

# Finishing and polishing glass-ionomer cements

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Four different methods for finishing and polishing the surfaces of two different glass-ionomer cements were studied by measuring the roughness of specimens at different stages of the procedures. Method 1 consisted of the four 3M Sof-Lex XT discs. Method 2 included a round, fine-grit diamond and the Vivadent polisher. In method 3 a round Arkansas stone and the Vivadent polisher were used. Method 4 comprised medium and fine sand and fine cuttle paper discs. Petroleum jelly was always used, to prevent heating and desiccation of the specimens. The cements used were KetacFil and KetacSilver. The smoothest surface was found after removal of the strip. The Sof-Lex medium disc gave the least rough surface for KetacFil, whereas the fine cuttle disc gave the smoothest finish for KetacSilver. Discs in sequence are to be preferred to diamonds and stones. □ *Dental materials; in vitro study; operative dentistry*

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Glass-ionomer cements have gained an increasing acceptance in clinical use since they were introduced in the early 1970s (1, 2). Because of their adhesiveness to dental hard tissues, their anticariogenic properties, and their biocompatibility, they have become the materials of choice in many situations (3).

As restorative materials they have been used mainly in class-V and class-III preparations and in erosion and abrasion cavities. With the introduction of the so-called cermet glass-ionomer cements, in which metals are fused to the glass particles, it has also become possible to achieve acceptable clinical results in class-II preparations in primary molars (4).

Several investigations have dealt with the finishing of glass-ionomer cements (5–10). Although several products have been studied, reports concerning finishing and polishing of cermet glass-ionomer cements are lacking. Moreover, the methods used have varied considerably, making comparisons between different finishing techniques difficult.

The aim of the present investigation was to study the effect of four different finishing and polishing techniques on two different glass-ionomer cements. The materials selec-

ted represent a conventional restorative cement and a cermet restorative cement. Measurement of roughness has formerly been used to study surface characteristics of amalgam, composites, and glass-ionomer cements (5, 6, 8, 11–14) and was the method of choice for this investigation.

## Materials and methods

A conventional glass-ionomer cement (Ketac-Fil®) and a glass-ionomer silver cermet (Ketac-Silver®), both made by ESPE GmbH, FRG, and delivered in capsules from the manufacturer, were used in the investigation.

Forty specimens of each brand were made as follows: 5 cylindrical holes with a diameter of 4 mm and a depth of 3 mm were drilled in 16 circular resin blocks (Acryfix®, Struer, Denmark). The capsules were mixed and the materials inserted into the holes in accordance with the manufacturers' recommendations. The material was allowed to flow over the edges of the hole and was covered with a cellophane strip for the time recommended by the manufacturer. After removal of the strip, the specimens were covered with petroleum jelly and stored

in 100% humidity until measurements. Between each step in the finishing and polishing procedure the specimens were kept in a 0.9% NaCl solution.

The specimens were finished and polished with a slow-speed handpiece at 6000 rpm for 10 sec in each step. This was done to standardize the experimental conditions and to imitate the clinical situation, taking into consideration the time consumption. Petroleum jelly was always used, to prevent heating and desiccation of the specimens. The following instruments were used:

Method 1:

Sof-Lex discs (3M, USA)

- a) Coarse grit
- b) Medium grit
- c) Fine grit
- d) Superfine grit.

Method 2:

- a) Horico round, fine-grit diamond W001F025 (Horico, FRG)
- b) Vivadent wheel-shaped polisher (Vivadent, Liechtenstein).

Method 3:

- a) Round Arkansas stone 601 (Meissinger, FRG)
- b) Vivadent wheel-shaped polisher (Vivadent, Liechtenstein).

Method 4:

- Sandpaper discs (S.S. White, England)
- a) Medium-grit sandpaper disc
  - b) Fine-grit sandpaper disc
  - c) Fine-grit cuttle disc.

New discs were used for each specimen in method 1 and 4. Before the measurements the specimens were cleansed with a soft cloth under running water. The specimens were then covered with a drop of water, which was removed with a blast of air immediately before the registration of surface roughness.

*Roughness determination*

At the start of each series, and after each step in the finishing and polishing procedure, the surface roughness was determined with a profilometer (Pertometer W5A, Perthen, FRG), which calculated the arithmetic roughness value,  $R_a$ , in micrometers (11). The instrument was calibrated against a standard. The measuring unit of the pro-

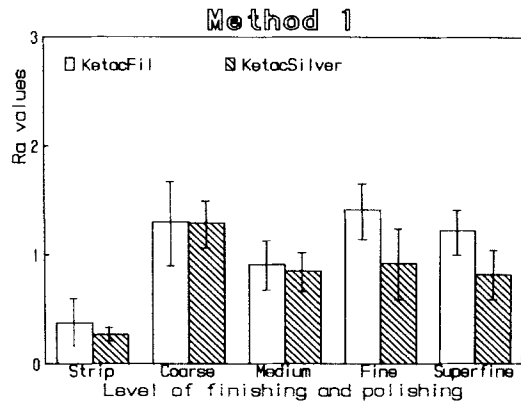


Fig. 1. Roughness ( $R_a$  in  $\mu\text{m}$ ) of KetacFil and KetacSilver after sequential use of coarse, medium, fine, and superfine 3M Sof-Lex XT discs. The bars represent mean values of 10 parallel specimens. Vertical lines indicate  $\pm 1$  standard deviation.

filometer was mounted in a profile projector (Nikon Profile Projector, Japan), so that the specimen could be aligned with the instrument.

Seven parallel scans, 1.5 mm long, separated by a distance of 0.1 mm were made, with another 7 parallel scans at right angles to the first ones: altogether, 14 scans. This procedure gave a total scan length of 21 mm for each specimen. The arithmetic mean of the 14 scans was chosen to represent the roughness of *one* specimen. Thus each condition was characterized by 10 independent specimens. The effect of the waviness of the

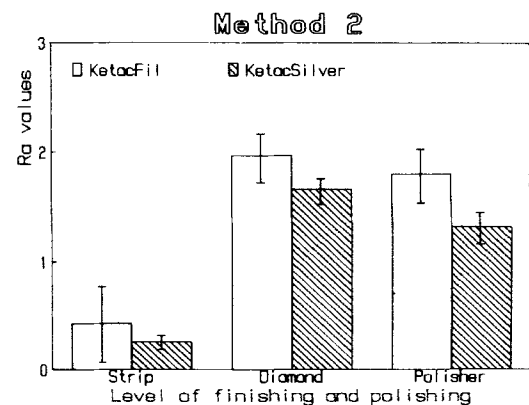


Fig. 2. Roughness ( $R_a$  in  $\mu\text{m}$ ) of KetacFil and KetacSilver after sequential use of round fine-grit diamond and Vivadent polisher. See also legend to Fig. 1.

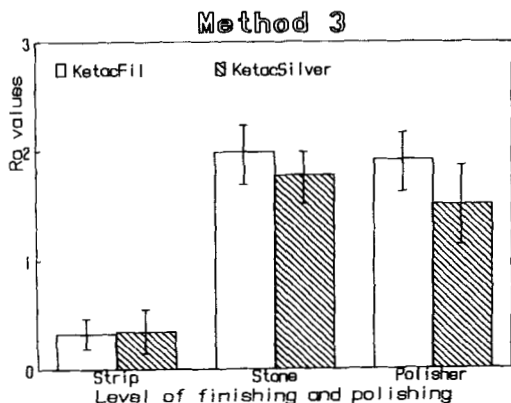


Fig. 3. Roughness ( $R_a$  in  $\mu\text{m}$ ) of KetacFil and KetacSilver after sequential use of round Arkansas stone and Vivadent polisher. See also legend to Fig. 1.

surface was minimized by using a filtration (cut-off) of 0.25 mm (11).

*Statistical evaluation*

Student's *t* test (two-sided) was used to evaluate the statistical significance of roughness values of the different steps for each finishing method. One-way analysis of variance was used to compare the initial values of the different methods.

**Results**

The  $R_a$  values of the specimens after the

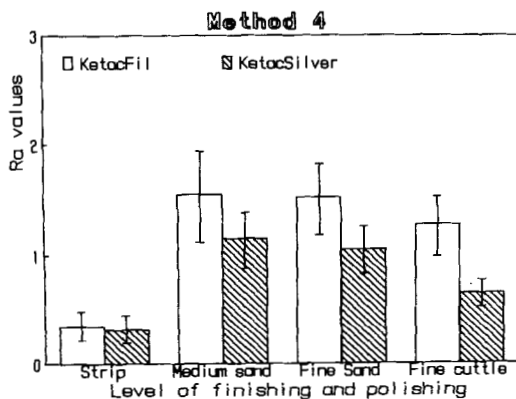


Fig. 4. Roughness ( $R_a$  in  $\mu\text{m}$ ) of KetacFil and KetacSilver after sequential use of medium and fine sand and fine cuttle paper discs. See also legend to Fig. 1.

different finishing and polishing procedures are shown in Figs. 1–4. The corresponding levels of significance are shown in Table 1.

No significant statistical difference was found between the roughness values of the surfaces for the different methods after removal of the strip. The first step in each method, which is a necessary procedure to remove excess filling material, leaves the surface in a rough condition, compared with the specimen surface after removal of the strip. None of the methods managed to return the roughness values to the initial levels (Figs. 1–4). Consequently, the reduction in roughness values was considered from the first step in the procedure and not from the starting level.

In method 1 the step from Sof-Lex discs coarse to medium gave a statistically significant reduction of the roughness level for both materials (Fig. 1). However, for KetacSilver no statistically significant reduction was found with the two last steps in the method. For KetacFil there was a statistically significant *increase* in roughness with the Sof-Lex fine disc and a statistically significant reduction with the superfine disc. However, this decrease in roughness did not bring the  $R_a$  back to the Sof-Lex medium level.

The round fine-grain diamond used in method 2 gave a very rough surface for both materials (Fig. 2). The Vivadent polisher reduced this roughness significantly but still left the surface in a rough condition. The round Arkansas stone used in method 3 gave results similar to those obtained with the diamond (Fig. 3). The Vivadent polisher reduced the roughness significantly for KetacSilver but not for KetacFil. In the paper disc series used in method 4 the greatest effect was attained by the last disc for both materials (Fig. 4). However, for KetacFil the reduction of roughness was not statistically significant. For KetacSilver the last step reduced the  $R_a$  level significantly.

The Sof-Lex medium disc gave the lowest  $R_a$  value for KetacFil, whereas the fine cuttle disc gave the smoothest finish for KetacSilver (Fig. 1). KetacSilver always had a lower  $R_a$  value than KetacFil except for the starting level of the specimens finished by method 3.

Table 1. Significance levels ( $p$ ) for change in surface roughness between sequential steps in three different polishing procedures for two different glass-ionomer cements (starting values not included)

Level of polishing	KetacFil	KetacSilver
Method 1		
Sof-Lex XT Coarse	$p < 0.05$	$p < 0.001$
Sof-Lex XT Medium	$p < 0.001^*$	NS
Sof-Lex XT Fine	$p < 0.05$	NS
Sof-Lex XT Superfine		
Method 2		
Fine-grained diamond	$p < 0.05$	$p < 0.001$
Vivadent polisher		
Method 3		
Arkansas stone	NS	$p < 0.05$
Vivadent polisher		
Method 4		
Medium sandpaper	NS	NS
Fine sandpaper	NS	$p < 0.001$
Fine cuttlefish paper		

\* Indicates an increase in roughness value. NS = not significant.

## Discussion

The results showed that no procedure restored the  $R_a$  values to the initial level for either of the glass-ionomer cements. This is in accordance with former studies (7, 12).

KetacSilver had a smoother surface than KetacFil after polishing. According to the manufacturer, there are two possible explanations for this: first, KetacFil has larger particles, an average particle size of 7  $\mu\text{m}$  compared with 4  $\mu\text{m}$  for KetacSilver. Second, the silver in the silver/glass fused particles in KetacSilver has a high ductility, which leads to an increase in the smoothness.

The medium 3M Sof-Lex XT disc gave the smoothest surface for KetacFil. The increase in roughness after the use of the fine and superfine discs may be attributed to the hard and inflexible plastic discs with edges that might leave coarse scratches also in a clinical situation. It is possible that 3M Sof-Lex discs made from softer material would have given a better result (8, 15). A similar, but far less marked, effect was seen for KetacSilver.

The fine-grit cuttle disc gave the lowest  $R_a$  value for KetacSilver. The size and hardness of the abrading particles seem to be appropriate for the present glass-ionomer cements. Moreover, the softening of the paper disc by the petroleum jelly may have prevented the edge of the disc from scratching the glass-ionomer surface.

The fine-grit diamond and the Arkansas stone were both effective in removing material but left the surfaces in a rough condition. Surprisingly, the Vivadent rubber polisher had no effect on this rough surface. This is in contrast to findings by others (6, 8) but could be explained by use of much coarser finishing procedures before polishing in the present study. A longer working period with the Vivadent polisher could possibly improve the results.

To minimize potential experimental variables, petroleum jelly was used instead of water spray as a lubricant. Petroleum jelly prevents desiccation of the material (6), and it has been suggested that the use of petroleum jelly may give better results than water spray during finishing and polishing procedures (6, 7, 12).

On the basis of the present results, we recommend that glass-ionomer cements should be placed with a minimum of excess material, which reduces or eliminates the need for finishing procedures. If corrections are needed, use of sandpaper/cuttle discs in sequence or the Sof-Lex XT discs gives acceptable results. Should diamonds or stones be needed to remove large excesses of material, care must be taken to ensure that the resulting rough surface is smoothed, using the present discs wherever possible. The Vivadent rubber polisher used with petroleum jelly for the same period of time will leave the surface rough.

On the basis of this study it is impossible to assess the permanence of the polished surface. Former studies of glass-ionomer restorative materials have shown that the surface roughness increases after exposure to oral fluid and oral hygiene procedures (16, 17). Since no such data exist for the fate of KetacSilver surfaces, a clinical study has been initiated to evaluate this effect on the material.

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