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Wear of conventional and pre-polymerized composite materials under erosive/abrasive conditions

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Keywords: Erosion, abrasion, wear, composites

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Abstract:

The aim of this study was to examine the wear of three different composite materials usable for vertical bite reconstruction under erosive/abrasive conditions and to compare them with the bovine dental hard tissues enamel and dentin in-vitro. The composite materials Filtek Supreme XTE, CeraSmart and Brilliant Crios and bovine enamel and dentin specimens were evenly allocated to five groups (n=10). Samples were firstly exposed to hydrochloric acid for 1 min, then stored for 30 min in artificial saliva. In the second step, the samples were brushed for 1 min with 100 brushing strokes each and an applied force of 2.5 N in an automated brushing device. After 60 of these erosive/abrasive cycles, wear of the samples was determined by contact profilometry. Filtek Supreme XTE showed significantly less wear (mean \pm standard deviation; $0.15 \pm 0.11 \mu\text{m}$) compared to the other two composite materials ($p < 0.05$). No significant difference ($p > 0.05$) could be found between CeraSmart ($0.25 \pm 0.03 \mu\text{m}$) and Brilliant Crios ($0.24 \pm 0.04 \mu\text{m}$). The two bovine dental hard tissues, enamel ($13.70 \pm 0.94 \mu\text{m}$) and dentin ($50.08 \pm 4.46 \mu\text{m}$), each showed a significantly higher amount of wear than the three restorative materials ($p < 0.05$). In conclusion, this study exhibited that the three composite materials, Filtek Supreme XTE, CeraSmart and Brilliant Crios, were more resistant under erosive/abrasive conditions compared to bovine enamel and bovine dentin, respectively.

Introduction:

Tooth wear describes the removal of dental hard tissue due to various factors such as abrasion, attrition and erosion. In this communication we use the term "erosive tooth wear" to emphasize that erosion, in principle, can be responsible for the wear, but does not have to be the only cause. It is assumed that erosions can be found in 30-50% of deciduous teeth and 20-45% in permanent teeth (SCHLUETER & LUKA 2018). On the other hand, the prevalence of caries has declined sharply from 1970 to 1996 in Swiss military recruits (MENGHINI ET AL. 2001). Even today, a German study by Schmoeckel et al. (SCHMOECKEL ET AL. 2021) shows that the prevalence of caries has tended to decrease over the last 10 years. This could be a possible explanation why erosive tooth wear is receiving increasing attention in dentistry.

The direct action of acids on clean tooth substances leads to erosive tooth wear. The attack of the acid and/or an acidic chelating agent leads to the demineralization of the hydroxylapatite crystals on the tooth surface respectively to the dissolution of calcium and phosphate ions (HELLWIG ET AL. 2018).

A distinction is made between exogenous, endogenous and idiopathic causes of erosion. Extrinsic acids are considered to be a strong risk factor for erosive tooth wear. These are mainly acidic drinks and foods that come into contact with the teeth (LUSSI & JAEGGI 2008). There is a significant correlation between the prevalence of erosive tooth wear and the consumption of soft drinks, alcoholic beverages, fresh fruits and vitamin C tablets (AL-DLAIGAN ET AL. 2001). But a low pH-value of the product is not the only decisive factor for erosive tooth wear. If the solution has a low pH-value, but is oversaturated with calcium and phosphate ions compared to the dental hard tissue, no or only slight dissolution will occur (BARBOUR & LUSSI 2014). Gastric juice composed mainly of hydrochloric acid is a further important risk factor for the occurrence of erosive tooth wear in people with an eating disorder or gastroesophageal reflux disease (SCHEUTZEL 1996). A study by Jordão et. al. (JORDÃO ET AL. 2020) showed that gastroesophageal reflux disease leads to significantly more erosive tooth

wear and a multidisciplinary medical and dental approach is recommended to develop a meaningful solution to the problem. If there is no obvious cause for erosive tooth wear, an idiopathic cause might be assumed. It has to be noted that in the course of life it is completely normal for some dental hard tissue to be lost. However, this physiological loss does not necessarily require restorative therapy (ATTIN ET AL. 2021). As the loss of dental hard tissue progresses through to the dentin, it causes the patient's OHRQoL (Oral-health-related-quality-of-life) to steadily decrease. From the aesthetic appearance to a restricted chewing function to the painful hypersensitivity of the teeth are all factors that can cause a patient's suffering (AL-OMIRI ET AL. 2006; ATTIN ET AL. 2021). But before starting any therapy, it is important to investigate the causes for a severe loss of dental hard substances. The long-term success of the treatment depends heavily on whether the oral situation can be stabilized with targeted preventive measures.

The vertical bite elevation with composite is a method to treat heavily worn teeth in a way that is preserving the remaining substance and less expensive than conventional therapy with indirect restorations (TAUBÖCK ET AL. 2021). Due to the constantly improving material properties of composites, their indications are also increasing steadily (LYNCH ET AL. 2014). Generally, direct and indirect adhesive composite restorative materials might be used for this purpose. Dentists are more likely to resort to indirect restoration methods the larger the defects are (KANZOW ET AL. 2019). A conceivable indirect method is possible thanks to the improvement of modern techniques in Computer Aided Design and Computer Aided Manufacturing (CAD / CAM). The aim is to record the current intraoral situation with the help of an intraoral scan. On the basis of this, the workpieces can be digitally modeled and then ground out of different materials such as ceramics or pre-polymerized composites (BOSCH ET AL. 2015; REICH ET AL. 2016). With the indirect approach, however, it is rather difficult to enable a purely defect-oriented restoration compared to direct restorations. This means that in the case of indirect restorations it is more likely to be necessary to remove

some additional healthy dental hard tissue by preparation (ATTIN ET AL. 2021).

Another important aspect, for the selection of a suitable restoration, is the influence of the degree of polymerization of a composite material. This depends largely on the distance of the light source used, on the intensity and the wavelength of the light source (RUEGGEBERG & JORDAN 1993; TAUBÖCK ET AL. 2011). But properties of the composite itself, such as the layer thickness used, the color, the composition and the translucency, also play an important role (MURCHISON & MOORE 1992; LUI 1994; MARTIN 1998; TAUBÖCK ET AL. 2011). If a layer thickness of more than 2 mm is used with conventional composite, incomplete polymerization can occur (WATTS & CASH 1994; PRATI ET AL. 1999; TAUBÖCK ET AL. 2011). This incomplete polymerization has the consequence that the mechanical properties of a restoration decrease (LOVELL ET AL. 2001; TAUBÖCK ET AL. 2011) and, under certain circumstances, residual monomers are released, which can have a negative effect on the pulp (HEBLING ET AL. 1999; TAUBÖCK ET AL. 2011). Based on these facts, it can be assumed that the industrial pre-polymerized composite blocks have some advantages over conventional composites.

To our best knowledge, there are no studies comparing the performance of pre-polymerized composite materials with conventional composite materials under erosive/abrasive conditions. Therefore, the aim of the present study was to investigate pre-polymerized and conventionally unpolymerized composite materials concerning their wear under erosive/abrasive conditions. Moreover, the composite materials are used to replace the two dental hard tissues, enamel and dentin. In the reconstructed dentition, they oppose the same influences, which is why a comparison of their resistance to erosive / abrasive conditions is important.

The null hypothesis was that the tested composite materials did not show any significant different wear compared to bovine enamel and bovine dentin under in-vitro erosive/abrasive conditions.

Materials and Methods:

Used composites:

Three different composite materials were tested in this study. Filtek Supreme XTE Universal Composite (3M AG, Rüslikon, Switzerland) was used as a representation of direct composite materials. As pre-polymerized CAD/CAM- composites the products CeraSmart (GC Corporation, Tokyo, Japan), a composite with a hybrid nano ceramic matrix and Brilliant Crios (Coltène/Whaledent AG, Altstätten, Switzerland) which consists of a matrix of micro-fillers were used. The latter two materials are pre-polymerized blocks to be used with the Cerec System (Dentsply Sirona, New Carolina, USA).

Sample preparations:

Five different sample groups with ten samples each were prepared. Bovine teeth were used for the enamel (crowns) and dentin (roots) specimens. A cylindrical sample with a diameter of 3 mm was drilled out with a diamond coated trepan drill. The resulting samples were then embedded in acrylic resin (Paladur[®], Heraeus Kulzer, Hanau, Germany) using a silicone mold and a pressure pot (13 min, 45°C, 3 bar). Samples were then polished, using a grinding machine (GEKO SiC Foil, Struers A/S, Ballerup, Denmark) with three different sandpapers (1000 grit for 10 s , 2000 grit for 20 s, and 4000 grit for 40 s) at a speed of 150 rpm was used. The heights of the samples were checked using a caliper (Hoffmann GmbH, Munich, Germany) and should be 3 mm. In order to have reference points for the profilometric measurement, the samples were each marked with two notches on the embedding material at a distance of 3.8 mm (In-house production of the Center for Dental Medicine, University of Zurich, Zurich, Switzerland). The three different composite specimens were made in a similar manner. CeraSmart and Brilliant Crios samples were milled directly from their respective blocks. The Filtek Supreme XTE was firstly applied into a round plastic molds with a diameter of 3 mm. To ensure good polymerization two increments of about 1.5 mm were used. The height of the

respective increments was checked with a periodontal probe. The two Increments were then each polymerized for 30 seconds using a halogen polymerization lamp with light at a wavelength of 450-490 nm (bluephase® (G2), Ivoclar Vivadent, Schaan, Principality of Liechtenstein). According to the manufacturer, the polymerization lamp performs 1200 mW/cm². The polymerization lamp was checked for consistency before and after curing with a radiometer (Optilux Radiometer, SDS Kerr; Orange, CA, USA). The further procedure corresponds to that of the bovine enamel and bovine dentin samples. Two samples of the respective material were always clamped together in a sample container. The reference notches were covered with adhesive tape to protect them.

The samples were stored in tap water between the cycles and overnight. A study by Attin et al. (ATTIN ET AL. 2009) was able to show that storage in tap water has no significant influence on the measurement.

Toothpaste slurry:

The slurry was freshly made every morning and consists of 200 g Colgate Total Original toothpaste (Colgate Palmolive GABA, Therwil, Switzerland) mixed with 400 g artificial saliva. The artificial saliva was prepared following the formulation given by Klimek et al. (1982). To ensure a homogenized slurry, it was stirred with a magnetic stirrer throughout the day.

Erosive/abrasive procedure:

After the baseline profiles of each sample were recorded, the samples were eroded for 1 min with about 10 ml/per sample hydrochloric acid (pH = 2.3) without additional movement. The samples were then rinsed with water for 10 s and later stored in artificial saliva for 30 min. Afterwards they were rinsed again with water for 10 s and clamped in a brushing machine (In-house production of the Center for Dental Medicine, University of Zurich, Zurich, Switzerland). The samples were each covered with the toothpaste slurry and abraded with a force of 2.5 N for

one minute with a total of 100 brushing strokes. The contact pressure was checked in the morning before the first test run using a Newton meter (Pesola AG, Schindellegi, Switzerland). The toothbrushes used for the experiments were Paro M43 (Esro AG, Thalwil, Switzerland). This cycle was repeated twelve times a day for five days, which means a total of 60 times per sample. Therefore, each sample received a total of 60 minutes of acid attack and 6000 brushing strokes. In figure 1, a flowchart of the whole experimental procedure is presented.

Determination of erosive/abrasive wear:

During the experiments the reference notches were covered with adhesive tape. This ensured that the wear only took place between the reference notches. In order to measure and compare the profilometrically determined baseline and end profiles (MarSurf GD25, Mahr GmbH, Göttingen, Germany), the adhesive tapes were removed before measurements. The results provides values for the erosive/abrasive wear in μm for each sample. Hartz et al. (HARTZ ET AL. 2021) described the surface profilometry in detail.

Statistical analysis:

Each individual sample was measured on five parallel tracks (profiles). The different tracks were each 250 μm apart, so that a total of 1 mm is covered in the central area of the sample. The wear recorded for these five profiles per sample was averaged. This resulted in a single result per sample or a total of ten per group. The logarithmized data roughly followed a normal distribution, which is why they were considered good for an ANOVA (one-way analysis of variances). After the ANOVA, post-hoc comparisons with Tukey-test was carried out in pairs with the p-values adjusted for multiple testing according to Tukey. The p-value was set at 0.05. This testing showed significant differences between the groups ($p < 0.05$).

Results:

The resulting wear in the different groups after a total of 60 erosion and abrasion cycles is presented in figure 2.

Compared to the composite materials, the two bovine dental hard tissues have experienced significantly higher wear ($p < 0.05$) (mean \pm standard deviation; bovine enamel: $13.70 \pm 0.94 \mu\text{m}$; bovine dentin: $50.08 \pm 4.46 \mu\text{m}$). Furthermore, bovine enamel is significantly more resistant to erosion and abrasion than bovine dentin ($p < 0.05$). The wear of the two restoration materials CeraSmart ($0.25 \pm 0.03 \mu\text{m}$) and Brilliant Crios ($0.24 \pm 0.04 \mu\text{m}$) did not differ significantly from each other ($p > 0.05$), whereas Filtek Supreme XTE ($0.15 \pm 0.11 \mu\text{m}$) showed significantly less wear ($p < 0.05$).

Discussion:

The null hypothesis had to be rejected because the wear of the restorative materials differed significantly from the bovine enamel and bovine dentin.

In this study, the resistance of various composite materials under erosive and abrasive conditions was investigated in-vitro. It is therefore clear that the results cannot completely reflect the exact intraoral situation. Compared to human teeth, bovine teeth have a larger surface and no carious lesions. These two facts increase the comparability of the samples used (MELLBERG 1992; WIEGAND & ATTIN 2011; YASSEN ET AL. 2011). However, bovine enamel has a smaller content of calcium and phosphate than human enamel. Since this is related to faster demineralization, it can be assumed that the substance removal in experiments with bovine teeth is higher than would be the case with human teeth (ESSER ET AL. 1998; ATTIN ET AL. 2007; LAURANCE-YOUNG ET AL. 2011).

In-vivo the saliva is able to form an acquired pellicle on dental hard tissues and on restorative materials. This membrane consists of deposited organic biopolymers and the artificially saliva used in the study lacks these organic molecules, so that no pellicle formation occurs. However, it is discussed that the pellicle plays a decisive role in the surface protection against acidic attacks (MECKEL 1968; HANNIG ET AL. 2007).

Monoprotic hydrochloric acid with a pH of 2.3 was used for the experiments to simulate gastric acid attacks. Gastric juice contains hydrochloric acid with a pH value between 1-2. It also contains numerous enzymes which could also contribute to erosion (SCHLUETER ET AL. 2012). To simulate intrinsic acid attacks, hydrochloric acid is therefore a good choice. In addition, hydrochloric acid has already been used in various other erosion studies (WILLUMSEN ET AL. 2004; WIEGAND ET AL. 2007; HOVE ET AL. 2007). A review by Wiegand & Attin (WIEGAND & ATTIN 2011) examined suitable parameters for erosion/abrasion tests. An erosion time that does not exceed 2 min per cycle is recommended. The acid attacks carried out in the present study do not contradict this recommendation. It

should be noted that twelve acid attacks per day were applied to test the resistance of the restorative materials under harsh conditions.

For the abrasion tests, however, Wiegand & Attin (WIEGAND & ATTIN 2011) only recommend two abrasion cycles per day. This corresponds to tooth brushing twice a day. Within 5 s 10-15 brush strokes should be induced (WIEGAND & ATTIN 2011). In this experiment, the samples were exposed to 100 brushing strokes within one minute per cycle. With a total of twelve cycles per day the induced abrasion exceeds the recommendations by far and thus rather represent "extreme conditions". If one assumes that 15 brushing strokes per area twice a day correspond to the situation in vivo, then the number of brush strokes used corresponds to an in vivo situation over 200 days.

In-vivo there are numerous factors, other than toothbrushing, that contribute to the development of abrasion. These missing factors could be compensated somewhat by more brushing strokes. Excessive dental care with toothbrushes is often cited as a main reason for the occurrence of abrasions. But tooth-to-tooth contacts also lead to loss of substance in-vivo in the form of attritions. This often affects people who suffer from bruxism and therefore often grind their teeth (XHONGA 1977). Abrasive (mechanical) tooth wear is therefore multifactorial and occurs as well combined with erosive (chemical) tooth wear (VERRETT 2001). It has to be noted that under erosive conditions, the restorations itself can be responsible for the removal of enamel on the antagonist (WIEGAND ET AL. 2017).

The most durable material of the present study, Filtek Supreme, is a nanoparticle composite. This means that the diameter of the inorganic filler particles is 1-100 nanometers and a filler content varies from 71.9% to 84.1% (BEUN ET AL. 2007). Brilliant Crios, on the other hand, is a so-called microfiller composite. The particle size is less than a micrometer and a filler content of 51.3 to 54.9% can be achieved for microfilled composites (BEUN ET AL. 2007). CeraSmart is a combination of ceramic and composite and tries to combine the best properties of both material groups. Such combinations are also called hybrid-materials and the filler

values vary from 71% to 79.7% (BEUN ET AL. 2007). The wear resistance of composites depends, among other variables, on the amount of filler, the particle size and shape and the degree of polymerization. The mechanical properties improve with an increasing content of inorganic filler, while the polymerization shrinkage decreases (BEUN ET AL. 2007; YIN ET AL. 2019; RODRÍGUEZ ET AL. 2019). A study by Beun et al. (BEUN ET AL. 2007) could show, that the mechanical properties of microfilled composites are by far the lowest. On the other hand, nanofilled and universal hybrid composite show more or less comparable mechanical properties, with slightly advantages for the nanofilled composites (BEUN ET AL. 2007).

Pre-polymerized composite blocks seem to have a higher conversion rate than conventional heat-cured PMMA (Polymethylmethacrylate) and thus release significantly fewer monomers than conventional polymerized composite materials (AL-DWAIRI ET AL. 2020; MOUROUZIS ET AL. 2020). However, it has to be taken in consideration, that the material properties of composite will not surpass those of glass ceramics and ceramics. It is therefore important to explore the long-term advantages and disadvantages of each material in clinical trials before deciding whether to use it on an individual patient (RUSE & SADOUN 2014; LUCSANSZKY & RUSE 2020).

By using conventional composite or pre-polymerized CAD/CAM composite blocks, the practitioner has less invasive treatment methods available. Since not every composite material is suitable, the different materials must first be subjected to various tests and long-term clinical trials. Moreover, it is important to check the materials for their durability under erosive/abrasive conditions. This has a decisive influence on the long-term success rate of bite elevation with composites. Previous studies showed promising results for direct composite restorations in patients with severe tooth wear up to a follow up after 11 years (SCHMIDLIN ET AL. 2009; ATTIN ET AL. 2012; LOOMANS ET AL. 2018; TAUBÖCK ET AL. 2021).

In the future, more long-term studies on vertical bite reconstruction with composites will be needed, so that patients can be offered a less invasive alternative to conventional therapies as mentioned above.

Conclusion:

Within the limitations of the present study, it can be concluded that the three restoration materials Filtek Supreme XTE, CeraSmart and Brilliant Crios are less susceptible under erosive/abrasive conditions than the two bovine dental hard tissues enamel and dentin.

Extended abstracts:

Deutsch:

Zusammenfassung: Im Rahmen der vorliegenden Studie konnte festgestellt werden, dass die drei Restaurationsmaterialien Filtek Supreme XTE, CeraSmart und Brilliant Crios unter erosiven/abrasiven Bedingungen weniger Abnutzung zu verzeichnen hatten als die beiden bovinen Zahnhartsubstanzen Schmelz und Dentin. Insbesondere das Filtek Supreme XTE ist gegenüber Erosionen und Abrasionen sehr beständig.

Einleitung: Ziel dieser Studie war es, den Verschleiss von drei möglichen Kompositmaterialien für eine vertikale Bissrekonstruktion unter erosiven/abrasiven Bedingungen zu untersuchen und in-vitro mit den bovinen Zahnhartsubstanzen Schmelz und Dentin zu vergleichen. Die vertikale Bisserrhöhung mit Komposit ist eine Methode, um stark abgenutzte Zähne substanzerhaltend und kostengünstiger zu behandeln als die konventionelle Therapie mit indirekten Restaurationen.

Material und Methoden: Aus den Materialien Filtek Supreme XTE, CeraSmart und Brilliant Crios sowie den bovinen Zahnhartsubstanzen Schmelz und Dentin wurden je 10 Proben hergestellt ($n = 10$). Sie wurden 1 min lang mit ca. 10 ml Salzsäure ($\text{pH} = 2,3$) je Probe ohne zusätzliche Bewegung erodiert und anschliessend 10 s mit Wasser gespült. Im Anschluss erfolgte eine Lagerung für 30 min in künstlichem Speichel. Die Abrasion erfolgte mit einer Bürstmaschine. Die Proben wurden dabei jeweils mit einem Zahnpasta-Slurry bedeckt und mit einer Kraft von 2,5 N eine Minute lang mit insgesamt 100 Bürstenstrichen gebürstet. Dieser Zyklus aus Erosion und Abrasion wurde fünf Tage lang zwölf Mal am Tag wiederholt. Somit durchlief jede Probe insgesamt 60 Minuten Säureangriff und 6000 Bürststriche. Die Bestimmung des Abtrages erfolgte mittels Profilometrie.

Resultate: Im Vergleich zu den Kompositmaterialien zeigten die beiden bovinen Zahnhartsubstanzen einen signifikant höheren Abtrag ($p < 0,05$) (Mittelwert \pm Standardabweichung; Schmelz: $13,70 \pm 0,94 \mu\text{m}$; Dentin: $50,08 \pm 4,46 \mu\text{m}$). Ausserdem ist boviner Schmelz deutlich

widerstandsfähiger gegen Erosion und Abrasion als bovines Dentin ($p < 0.05$). Der Abtrag der beiden Restaurationsmaterialien CeraSmart ($0.25 \pm 0.03 \mu\text{m}$) und Brilliant Crios ($0.24 \pm 0.04 \mu\text{m}$) unterschied sich nicht signifikant voneinander ($p > 0.05$), während Filtek Supreme XTE ($0.15 \pm 0.11 \mu\text{m}$) einen deutlich geringeren Abtrag ($p < 0.05$) zeigte.

Diskussion: In dieser Studie wurde die Beständigkeit verschiedener Restaurationsmaterialien unter erosiven und abrasiven Bedingungen in-vitro untersucht. Es ist daher klar, dass die Ergebnisse die genaue intraorale Situation nicht vollständig wiedergeben können. Das Vorliegen des Pellikels in-vivo könnte dabei eine entscheidende Rolle spielen. Die Menge an Säureattacken und Bürststrichen in dieser Studie sind als Extrembedingungen anzusehen und können keinesfalls in-vivo übertragen werden.

Es wird vermutet, dass vorpolymerisierte Kompositblöcke welche für das CAD/CAM-System verwendet werden können, Vorteile gegenüber den konventionell mit der Polymerisationslampe ausgehärteten Kompositen bieten.

Zukünftig werden mehr Langzeitstudien zur vertikalen Bissrekonstruktion mit Kompositen benötigt, um Patienten eine weniger invasive Alternative zu konventionellen Therapien anbieten zu können. Insbesondere die Beständigkeit unter erosiven/abrasiven Bedingungen spielt für den Langzeiterfolg eine entscheidende Rolle.

French

Résumé

Dans la présente étude, il a été constaté que les trois matériaux de restauration Filtek Supreme XTE, CeraSmart et Brilliant Crios ont subi moins d'usure dans des conditions érosives/abrasives que les deux substances dures émail et dentine de la dent bovine. En particulier, Filtek Supreme XTE est très résistant à l'érosion et à l'abrasion.

Introduction : L'objectif de cette étude était d'investiguer in vitro dans des conditions érosives/abrasives l'usure de 3 matériaux composites utilisables pour la reconstruction verticale

de l'occlusion, et de la comparer dans les mêmes conditions avec l'usure des substances dures émail et dentine de la dent bovine. L'élévation verticale de l'occlusion avec du composite est une méthode de traitement des dents fortement usées qui préserve la substance dentaire et dont l'économicité est plus favorable que le traitement conventionnel par des restaurations indirectes.

Matériel et méthodes : Dix échantillons ($n = 10$) ont été préparés à partir de chacun des matériaux Filtek Supreme XTE, CeraSmart et Brilliant Crios ainsi que des substances dures émail et dentine de la dent bovine. Ils ont été érodés pendant 1 min avec environ 10 ml d'acide chlorhydrique ($\text{pH} = 2,3$) par échantillon, sans agitation concomitante, puis rincés à l'eau pendant 10 secondes. Ensuite, ils ont été placés dans de la salive artificielle pendant 30 minutes. L'abrasion a été réalisée avec une machine à broser. Les échantillons ont été recouverts d'une pâte dentifrice et brossés avec une force de 2,5 N pendant une minute, avec un total de 100 passages de brosse. Ce cycle d'érosion et d'abrasion a été répété 12 fois par jour pendant 5 jours. Ainsi, chaque échantillon a subi au total 60 minutes d'attaque acide et 6000 coups de brosse. La détermination quantitative de l'abrasion a été effectuée par profilométrie.

Résultats : Par rapport aux matériaux composites, les 2 matériaux dentaires durs bovins ont montré une abrasion significativement plus importante ($p < 0,05$) (moyenne \pm écart-type ; émail : $13,70 \pm 0,94 \mu\text{m}$; dentine : $50,08 \pm 4,46 \mu\text{m}$). En outre, l'émail bovin est significativement plus résistant à l'érosion et à l'abrasion que la dentine bovine ($p < 0,05$). L'érosion des deux matériaux de restauration CeraSmart ($0,25 \pm 0,03 \mu\text{m}$) et Brilliant Crios ($0,24 \pm 0,04 \mu\text{m}$) ne différait pas significativement l'un de l'autre ($p > 0,05$), alors que Filtek Supreme XTE ($0,15 \pm 0,11 \mu\text{m}$) a présenté une érosion significativement plus faible ($p < 0,05$).

Discussion : Dans cette étude, la résistance de différents matériaux de restauration a été étudiée *in vitro* dans des conditions érosives et abrasives. Il est donc clair que les résultats obtenus ne peuvent pas refléter entièrement la situation *intraorale* exacte. La présence *in vivo* de la pellicule salivaire pourrait jouer à cet égard un rôle déterminant. Dans cette étude, la quantité des attaques

acides et le nombre de coups de brosse correspondent à des conditions extrêmes, qui ne peuvent en aucun cas être transposées *in vivo*.

On suppose que les blocs de composite prépolymérisés qui peuvent être utilisés dans les systèmes CAD/CAM offrent des avantages par rapport aux composites durcis à la lampe de polymérisation traditionnelle.

À l'avenir, des études à long terme supplémentaires sur la reconstruction verticale de l'occlusion avec des composites sont nécessaires pour pouvoir proposer aux patients une alternative moins invasive aux thérapies conventionnelles. En particulier, la résistance aux conditions érosives/abrasives joue un rôle déterminant pour le succès à long terme.

Acknowledgment:

The current study is part of and in parts identical with the master thesis “Untersuchung der Beständigkeit von Kompositen zur Bisshebung unter erosiven/abrasiven Bedingungen” by M. Zoller, performed at the University of Zurich, Switzerland, under the supervision of FJ. Wegehaupt.

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Figures:

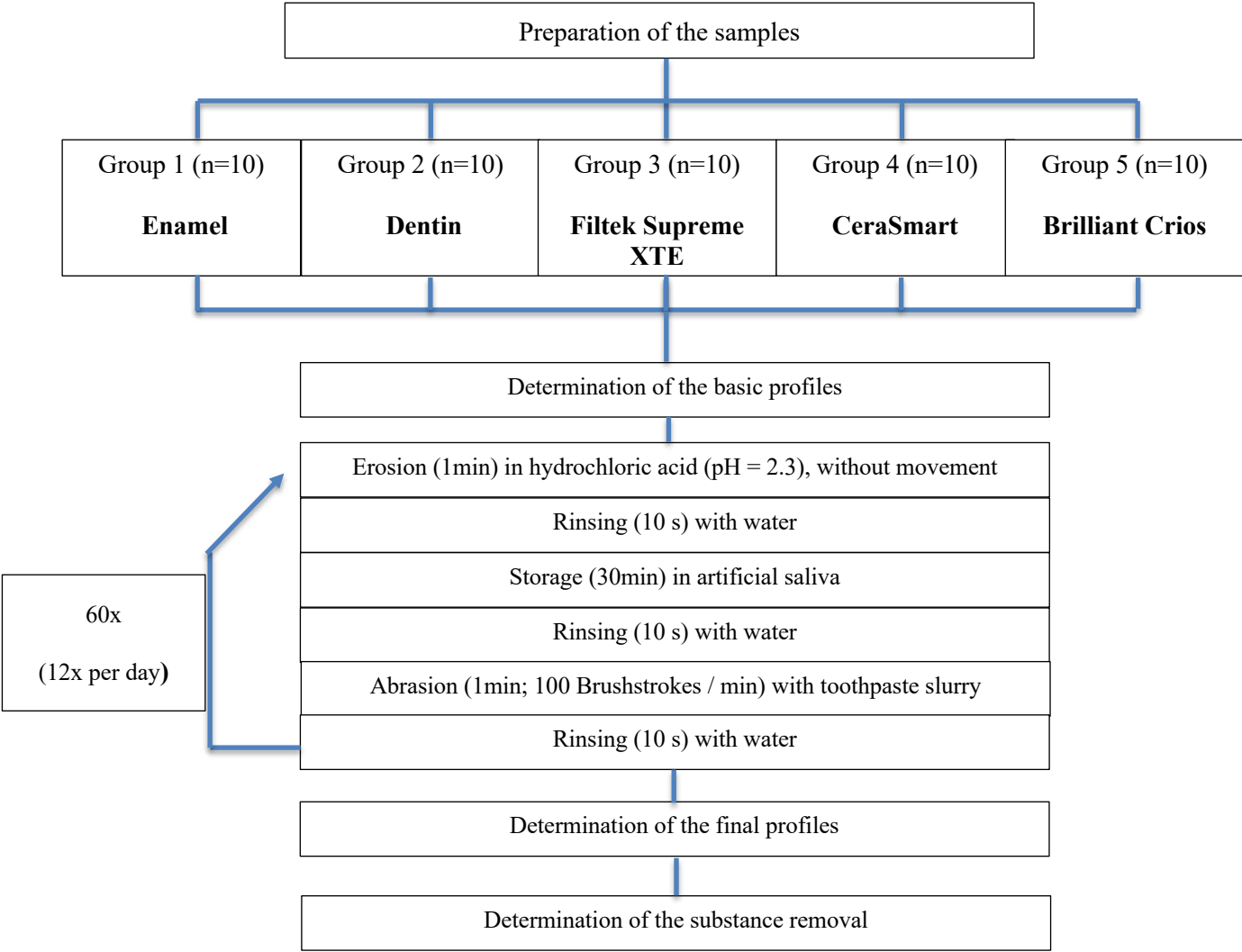


Figure 1: Schematic representation of the test procedure

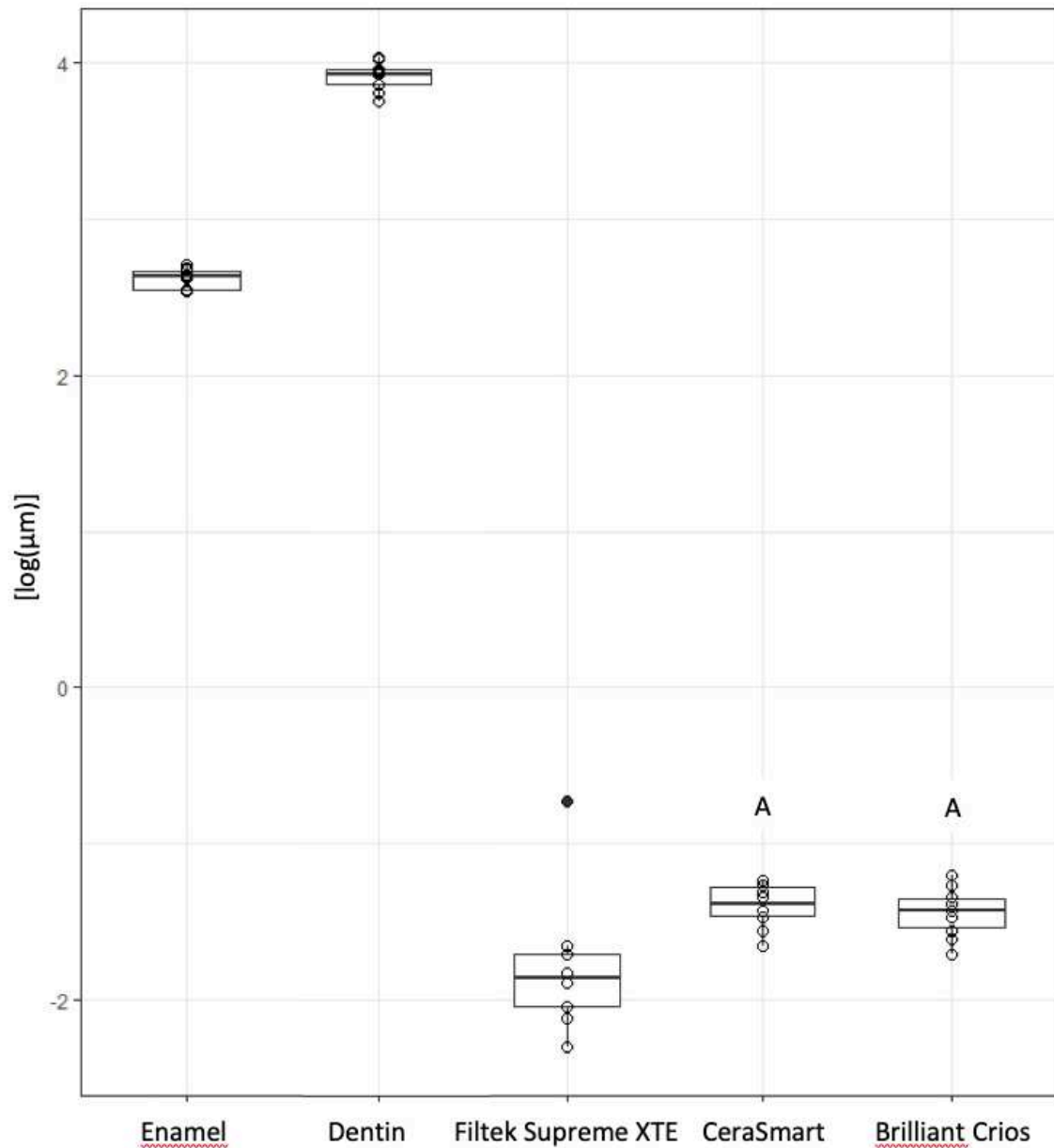


Figure 2: Erosive/abrasive wear [μm] in logarithmic form of the five materials under investigation. The boxes represent the 25th and 75th percentile, respectively. The center line indicates the median and the circles represent the respective mean values per sample. Only the CeraSmart and Brilliant Crios groups do not differ significantly from each other. Box plots marked with the same letter, do not differ significantly from each other.