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Effects of Prophy Pastes on Composite Resin Surfaces

SUMMARY

The effects of prophy pastes on the surfaces of composite materials should be considered for appropriate use. In this study, the effect of several prophy pastes which are marketed by the manufacturers as "fine" or "one step" was tested on composite surfaces. Products used in this study were Cleanic® and CleanPolish (both KerrHawe), Nupro® (Dentsply) and Proxyt® fine (Ivoclar Vivadent). Scanning electron microscopic images and gloss measurements revealed significant differences between prophy pastes with respect to surface alterations. In contrast to some of the other products, Proxyt fine did not compromise surface gloss, in some cases, it even improved surface polish. Scanning electron microscopic pictures revealed smooth surfaces after polishing with this material.

INTRODUCTION

Cleaning with prophy pastes is a standard dental procedure. The pastes are applied on the teeth with rotating instruments using nylon brushes or rubber cups. They remove bacterial biofilms, dental plaque and stains, and they smooth out rough surfaces. Therefore, these products are available in various abrasive levels.

The basic requirement of these pastes is to clean and polish dental surfaces as effectively and gently as possible (¹BOSE and OTT 1995). Abrasion of natural tooth structure and of restorative materials should be kept to a minimum and surfaces should be as smooth as possible after the treatment. Rough surfaces provide conditions that are conducive to the colonization of bacteria. As a result, they increase the risk of caries, incipient caries at restoration margins and periodontal as well as peri-implant disease (²EINWAG et al. 1990; ³QUIRYNEN and BOLLEN 1995). Moreover, rough surfaces are uncomfortable for patients, as the tip of the tongue is very sensitive to even the slightest irregularities in the composite resin surface (⁴JONES et al. 2004). In dental restorations, abrasion causes irreversible damage. What is more, roughened surfaces lose their lus-

tre and become susceptible to discolouration, which affects their esthetic appearance.

Apart from the abrasiveness of the pastes, additional factors influence the treatment results: for example, the treatment time, the pressure applied and the rpms of the instrument as well as the type of brush or cup used (⁵CHRISTENSEN and BANGERTER 1984). In addition, the specific properties of the tooth structure or restorative material involved significantly influence the outcome.

The aim of the present study was to examine the effect of different prophylactic pastes on the surfaces of conventional composite resins.

MATERIALS AND METHODS

The composite resins used in this study are listed in Table 1, while the prophy pastes are shown in Table 2. In the case of Proxyt® and Nupro®, which are available in several grit sizes, only the finest versions were used in this investigation. The Proxyt paste examined in this study was a further developed version of the material previously marketed under the same name. Cleanic® is a one-step prophy paste, which according to the manufacturer changes from a

Literature:

¹Bose M, Ott KHR. Glättung von (Füllungs-)Werkstoffen, Zahnschmelz und Dentin durch Prophylaxepasten in vitro. *Dtsch Zahnärztl Z* 1995;50:840-843.

²Einwag J, Ulrich A, Gehring F. In-vitro-Plaquanlagerung an unterschiedliche Füllungs-materialien. *Oralprophylaxe* 1990;12:22-25.

³Quiryneen M, Bollen CML. The influence of surface roughness and surface-free energy on supra- and sub-gingival plaque formation in man. *J Clin Periodontol* 1995;22:1-14.

⁴Jones CS, Billington RW, Pearson GJ. The in vivo perception of roughness of restorations. *Br Dent J* 2004; 196:42-45; discussion 31.

⁵Christensen RP, Bangertter VW. Determination of rpm, time, and load used in oral prophylaxis polishing in vivo. *J Dent Res* 1984;63:1376-1382.

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Figure 1 A-D: Scanning electron micrographs of the abrasive particles of different prophy pastes

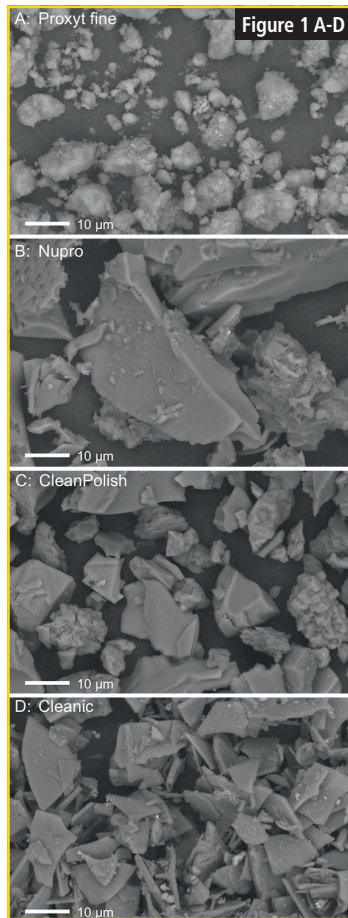


Table 1: Composite resins used in the study. The brands (®, ™) belong to the respective manufacturers.

Table 1			
Composite resin	Manufacturer	Batch	Shade
IPS Empress® Direct	Ivoclar Vivadent	M54674	A3 Enamel
Tetric® EvoCeram	Ivoclar Vivadent	M53444	A3
Filtek™ Supreme XT	3M Espe	9FM	A3E
Tetric® EvoFlow	Ivoclar Vivadent	M61729	A3
X Flow™	Dentsply	0905000302	A3

Table 2: Tested prophy pastes. Of the products offered in different levels of abrasion, the finest paste was used. The abrasives used in these pastes are shown in Figure 1.

Table 2			
Prophy pastes	Manufacturer	Batch	Level
Proxyt®	Ivoclar Vivadent	N65907	fine
Nupro®	Dentsply	08070103	fine
CleanPolish	KerrHawe	40700037	
Cleanic®	KerrHawe	2904293	

cleaning paste to a polishing paste within 15 s. Figure 1 shows the quality and size of the abrasive particles contained in these products.

Fabrication of the composite resin specimens

The composite resin was pressed into metal moulds measuring 10 mm in diameter and 2 mm in thickness between plastic foil. Subsequently, both sides of the specimens were polymerized for 3 min each in a Spectramat light-curing unit (Ivoclar Vivadent, Schaan, Liechtenstein). Next, the samples were ground with a 40 µm-grit diamond disc under water cooling. They were successively polished with 70, 15 and 6-µm grit Apex diamond polishing discs (Buehler, Düsseldorf, Germany). As a result, an even medium

gloss was achieved, which allowed the determination of increasing or decreasing lustre caused by polishing with the prophylactic pastes.

Gloss measurements

The surface gloss of the test specimens was measured with a Novo-Curve gloss meter (Rhpoint Instruments, Bexhill-on-Sea, UK). In this device, a light ray was directed at the specimen at an incidence angle of 60°. The intensity of the reflected beam was measured to determine the surface gloss. Four samples per test group were measured from four different directions. These 16 readings were used to calculate the average and standard deviation of the surface gloss. Before the measurements were carried out, the device was calibrated with a standardized

black glass tile (a reading of 100% corresponds to maximum gloss). For the statistic evaluation, the average of four gloss readings of a specimen was calculated. Next, the gloss results before polishing were compared to those after 5-s and 20-s polishing of the four specimens of a test group in a paired two-sample t-test.

Polishing of the test specimens

First, the samples were mounted in a device which maintained a constant contact pressure of 200 g with a pneumatic cylinder during the polishing process. The samples were polished with a contra-angle handpiece (Intra LUX head 68LH, KAVO, Bieberach, Germany) at 2000 rpm to examine the effects of the prophy pastes on the lustre of composite resins. Medium-hard webbed rubber cups (Produits

Dentaires SA, Vevey, Switzerland) were used for this purpose. For each combination of prophy paste and filling material, a new rubber cup was used to prevent carry-over of abrasive medium. After the first gloss measurements, the test specimens were polished for 5 s. Subsequently, they were washed with water and dried, and their surface gloss was measured again. Finally, the samples were polished for another 15 s and their gloss was measured. An additional test specimen per test group was used to take SEM images of the surfaces before and after polishing for 5 s.

Scanning electron micrographs

In order to clearly view the surfaces, the composite resin samples were coated with gold/palladium and examined under the field emission microscope (Zeiss Supra 40VP, Carl Zeiss, Oberkochen, Germany) at 200-fold magnification using the material contrast imaging mode.

Isolation of the abrasives

The abrasives contained in the different prophy pastes were also examined by scanning electron microscopy. For this purpose, 1-2 g of paste was suspended in 10 ml deionized water in each case. Subsequently, the suspensions were centrifuged for 10 min at 8000 rpm. The supernatant containing the soluble components of the products was discarded and the centrifuged solids were examined in the SEM at 1000-fold magnification.

RESULTS

Surface gloss

Initially, the prepared test specimens demonstrated an average gloss of 30% (X-Flow™) to almost 60% (IPS Empress® Direct).

After 5-s polishing, the changes in gloss of the composite resins IPS Empress Direct, Tetric® EvoCeram and Tetric® EvoFlow were minimal, irrespective of the prophylactic paste used (Fig. 2A, B, D). However, a slightly to clearly visible loss of lustre was observed on Filtek™ Supreme XT and X-Flow surfaces polished with Nupro fine and Cleanic (Fig. 2C, E).

After additional polishing for 15 s, these changes became even more pronounced. The new Proxyt fine paste did not cause any loss of gloss in any of the composite resins tested. In fact, IPS Empress Direct and the flowable materials Tetric EvoFlow and X-Flow in particular exhibited a significant increase in lustre (Fig. 2A-E). None of the other prophy pastes was capable of notably heightening the gloss of the composite resins. On the contrary: Nupro fine caused significant loss of lustre in Filtek Supreme XT and X-Flow. The lustre of all the composite resins tested declined after the treatment with Cleanic. CleanPolish was shown to slightly reduce the gloss of X-Flow (Fig. 2A-E).

In short, the gloss of the composite resins IPS Empress Direct and Tetric EvoCeram was found to be least modified by the prophy pastes. In contrast, the prophy pastes had significantly different effects on the surfaces of Filtek Supreme XT, Tetric EvoFlow and X-Flow. Proxyt fine tended to improve the lustre of the composite resins tested, while Nupro and Cleanic reduced their gloss.

Scanning electron micrographs

Figures 3A-E show IPS Empress Direct before polishing and after 5-s polishing with the new Proxyt fine, Nupro fine, CleanPolish and

Cleanic. As the composite test specimens were polished to an average rather than a high gloss finish, the pre-treatment picture (Fig. 3A) shows minimal traces of processing as a result of the sample fabrication technique. Comparable traces were found in the other materials before they were polished. After polishing with Proxyt fine, hardly any changes were visible on the surface of IPS Empress Direct samples. On closer inspection, the edges of the initial scratches were somewhat rounded (Fig. 3B). Nupro and CleanPolish created clearly visible scratches, that were, nevertheless, quite shallow (Fig. 3C, D). Cleanic produced deep scratches in IPS Empress Direct after only 5-s polishing (Fig. 3E).

Figure 4 shows the same series of pictures for Filtek Supreme XT. After polishing with the new Proxyt fine, the scratches caused during the fabrication of the test samples were less pronounced (Fig. 4B). The other prophy pastes caused light marks (Fig. 4C, D), while Cleanic produced pronounced scratches (Fig. 4E).

It would go beyond the scope of this publication to provide pictures of all five of the composite resins tested with all the different pastes. Nevertheless, to illustrate that the effect on flowable materials is comparable, selected pastes were used on Tetric EvoFlow (Fig. 5) and X-Flow (Fig. 6).

In short, the results of the SEM examinations show that the prophy pastes used in this study can be ranked according to a distinct sequence of scratch levels. Of the products tested, Cleanic left the deepest scratches. The marks produced by Nupro fine were shallower. CleanPolish only left light scratches. Proxyt fine did not

scratch the composite resin surfaces at all. Figure 1 shows the abrasives contained in the different prophylaxis pastes, which clearly differentiate the products.

DISCUSSION

For routine professional tooth cleaning, the use of a minimally abrasive prophylaxis paste is sufficient, as long as the teeth do not show any tough stains. Pastes that are declared to be minimally abrasive should not abrade sensitive surfaces, hardly cause scratching and produce the smoothest possible surface. These factors are of considerable importance, as professional tooth cleaning is a measure that is carried out on a regular and recurring basis.

The present examinations confirm that different prophylactic pastes have significantly different effects on composite resin surfaces. That is, not all of the pastes can be regarded as being gentle. Furthermore, it was shown that the different types of composite demonstrate varying susceptibility to scratching. Various studies confirm this finding (⁶JAEGER et al. 2005; ⁷RÜHLING et al. 2004).

The gloss measurements of the flowable composite resins Tetric EvoFlow and X-Flow showed that Proxyt heightens their lustre. However, the surface gloss decreased considerably with the use of Nupro, CleanPolish and Cleanic (Fig. 2). Furthermore, it is important to note that Tetric EvoFlow was considerably shinier before the treatment than X-Flow as a result of its different formulation and fillers (Fig. 5A, 6A).

The results for the composite resins IPS Empress Direct, Tetric EvoCeram and Filtek Supreme XT were as follows (Fig. 2): CleanPolish improved the surface gloss of IPS Empress Direct and Filtek Supreme XT, while it decreased the lustre of Tetric EvoCeram. Nupro fine maintained the surface lustre of IPS Empress Direct after 5 s. Nevertheless, a reduction in gloss was observed on Tetric EvoCeram and Filtek Supreme XT. Cleanic was shown to cause considerable loss of lustre and surface scratching on all the composite resins tested (Fig. 2). It is interesting to note that the surface gloss after 20-s cleaning was even lower than that after 5 s. As a result, the claim that the cleaning paste turns into a polishing paste due to the perlite particles seems doubtful (⁸LUTZ et al. 1995). Proxyt maintained or increased the lustre of all the composite resins tested. The scanning electron micrographs show smooth surfaces to a large extent (Fig. 3B, 4B, 5A, 6A).

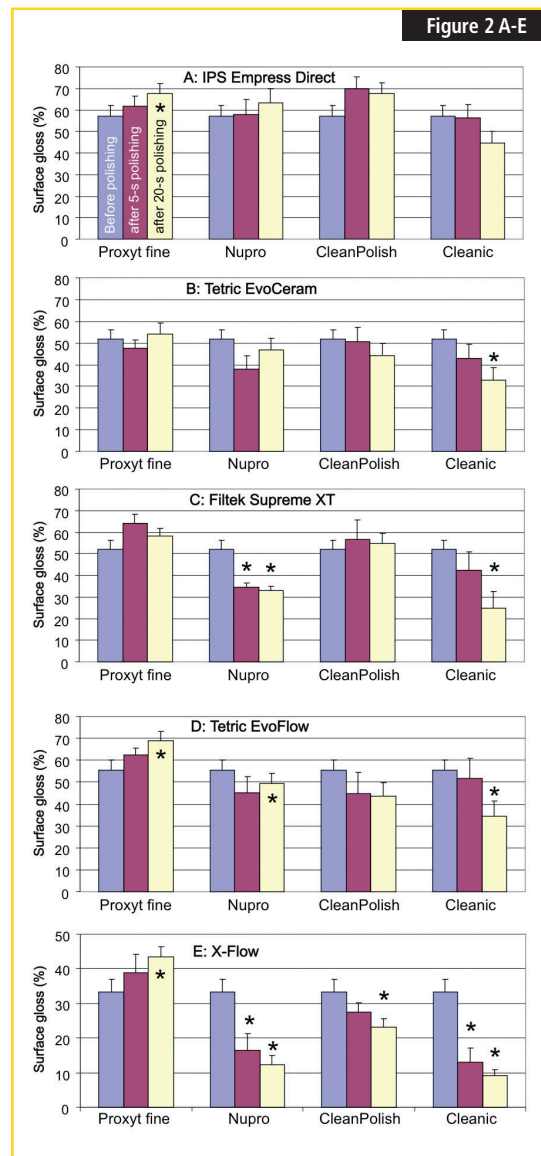


Figure 2: Surface gloss of composite resin filling materials before polishing (blue), after 5-s polishing (purple) and after 20-s polishing (yellow) with different prophylaxis pastes. The measurements labelled with "*" differ from the pre-polishing values with a level of significance of $p < 0.01$.

⁶Jaeger R, Deissenbeck M, Jaeger D, Soltész U. Abrieb von Dentalersatzwerkstoffen durch Prophylaxepasten. *Quintessenz* 2005;56:61-65.

⁷Rühling A, Wulf J, Schwahn C, Kocher T. Surface wear on cervical restorations and adjacent enamel and root cementum caused by simulated long-term maintenance therapy. *J Clin Periodontol* 2004;31:293-298.

⁸Lutz F, Imfeld T, Schüpbach P. Prophylaxepasten - das neue Abrasiv Perlit im Vergleich zu konventionellen Putzkörpern. *Schweiz Monatsschr Zahnmed* 1995;105:30-39.

⁹Stokey GK, Schemehorn BR. A method for assessing the relative abrasion of prophylaxis materials. *J Dent Res* 1979;58:588-592.

These results are consistent with those of other studies in which the substance loss of various restorative materials was evaluated after cleaning with Cleanic or Proxyt. In these studies, cleaning with Cleanic showed stronger abrasion (⁷ RÜHLING et al. 2004).

A close examination of the abrasives provides an indication of the different effects of the prophylaxis pastes tested. The pyrogenic silicic acid contained in Proxyt does not exhibit any sharp edges in contrast to the particles of other pastes (Fig. 1). In addition, the hardness and concentration of the abrasive materials as well as the different formulas of the paste base largely determine the characteristics of the products.

CONCLUSIONS

Scratches in composite resins irreversibly compromise the quality of these materials and roughen their surfaces. Furthermore, the marginal integrity of dental restorations may be impaired. Rough filling surfaces offer an attractive ground for the colonization of bacterial biofilms and therefore heighten the risk of incipient caries, gingivitis and mucositis and compromise the health of adjacent teeth. Therefore, it is

important to know whether or not the patient already has composite resin restorations when the suitable prophy paste is chosen. Ideally, the practitioner should be aware of the type of material used. In addition, the potential effect of the paste on the restoration surface should be considered. In this context, the RDA value of the paste provides a guideline about the relative abrasion of the product with regard to sensitive dentin tissue (STOOKEY and SCHEMEHORN 1979). A minimally abrasive paste

is usually sufficient for routine professional tooth cleaning and maintaining good oral health. *pi*

ACKNOWLEDGEMENTS

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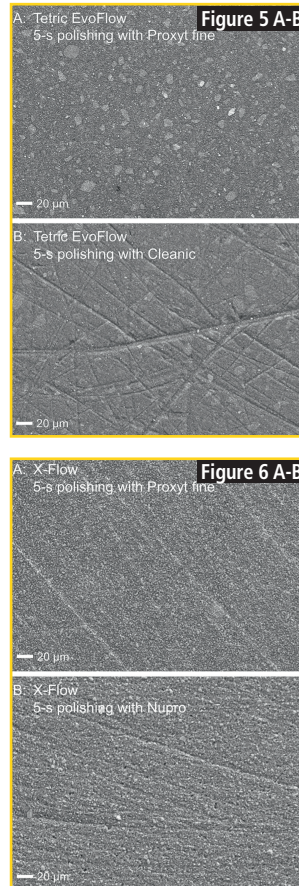
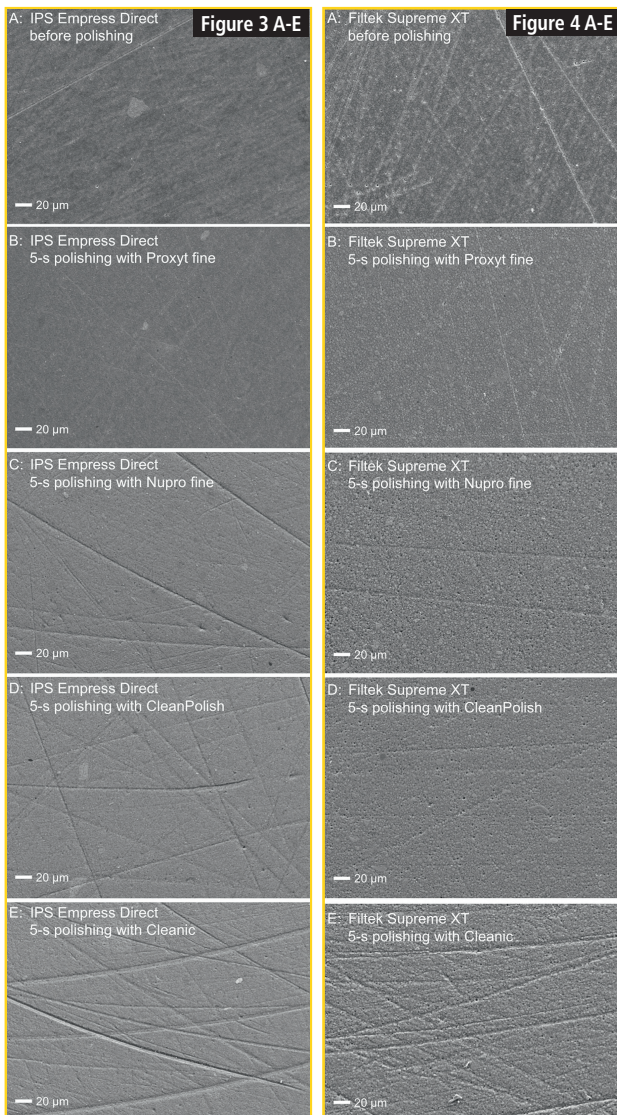


Figure 3: SEM image of the surface structure of IPS Empress Direct before and after 5-s polishing

Figure 4: Surface structure of Filtek Supreme XT before and after 5-s polishing with various prophy pastes

Figure 5: Surface structure of Tetric EvoFlow after 5-s polishing with Proxylt fine or Cleanic

Figure 6: Surface structure of X-Flow after 5-s polishing with Proxylt fine or Nupro

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