reasons. For their resolution, several authors have proposed the application of remineralizing agents. The aim of this clinical study is to evaluate the stability of the color change of the lesion after 3 years of using the resin infiltration technique.

**Methods:** forty unrestored, idiopathic, or post-orthodontic, cavitating-free WSLs were treated with the resin infiltration technique. The color of the WSLs and adjacent healthy enamel (SAE) was evaluated using a spectrophotometer before and after the treatment (T0, T1), after 12 months (T2) and 36

months (T3). The Wilcoxon test was used to evaluate the significance of the variation of color  $\Delta E$  between time intervals.

**Results:** comparing the color difference, the  $\Delta E$  value decreased significantly from T0 to T1 in 95% of the treated lesions. 100% of the samples showed no variation of  $\Delta E$  between T1 to T2 and between T2 to T3. The correlation between the period of onset of the lesion and  $\Delta E$  between T0 and T1 was not statistically significant.

**Conclusions:** evaluating the results obtained, the resin infiltration technique has been shown to be effective in resolving WSLs. However, more research is needed to evaluate the long-term stability of the results and the effects of the chemical composition of the resin used.

## EFFECT OF LIGHT-CURING PROTOCOL ON MARGINAL CONTINUITY OF ADHESIVE CROWNS

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**Aim:** to investigate the marginal continuity of dual-curing cements when submitted to different curing protocols. The null hypothesis tested were that marginal continuity was not influenced by tooth surface pre-treatment and different curing protocols.

**Methods:** single-rooted teeth (n = 96) were prepared for a full-crown with chamfer margin, which were milled with lithium silicate. Crowns were luted using an universal dual-curing cement with different approaches (n = 48 each): self-adhesive mode(G1); adhesive mode(G2).

Samples were then divided in 4 subgroups (n = 12 each) according to the light-curing protocol employed: 20s per side (S1); self-cure of the cement (S2); tack-cure plus 20s per side after excess removal (S3); 60s per side (S4).

Specimens were scanned using a Micro-CT before and after 10.000 cycles of thermocycling to reveal interfacial gap pro-

gression. Data were statistically analyzed with three-way ANOVA and Tukey tests ( $p < 0.05$ ).

**Results:** three-way ANOVA test showed that the core sandblasting ( $p = 0.0036$ ) and the curing technique significantly influence external gap ( $p = 0.00001$ ).

Tukey test revealed that the self-curing process was significantly better than all the other tested techniques, while the tack-curing showed worse external and internal gaps and worse absolute discrepancy than 20s and 60s light-curing processes.

**Conclusions:** tack-curing technique seems to negatively affect the marginal discrepancies when luting lithium silicate adhesive crowns, while the self-curing process showed the lowest gaps.

Therefore, the first null hypothesis was rejected.

## INFLUENCE OF DIFFERENT SHADES AND THICKNESS ON DEGREE OF CONVERSION OF BULK-FILL COMPOSITE

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**Aim:** the study aims to evaluate the influence of thickness and shades on polymerization by evaluating the degree of conversion (DC) of Bulk-fill resin composites.

**Methods:** in this *in vitro* study, four shades (Universal, A1, A2, A3) of a bulk-fill flowable composite (SDR® flow+, Dentsply) were tested. 36 specimens were prepared bulk-filling mold with different thicknesses (2 mm, 4 mm, 8 mm) and light-cured according to the manufacturer protocol. The DC was measured after 24 hours with Fourier Transform Infrared Spectroscopy with attenuated total reflectance (ATR-FTIR) at the top and bottom of disk-shaped samples. Statistical analysis was performed.

**Results:** DC measured at the top of samples ranged between 74.95% (U) and 68.34% (A2), while bottom DC ranged between

62.04% (A2, 2 mm) and 44.92% (U, 8 mm). Differences were observed among shade and depth groups ( $p < 0.05$ ). The means bottom to top ratio ranged between  $82,51 \pm 3,1$  and  $66,31 \pm 3,6$ .

**Conclusions:** the results showed that both variables influenced polymerization, with depth having a greater impact. The color and translucency characteristics of the analyzed composite material were also influenced by thickness, so, as chroma increases, there may be a reduction in the ability of light to pass through the material. Knowledge of polymerization and material characteristics is important for achieving better restorations with BFRs. *In vitro* studies evaluating primarily shrinkage stress polymerization and clinical trials are necessary.