Restorative Dentistry

Cleaning and polishing efficacy of abrasive-bristle brushes and a prophylaxis paste on resin composite material in vitro

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Objective: This study evaluated the cleaning and polishing effect of a prophylaxis paste (Cleanic), two differently shaped abrasive-bristle brushes (Occlibrush normal cup and Occlibrush minipoint), and a nylon-bristle brush (Prophy brush) on a fine (Tetric Ceram) and a coarse hybrid resin composite (Tetric Condens) under standardized conditions. Method and materials: A total of 48 round specimens with a diameter of 17.2 mm (232.32 mm²) of a fine and a coarse hybrid resin composite were readied and fixed on scanning electron microscopic mounts. After a standardized polishing procedure, the mean surface roughness values were evaluated using five horizontal and five vertical measurements over an area of 1 x 3 mm. The gloss of each specimen was assessed with a spectrophotometer. Both hybrid resin composite groups were treated with one of the following instruments: a nylon-bristle brush (n = 8), a normal-cup abrasive-bristle brush, or a minipoint abrasive-bristle brush. The medium used was either water (control) or a prophylaxis paste. Surface roughness and gloss were measured after instrumentation times of 15, 30, 60, 90, and 120 seconds. For the evaluation of cleaning ability, another 48 total round specimens of fine and coarse hybrid resin composite were covered with a thin layer of black dispersion color and air dried for 24 hours. Specimens were treated with a nylon-bristle brush or an abrasive-bristle brush in combination with water or prophylaxis paste for 15, 30, 60, 90, and 120 seconds. At the beginning and after every treatment interval, the specimens were scanned, the images were digitized, and the percentage of cleaned surface was measured planimetrically. Results: The abrasive-bristle brush, used in combination with water, produced the best outcomes for cleaning ability, surface roughness, and gloss on resin composite restorations. Conclusion: There is no positive cumulative effect when an abrasive-bristle brush, with its cleaning and polishing effect, is used in conjunction with a prophylaxis paste. Abrasive-bristle brushes used with plain water are highly suitable for cleaning and polishing resin composite surfaces. (Quintessence Int 2002;33:691-699)

Key words: abrasive-bristle brush, cleaning ability, gloss, prophylaxis paste, surface roughness, tooth-colored restoration

CLINICAL RELEVANCE: Recently established quality guidelines for restorative dentistry in Switzerland have revealed the need for professional maintenance of tooth-colored restorations. An abrasive-bristle brush used with water alone is highly suitable for cleaning and polishing resin composite surfaces. The addition of prophylaxis paste offers no extra benefit.

The desire to use resin composites as restorative materials in posterior teeth is based on esthetic concerns. The term tooth-colored restoration is therefore self-defining. The establishment or the reestablishment of secondary oral health has not only the preservation of dental hard structures and the restitution of tooth form and function as major aims but also the imperceptiveness of restorations at normal talking distance as a goal. In Switzerland, long-term quality warranties of 8 years for direct restorations and 10 years for indirect restorations have been established; the guidelines institute high demands concerning the quality of restorations.¹² These goals may be difficult to achieve, however. The main problems that present are changes in the color of the material as well as superficial and marginal discoloration.³ Therefore, a successful care concept has not only to discern and to avoid new caries and attachment loss arising from periodontal disease but also to preserve the quality of the restoration in a specific and prophylactic way.

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Ferrari et al. demonstrated the importance of periodic maintenance of restorations in a 5-year clinical study. Sixty esthetic Class III, Class IV, and Class V restorations were placed and reexamined every 6 months, using Ryge and Snyder's criteria for marginal integrity, anatomic form, and color stability. Patients in the trial periodically received conservative restoration polishing and professional toothcleaning. Despite this intensive maintenance care, after 5 years, only 50% of the evaluated restorations received an Alpha score for color stability. Fifteen percent of all restorations required replacement for other reasons. These results demonstrate the needs and problems of maintenance care.

Baillod et al. also examined 60 Class III and Class IV restorations clinically, after placement and after 3, 6, and 12 months. They evaluated marginal adaptation with a scanning electron microscope, using the replica technique. All restorations were rated Alpha or Bravo. The percentage of “continuous margins” was about 90% initially and increased to 95% at 12 months. This can be explained by the repeated refinishing of marginal imperfections at all recall intervals.

Contouring, finishing, and polishing procedures immediately after the placement of tooth-colored adhesive restorations are a prerequisite to achieving a high initial restoration quality, including smooth surfaces to minimize accumulation of plaque. Freshly cured composites have a physically, chemically, and esthetically inferior, resin-rich surface layer, in which polymerization is inhibited by oxygen. Ideally, a filler-rich, enamel-like, polished, and glossy surface must be achieved in combination with a perfect marginal adaptation. In addition, repolishing within a few days or weeks after placement of the restoration optimizes the initial restoration quality.

The long-term quality is ensured by consistent professional maintenance care. To this end, many instruments are at the disposal of dentists and dental hygienists. These instruments are used in refinishing and polishing; elimination of excess material, detached flashes, and marginal imperfections; and removal of marginal and superficial discoloration. However, within the realm of professional dental hygiene procedures, gentle, nondestructive instruments are indicated.

The use of prophylaxis pastes in combination with rubber cups, nylon-bristle brushes, or abrasive-bristle brushes is accepted, although controversial. Self-regulating abrasive prophylaxis pastes with the abrasive medium perlite consistently yield low relative dentin and enamel abrasion values, good cleaning ability, and good surface roughness scores. They thus seem to be suitable for the removal of hard and smooth deposits from hard dental structures, as well as for restoration maintenance.

Clinical experience suggests that stain can be removed more efficiently from dentin and enamel surfaces when an abrasive-bristle brush is combined with a prophylaxis paste. This hypothesis should be tested with regard to the maintenance of resin composite restorations. Therefore, it was the aim of this study to evaluate the effect of two differently shaped abrasive-bristle brushes and a nylon-bristle brush in combination with a prophylaxis paste or water alone on stained composites. In this research, cleaning ability and final surface quality, ie, surface roughness (Ra) and gloss, were assessed. Additionally, the aim was to provide general practitioners with guidelines for the selection of adequate cleaning and polishing instruments for stain removal and optimization of restoration surface quality.

METHOD AND MATERIALS

The appearance of the brushes (Hawe Neos) is similar to that of currently available prophylaxis brushes. The brushes are available in the form of cups and mini-points (Fig 1). To prevent confusion with prophylaxis brushes, the metallic parts are gold plated. The bristles are made of a special, rather rigid polycarbonate fiber, which is impregnated with silicon carbide particles.

Cleanic (Hawe Neos) is a prophylaxis paste combining a good cleaning ability with a simultaneous polishing, ie, morphologic smoothing of the surfaces, causing minimal abrasion. This paste contains perlite, a natural glass with a sheetlike geometry of particles (Fig 2). The average grit size of these abrasives is 40 μm and decreases during instrumentation as the particles become rounded.
These materials can be used to polish ceramics, resin composites, and "compomers" as well as to polish the teeth during a dental prophylaxis.

**Measurement of surface roughness and gloss**

A total of 48 round specimens, with a diameter of 17.2 mm (232.32 mm²), were made of a fine hybrid resin composite (Tetric Ceram, Vivadent) and a coarse hybrid resin composite (Tetric Condense, Vivadent). They were fixed on scanning electron microscopic mounts (PPK). All specimens were then ground smooth with a rotating sandpaper device (Pedemax-2, Struers) and waterproof silicon carbide papers (Struers). Minimal pressure was applied for 15 seconds each with 1,200 and 2,400 grit papers and for 1 minute with 4,000 grit paper.

After this standardized polishing procedure, the mean surface roughness values were evaluated with five horizontal and five vertical measurements taken over an area of 1 × 3 mm (Talysurf 50, Rank Taylor Hobson). In addition, the gloss of each specimen was determined with a spectrophotometer (Minolta CM 508d), as described in standard specification 5033 of the International Standardization Organization (gloss: sphere geometry D/8°, specular component included, and specular component excluded).

After evaluation of all baseline data, the specimens of both hybrid resin composite groups were treated with one of the following instruments: a nylon-bristle brush (Prophy brush, Hawe Neos), an abrasive-bristle brush with a normal cup (Occlusbrush normal cup, Hawe Neos) and a minipoint abrasive-bristle brush (Occlusbrush minipoint, Hawe Neos). The instruments were operated at 5,600 rpm in a slow contra angle-handpiece (120 IS Micro Mega) used with a standardized force of 2 N, ensured by the use of an 8,600-digital multimeter specifications control device (Kontron Electronic). The media used were either water (control) (n = 8) or a prophylaxis paste (Cleanic, Hawe Neos) (n = 8). Every 15 seconds, specimens were rinsed for 15 seconds with distilled water, and a fresh portion of prophylaxis paste was applied.

Surface roughness and gloss measurements were taken after instrumentation times of 15, 30, 60, 90, and 120 seconds. In addition, impressions were made after every treatment interval in a low-viscosity polyvinyl siloxane (President light body, Coltène), and replicas were made (Stycast 1266, ICI). These replicas were analyzed under a scanning electron microscope (Amray 1810) at a magnification of ×500.

The measured mean surface roughness values at all intervals and treatment steps were statistically analyzed with the unpaired t test, performed with a computer program (Stat View TM II).

**Assessment of cleaning ability**

For the evaluation of cleaning ability, another 48 total round specimens of fine and coarse hybrid resin composite were fixed on scanning electron microscopic mounts. The specimens were mechanically smoothed for 15 seconds with 1,200-grit silicon carbide paper as described earlier. All specimens were then covered with a thin layer of black dispersion color (Exponit black 380, Bosshard), and air dried for 24 hours. This industrial color suitably simulates staining in vitro, because it consists of black ferric oxide (Fe₂O₃) particles varying in size from 30 to 50 μm in a matrix of polyvinyl acetate. Furthermore, this dispersion color has excellent wetting properties, has a low water sorption potential, is not water soluble after drying, and also resists large changes in pH values.

Eight specimens each were treated with either a nylon-bristle brush or abrasive-bristle brushes (Occlusbrush), in combination with water or a prophylaxis paste (Cleanic) for 15, 30, 60, 90, and 120 seconds. The brushes were operated at 3,600 rpm with a standardized force of 2 N. At the beginning and after every treatment interval, the specimens were scanned (Hewlett Packard C1750A), the images were digitized, and the percentage of cleaned surface was measured planimetrically. Unpaired t tests were used to compare the groups statistically.

**RESULTS**

**Surface roughness and gloss**

On both hybrid resin composites, independent on the type of brush used, the prophylaxis paste produced a
significantly greater increase in mean surface roughness ($P = .001$) than did water (Figs 3 and 4).

The initial gloss after standard polishing with 4,000-grit silicon carbide paper indicated that the fine hybrid resin composite had superior polishing ability. On both composite materials, all instruments produced a higher gloss when used with water rather than in combination with the prophylaxis paste.

### Micromorphology

The scanning electron microscopic views of both composite materials after standard polishing clarified the difference concerning filler dimensions. In the coarse hybrid resin composite (Fig 5), the coarse filler particles are clearly visible, whereas the fine hybrid resin composite (Fig 6) shows a smooth, even, although porous, surface.

On the fine hybrid resin composite, all instruments in combination with water produced a smooth surface after a 15-second instrumentation (Fig 7). This correlated with the modest increase in surface roughness values and did not differ significantly from the untreated and polished surfaces at baseline. In contrast, all specimens treated with the prophylaxis paste showed clear surface alterations. Only the normal cup of the abrasive-bristle brush (Occlubrush) produced no scratches (Fig 8).

On the coarse hybrid resin composite, the tested instruments showed different results. With water alone, the Occlubrush normal cup produced a visibly smoother surface than was present at baseline (Fig 9). The nylon-bristle brush led to an apparent reduction of the filler particle size, whereas the minipoint produced no surface alterations. The micromorphologic appearance correlated with the measured Ra values. In combination with prophylaxis paste, a clear roughening effect was seen. The minipoint abrasive-bristle brush produced the visibly smoothest surface, whereas the normal cup as well as the nylon-bristle brush resulted in a coarse micromorphology (Fig 10).
Fig 5 Scanning electron microscopic observation of the coarse hybrid resin composite after standard polishing with 4,000-grit silicon carbide paper. (Original magnification x500.)

Fig 6 Scanning electron microscopic observation of the fine hybrid resin composite after standard polishing with 4,000-grit silicon carbide paper. (Original magnification x500.)

Fig 7 Smooth surface on the fine hybrid resin composite after 15-second instrumentation with an abrasive-bristle brush (Occlusalnormal cup) and water. (Original magnification x500.)

Fig 8 Fine hybrid resin composite treated with an abrasive-bristle brush in combination with prophylaxis paste (Cleanic). (Original magnification x500.)

Fig 9 Coarse hybrid resin composite treated with the abrasive-bristle brush and water. (Original magnification x500.)

Fig 10 Coarse micromorphology on the coarse hybrid resin composite after 15-second instrumentation with the abrasive-bristle brush in combination with prophylaxis paste (Cleanic). (Original magnification x500.)
Cleaning ability

As expected, the cleaning ability of the nylon-bristle brush without prophylaxis paste was poorest on both composite materials and did not exceed the 15% mark, even after 2 minutes of instrumentation (Figs 11 and 12).

The abrasive-bristle brushes with plain water showed better cleaning effects, particularly within the 60-second instrumentation bracket. This resulted in a steeper and exponential increase in measurable cleaning. In contrast, the Ra values pertaining to the combinations of prophylaxis paste with the normal-cup abrasive-bristle brush and prophylaxis paste with the nylon-bristle brush resulted in sigmoid curves over the same time interval. Thus, the paste had a lower final cleaning effect. After the 2-minute interval, both types of abrasive-bristle brushes showed a nearly 100% cleaning effect with water. The same was achieved with the prophylaxis paste in combination either with the nylon-bristle brush or the normal-cup abrasive-bristle brush.

The minipoint abrasive-bristle brush, when combined with the prophylaxis paste, showed a reduced cleaning ability. This instrument showed a clearly better cleaning ability with water alone.

Qualitative examination of the scanned specimens also clarified the better cleaning ability of the abrasive-bristle brushes when combined with water (Fig 13) rather than prophylaxis paste (Fig 14). The nylon-bristle brush exhibited almost no cleaning effect on the colored resin composite surfaces.
DISCUSSION

A high quality immediately after the completion of a restoration does not, in itself, guarantee high longevity. However, it improves the chances of remaining compliant with professional standards during the quality warranty period, despite a progressive loss of quality. Periodic recalls are undoubtedly important for the maintenance and the restitution of periodontal health.

However, routine cleaning procedures with conventional hand curettes and scalers, as well as sonic or ultrasonic devices, cannot be performed during periodic recalls without risking damage to the restorations. An in vitro investigation on the effect of metal and plastic curettes on the restorative interface of laboratory-made ceramic restorations revealed the importance of careful and gentle instrumentation during recall treatments. Attention must therefore be paid to the instrumentation during professional dental hygiene procedures and during cleaning and polishing of restorations.

In essence, prophylaxis pastes are able to clean restorative materials as well as enamel and dentin. Among these pastes, the self-regulating abrasive perlite has proven to be very efficient and yet gentle to dental hard structures. The main objective of cleaning is fast and efficient stain removal. At the same time, destructive abrasion on tooth and restoration surfaces and the resulting surface roughness should be minimized. Cleanic prophylaxis paste, based on perlite, fulfills these objectives very well.

Paste carriers also play an important role. Nylon-bristle brushes and rubber cups are the most commonly used application instruments. The rubber cup is to be preferred clinically because it is friendlier to the gingiva. The development of abrasive-bristle brushes has complemented the spectrum of clinically available instruments to finish resin-based restorations. They filled a critical gap for the polishing of these materials. These instruments proved to be useful, even for the removal of stain.

It might be considered advantageous to combine abrasive-bristle brushes and a prophylaxis paste to coordinate their benefits. No objective comparative studies combining surface treatment and cleaning ability seem to have been published previously. The present in vitro investigation aimed to compare, under standardized conditions, abrasive-bristle brushes with a nylon-bristle brush when used with water or in combination with a prophylaxis paste on two hybrid resin composites of different filler size.

Surprisingly, the clinically postulated high efficiency of the combination of an abrasive-bristle brush with a prophylaxis paste was not confirmed. For both hybrid resin composites, a highly significant difference was found in the induced surface roughness values of the water and the prophylaxis paste groups. These surface roughness values were micromorphologically corroborated by the scanning electron microscopic investigation.

The prophylaxis paste had no additional positive effect on gloss. Rather, the use of prophylaxis paste resulted in lower gloss values than were found after the standard polishing procedure. On the fine hybrid resin composite, Tetric Ceram, a high subjectively and objectively measured gloss was found after standard polishing; this could be maintained when water was used in combination with any of the brushes. On the coarse hybrid resin composite, Tetric Condense, the abrasive-bristle brushes even improved the gloss when used with water.
Cleaning efficiency showed similar tendencies. During the first minute of treatment, the abrasive-bristle brushes with water produced better cleaning than the same brushes with the prophylaxis paste. Subjective micromorphologic investigations confirmed these results. The following are possible explanations for these results: (1) With abrasive-bristle brushes, the clearance of the prophylaxis paste is high, i.e., the paste splatters away almost immediately and is therefore barely effective; or (2) the paste has a lubricating effect, thus reducing the cleaning efficiency of the abrasive-bristle brush.

On composite surfaces, the additional use of a prophylaxis paste did not enhance the cleaning ability of abrasive-bristle brushes. No superior surface qualities in roughness, morphology, or gloss were found. The subjective impression of clinicians that the combination of a prophylaxis paste with abrasive-bristle brushes may be advantageous, was not confirmed in this study. The working hypothesis was that the combination of abrasive-bristle brushes, with their cleaning and polishing effects, and a prophylaxis paste may have a positive cumulative effect. The clinical impressions of "practice suitability" probably developed because the stiffer abrasive bristles of the abrasive-bristle brush produce a higher pressure than the relatively softer nylon bristles. Therefore, this combination of pressure and prophylaxis paste may give a false, subjective impression of an improved effect.

It is clear that, for maintenance care of resin composite restorations, the use of an abrasive-bristle brush with water alone is preferred to the combination with prophylaxis paste.

These findings confirm those described by Bose and Ott, who investigated the effect of 29 prophylaxis pastes on surfaces of a microfilled and a hybrid resin composite. Roughness values recorded on polished composite surfaces (Ra values before treatment: 0.07 to 0.17 μm) ranged from 0.11 to 0.46 μm. On the other hand, 21 pastes also polished rough surfaces (Ra values before treatment: 0.96 to 1.11 μm) to an Ra value of 0.4 ± 0.1 μm within 15 seconds.

In addition, various other finishing and polishing systems and techniques have been described. Finishing diamonds have been shown to produce rough, trough-like surfaces compared to carbide burs. Neither should be used as finishing and polishing instruments, but they are suitable as instruments for initial shaping of the restoration. For polishing, other instruments, such as polishing disks, cups, and intraoral composite polishers yield better results when surface roughness is evaluated. In addition, polishing pastes also significantly decrease Ra values. Nevertheless, the surface characteristics are also material dependent following polishing with these instruments. Filler content, particle size, and the ability of the polishing system to abrade the filler may also contribute to the observed changes in surface characteristics.

Only limited data in the literature are available on the gloss obtained after polishing. For example, contrast gloss was measured in one study using a light scattering method. As observed in the present study, there was an inverse relationship between surface roughness and gloss, which was probably the result of an increase in diffuse reflection from a rougher surface.

With regard to the various bristle brushes used in professional cleaning and polishing, the following recommendations can be given:

1. For cleaning and polishing of dental hard tissue, nylon-bristle brushes in combination with a prophylaxis paste, particularly the perlite-based Cleanic, are indicated, because of the high cleaning ability, the low abrasivity, and the comparably low surface roughness that is induced.
2. Near the gingiva, softer, tissue-friendly rubber cups may be preferred.
3. On resin composite surfaces, the combination of abrasive-bristle brushes and water is to be preferred.

**CONCLUSION**

The results of this comparative in vitro study disclosed no additional positive effect when abrasive-bristle brushes were combined with a prophylaxis paste. There was evidence, however, that abrasive-bristle brushes used with water alone are very efficient instruments for cleaning and polishing resin composite surfaces. The use of abrasive-bristle brushes provides very favorable results in the maintenance of tooth-colored restorations.

**REFERENCES**


