Abrasion of acrylic veneers by simulated toothbrushing

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The abrasion responses were tested on four acrylic veneer materials, K+B Plus®, K+B 75®, Isosit®, and Ivocron®. The studies were performed in two independent research laboratories. Two different brushing machines were used with an abrasive slurry. The results were used for comparing the degree of abrasion for the resin materials. Three analytical methods of measuring the degree of abrasive wear were used: surface profile measurement, microscopic evaluation, and measurement of loss of volume. Isosit showed the best abrasion resistance of the four materials tested. □ *Crown and bridge prosthetics; dental materials; surface profile measurements; wear*

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Acrylic facings that have been abraded create clinical problems, such as esthetics and plaque accumulation. The abrasion is primarily caused by toothbrushing. However, the interactions of various types of deteriorating effects on acrylic veneers of crowns and bridges occurring in the oral cavity are complex, and it is difficult to separate the individual effects.

In vivo studies of the abrasive effect of toothbrush/dentifrice on acrylic facings suffer from several uncontrolled factors such as the influence of food, chewing habits, and variation in pressure force. When conducting in vitro wear tests it is desirable to simulate in vivo conditions as closely as possible. This includes the construction of machines that adequately test the resistance to toothbrush/dentifrice abrasion similar to those encountered in the mouth, giving results described by well-defined variables.

The objective of this study was to observe the abrasion resistance of four acrylic facing materials in vitro, using two different abrasion machines that were designed to simulate toothbrushing, over a period of 3–7 years.

Materials and methods

Thirty specimens were made of each of the following acrylic facing materials: K+B 75® and K+B Plus® (De Trey) and Ivocron® and Isosit® (Ivoclar). Incisal, body and cervical acrylic resins were used from each material. The specimens were baked into a metallic mold (21 × 15 × 4 mm) and mixed, processed, and polymerized in accordance with each manufacturer's specifications. The surface of interest was polished, using conventional dental laboratory methods. The specimens were kept in water for 30 days or longer at room temperature until mounted in the machines. They were all made in the same laboratory (Stockholm). All operations were performed by the same investigator (P. Wellton).

Two machines were constructed for the simulated toothbrushing, one in Beijing and one in Stockholm. Half of the specimens made were tested with each machine at room temperature.

The machine used in Stockholm consisted of a drive motor with an attached revolution vertical disc with eight toothbrush heads (Lactona soft) mounted on the periphery. The toothbrushes passed a slurry of Pepsodent toothpaste (30 g in 50 ml water). The specimen pressure to the toothbrush was 200 g, and each specimen was brushed with 25,000 strokes during a period of 6 h. New toothbrushes were used for each specimen. The tests were repeated on 10 specimens of

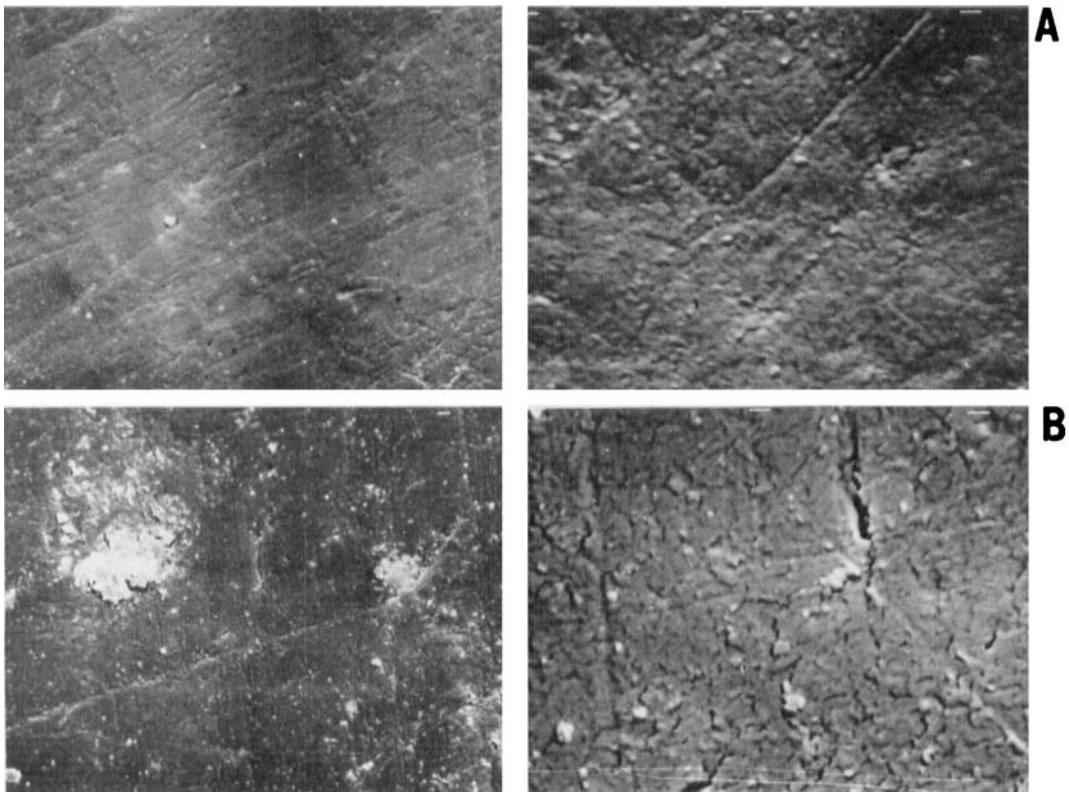

Fig. 1. SEM photographs of specimens at ×1000 and ×5000 magnifications after wear testing with a slurry of calcite powder (320 grit) and water on a soft cloth disc; 74 rpm for 2 h at a load of 1500 g. (A) Isosit®; (B) K+B 75®; (C) K+B Plus®; (D) Ivocron®.

each type. About half the surface of the specimens was covered with a metal foil to preserve an intact reference surface.

These specimens were analyzed by a profilometer, Talysurf, with an amplifier and a recorder, comparing the reference surface with the abraded part of the surface of the specimen. The profile of the surface was thus recorded and measured in accordance with methods previously reported (1, 2).

The machine used in Beijing consisted of a drive motor with two attached revolution vertical discs (150 mm in diameter) with a soft cloth mounted in between. The cloth passed a slurry of calcite powder (Mohs' hardness 3; 320 grit) in water at a 1:1 ratio. The specimen's pressure on the cloth was 1500 g (0.85 kg/cm^2). The rotation velocity was 74 rpm during a period of 2 h. The tests were repeated on five specimens of each type.

In the Beijing machine the degree of abrasion was calculated as loss of volume; the specimens were dried and weighed before and after the wear test to constant weight. The loss of volume was calculated by using the specific gravity, and the wear rate was calculated as loss of volume per sliding

Table 1. The abrasive wear rates expressed as the volume of material lost per unit sliding distance

Acrylic facing material	Wear rate (mm^3) mean ± SD of 5 specimens
Isosit®	21.6 ± 4.8
K+B 75®	455.2 ± 71.5
K+B Plus®	422.0 ± 60.5
Ivocron®	369.8 ± 34.4

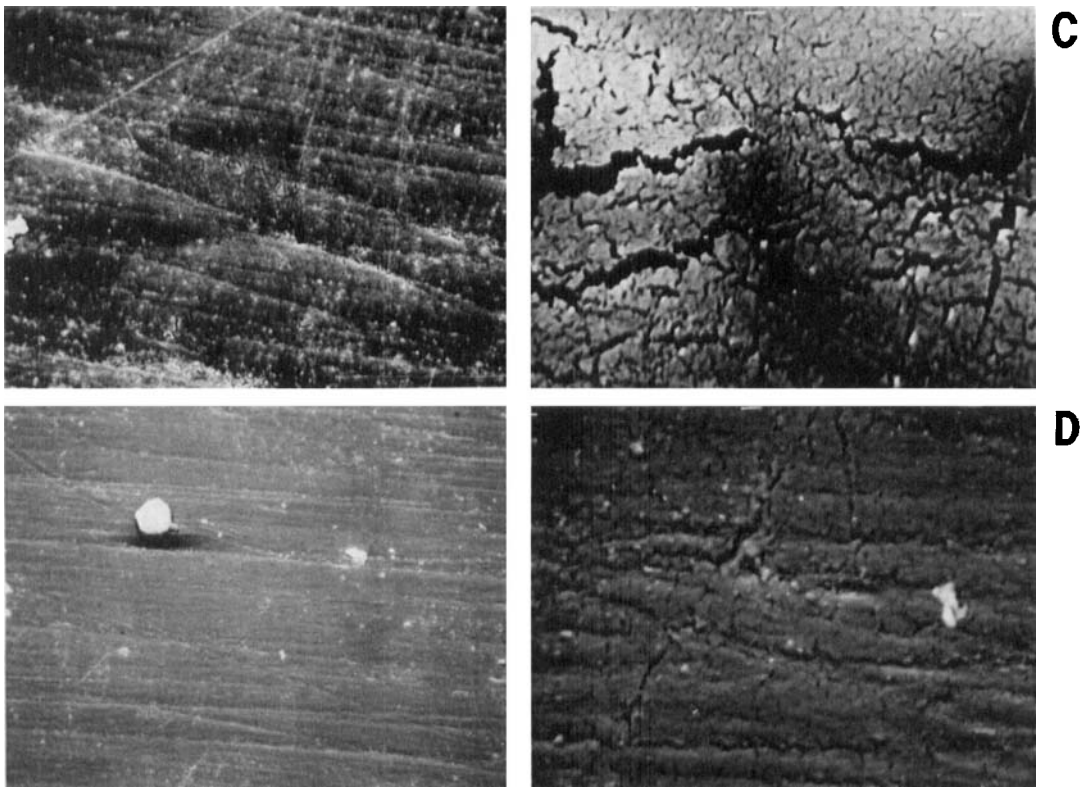

Fig. 1. (*Continued*).

millimeter. All the specimens were also studied in a scanning electron microscope (JSM-T20, Jeol) after having been coated with a gold film by an ion sputtering device.

Results

The microstructures of the wear patterns obtained with the Beijing machine, as seen in SEM photographs at ×1000 and ×5000 magnifications of the specimens, are presented in Fig. 1.

In the Isosit specimens no cracks were found similar to those observed in the other three materials. These patterns were obtained after abrasive wear for 2 h in the Beijing machine.

K+B 75 became more dull than the other three materials.

The decrease in volume of the specimens obtained with the same machine and wear procedure is tabulated in Table 1. There were no significant differences among K+B 75, K+B Plus, and Ivocron, but Isosit showed a significantly higher degree of abrasive wear resistance than the other three.

In the toothbrushing machine (the Stockholm machine) the surfaces of all specimens showed a reduction of the level as compared to the reference part of the surfaces measured by the Talysurf (Table 2).

Table 2. Profilometer readings indicating the difference between the level of the reference surface and the base line of the profiles

Acrylic facing material	Difference (μm), mean ± SD of 10 specimens
Isosit®	5.3 ± 2.1
K+B 75®	13.4 ± 2.9
K+B Plus®	17.9 ± 7.1
Ivocron®	17.6 ± 6.3

The profilometer data (Table 2) showed that the reduction of the profile heights of K+B 75, K+B Plus, and Ivocron were of the same order of magnitude. Isosit showed clearly less reduction than the other three materials.

When the incisal, body, and cervical materials from the same brand were compared, it was obvious that the incisal material showed somewhat more wear resistance than the body and cervical materials. This was the case for all four brands studied.

Of the four materials analyzed Isosit thus showed the greatest resistance to abrasion in the various comparative abrasion tests. There were no significant differences in the results obtained for the other three materials.

Discussion

Problems encountered in this type of study and interpretation of results have been discussed elsewhere (3–7). The influence of chemicals on the wear resistance has also been discussed (8).

Many factors may raise or lower the clinical rates of wear relative to the values obtained from these experimental designs on flat acrylic specimens at room temperature. Consequently, it is not possible to obtain a strong quantitative correlation between these in vitro studies and clinical observations of wear. However, a logical assumption may be that the order in which the materials were ranked for wear is probably the same as that shown clinically for the same materials.

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