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Abrasion Resistance of Veneering Materials to Tooth Brushing

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This study was carried out to comparatively examine abrasion which occurred as a result of brushing as well as abrasives in veneering materials used in prosthetic restorations. Twenty out of forty specimens prepared at the dimensions of 14×5×3 mm, there being ten specimens of each veneering materials, were subjected to tooth brushing with water alone. The other twenty specimens were subjected to a tooth brushing procedure with a paste- water mixture with the aim of evaluating the effects of abrasives on abrasion. As a result, it was statistically determined that porcelain, an ideal facet material, had the best resistance to abrasion by toothbrush, light cured aesthetic materials being second Poly methyl methacrylate had the least abrasion resistance.

Key words: Veneering materials, Abrasion resistance, Toothbrush

INTRODUCTION

Abrasion resistance and the firm of restorative materials used with an aesthetic aim are significant factors affecting clinical success[1,2]. The fact that the surface firm of restorative materials used in dentistry is at a ratio near that of the enamel makes it resistant to abrasion[3].

Porcelain is an excellent aesthetic material used in fixed prosthetics, but in recent years resins for crowns which can be constructed easily have been developed. Although the usage of methyl methacrylates has been common after improvement of their structures and colours, it is known that these materials have a lot of disadvantages. One of the most significant disadvantages is that they display quick abrasion. Efforts to increase the resistance of such acrylics to abrasion have become numerous in years and various composites including inorganic micro- filling which exist in Bowen's BIS-GMA resin matrix have been manufactured for this purpose[4,5]. Today, systems which greatly reduce laboratory procedures regarding these materials whose polymerization is obtained under heat and pressure and those polymerizated with light have been developed[6−8].

This study was carried out with the aim of comparatively examining abrasion occurring as a result of tooth brushing veneering materials used in prosthetic restorations.

MATERIAL AND METHODS

Aesthetic materials used in the study are shown in Table 1.

An automatic mechanical tooth-brushing machine designed according to suggestions offered by Hembree and Hembree[9] was used for the purpose of determining abrasion caused by routine tooth brushing. The machine consisted of a 50 rpm gearmotor (cone type design), with a six- digit electrical impulse counter, a five toothbrush stroke arm, and a specimen stage.

Teflon moulds (Teflon, polypenco-salford, Lancashire, UK) with dimensions of 14×5×3 mm were used to prepare specimens to be tested.

Dentacolor specimens were obtained by setting types into these moulds and photo polymerization using a blue- light on a 400 nm wavelength. Isosit specimens were obtained under heat and pressure and Biodent specimens were obtained by using short heating technique after taking wax specimens shaped with the help of a muffling mould (muffles reach their heating point in 30 minutes providing that they boiled for 30 minutes). Porcelain specimens were prepared by kiln-drying them in an oven at 800℃ after they were condensed by setting porcelain dough into these spaces. Porcelain specimens made of glazing but acrylic resin and composite specimens were polished using routine methods. After the surfaces of acrylic resin and composite specimens were smoothed by 1,000 SiC paper, they were polished with purnice powder as mentioned in ISO 14569-1.

A total of 40 specimens consisting of 10 specimens from each aesthetic type were dessicated for hours, their weight to the nearest 0.0001 gm was recorded (Sartorius Research R 200), and it was mounted on an acrylic resin stage.

It was decided that half of these specimens would be brushed with the paste-water mixture but the other half of them were brushed with water alone for the purpose of evaluating the effects of abrasives on abrasion. Colgate Precision Compact, a toothpaste used commonly as an abrasive, was chosen. This paste was mixed with 50% percent distilled water (half of it is paste, the other is water) according to researchers' suggestions[10].

Specimens which brushed with the paste-water mixture and with water alone were examined separately. Each specimen was brushed with a standard toothbrush (Oral-B 35) for 75,000 strokes, which is equivalant to approximately $4_{1/2}$ years of normal toothbrush abrasion based on estimates in previous investigations[11]. A new

Table 1 Used Materials

Veneering Materials	Brand name	Manufacturer
Methyl methacylate	Biodent K-B plus	De Trey Dentsply
Feldispatic porcelain	Porcelain	Ivoclar, Made in Liechtenstein
Inorganic micro filling composite	Isosit	Ivoclar, Made in Liechtenstein
Inorganic micro filling composite	Dentacolor	Kulzer GmBH, Germany

toothbrush was used with each specimen. Each toothbrush had a constant applied load of 1.37×10^{-4} Pa during the brushing cycle. At the end of the 75,000- stroke cycle each specimen was removed, dried in a dessicator for 24 hours, and weighed. The weights were recorded and then subtracted from the original weights to obtain the amount of weight loss during the 75,000- stroke cycle[10]. During the experiment, the paste- water mixture and the distilled water were applied to materials using an injector at certain intervals. The data constituted a statistically evaluated analysis of variance. The level of confidence was 95%.

SEM pictures obtained from the surfaces of specimens after the abrasion procedure, are shown in Figs. 1-4.

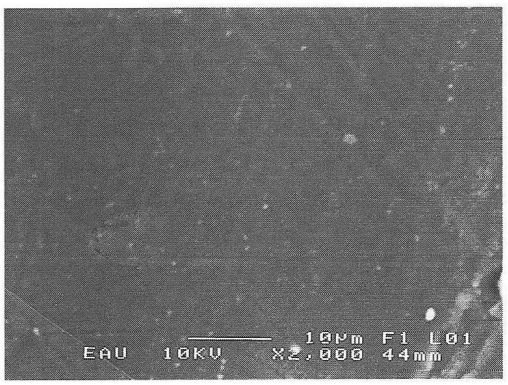


Fig. 1 SEM display obtained from porcelain specimens after (water) toothbrush abrasion.

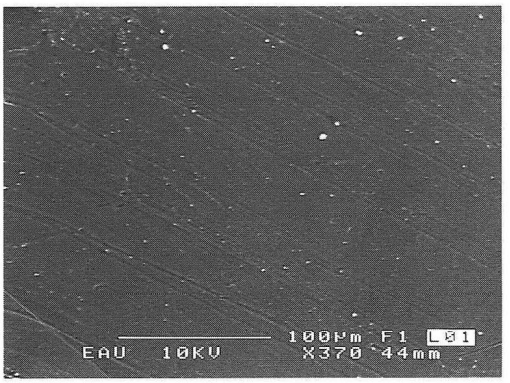


Fig. 2 SEM display obtained from porcelain specimens after (paste-water) toothbrush abrasion.

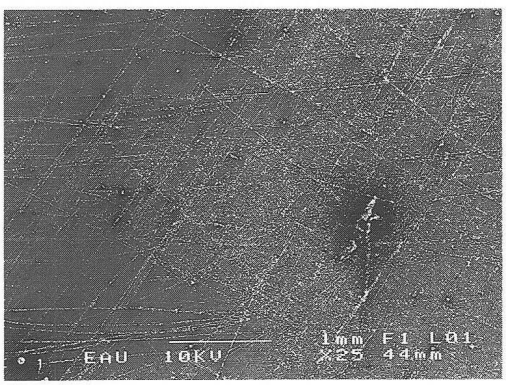


Fig. 3 SEM display obtained from Biodent specimens after (water) toothbrush abrasion.

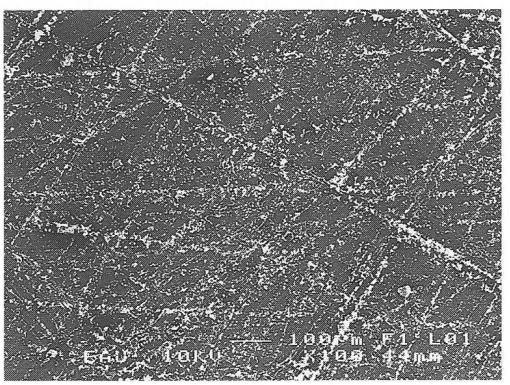


Fig. 4 SEM display obtained from Biodent specimens after (paste-water) toothbrush abrasion.

Table 2 The number of specimens and their values obtained after brushing veneering materials with the table presenting mean (mgr) and standard deviation

Veneering Materials	N	Without Paste		Paste	
		X	SD	X	SD
Dentacolor	10	0.79	0.01	1.50	0.01
Porcelain	10	0.25	0.01	0.92	0.01
Isosit	10	2.32	0.02	2.87	0.02
Biodent	10	7.54	0.03	11.82	0.03

RESULTS

It was statistically found ($p<0.001$) that the type of aesthetic material used and the effect of abrasives on abrasion were significant in the results of the analysis of the variance used for evaluating data.

The results of the mean and standard deviation of weight loss after brushing aesthetic materials with the paste-water mixture, water alone, as well as the results of multi-comparison test are shown in Table 2.

It was statistically determined (Table 2) that porcelain showed the least abrasion. Showed the most abrasion, Biodent and specimens brushed with the paste-water mixture even more than those brushed with water ($p<0.05$).

When evaluating the surface features of specimens, the same toothbrush brushing traces were noted in both the group with paste and without in the shape of continuous lines (Fig. 1, 2).

It was observed that Biodent specimens formed rougher surfaces and displayed deep brushing traces, especially after the brushing procedure compared with the others (Fig. 3, 4).

DISCUSSION

Studies dealing with abrasion have concentrated a great deal on the influence of types of brushes and filling- materials as well as various pastes, brushing techniques, and also on the features of abrasion on artificial teeth[12-14]. There has also been some research on the effects of brushing on veneering materials used in fixed prostheses[11,15-17].

As porcelain is superior to other aesthetic materials in its resistance to abrasion, it is obvious why porcelain is the most common facet material currently used[5,18]. It was determined that there was a loss of substance at a minimal level in porcelain specimens after brushing in this study. This result is similar to the findings of Staffanou *et al.*[10]. Fatigue in ceramics is a result of the subcritical growth of cracks, aided by the combined influence of water and stress[19].

It was shown that Dentacolor, whose polymerization was obtained with beans, was very resistant to abrasion. It was concluded that multifunctional methacrylic acid ester and silicon dioxide micro fillings at 0.04μm diameters aided its resistance

to the substance[20]. Yesil Duymus and Güldag[18] have stated that porcelain showed the least abrasion in their study with Dentacolor second.

In many studies researchers have pointed out that the abrasion ratios of composites depended on the number of fillings involved and their dimensions. The most resistant ones were composites in which there were a great number of big and firm fillings and that the ratio of abrasion increased as particular dimensions became smaller[21-25].

Kawai *et al.*[26] examined the influence of resin monomer composition against abrasion of toothbrushing, determining that the amount of abrasion was different in terms of its monomer content. It was determined that the weight loss after brushing in Isosit specimens, which include a small number of inorganic fillings, and in specimens whose polymerization was obtained with heat and pressure was more than that of porcelain specimens with much more abrasion because of methacrylates used commonly in routine.

This result agrees with the findings of Staffanou *et al.*[10] and Neil[27]. Poly methyl methacrylates are soft materials. The physical removal of plaque by brushing is important in the maintenance of oral health. However, there is a danger that brushing will abrade acrylic resin[28]. In this study, it was determined that Biodent, a methyl methacrylate, caused more abrasion after brushing than the other two substances. If Poly methyl methacrylates are used as aesthetic material, as Phillips[5] stated, the importance of advising the use of soft brushes and pastes with no abrasive influence for patients is understood. Haselden *et al.*[29] showed that cleaning pastes play a significant role in the wear of conventional acrylic resins, the relative abrasiveness of the dentifrices being substrate related. However, wear was less evident on the light activated urethane dimethacrylate resin. Brushing with water alone produced no detectable wear on any of the specimens. In this study, it was statistically determined that specimens brushed with the paste-water mixture and with water alone displayed different wear values. More wear was seen in group brushed with paste-water.

In recent times, flour in the form of sodium flour and sodium mono flora phosphate has been added to toothpastes in order to prevent the occurrence of carieous. It has been stated that the abrasive power of a toothbrush alone is very little unless it contains very hard hair and extreme force is applied during brushing. It is wiped with paste, abrasion increases[30].

Franz[31], in his study, examined the influence of various pastes and toothbrushes on composite filling-materials and plastic materials and stated that the firmness of the substance wasn't the only abrasive element, the surface structure, roughness and crystal structure of the substance also played a significant role in this action.

In general, toothpastes cause very little abrasion. Abrasion and cleaning procedures shouldn't be confused with each other. As long as the abrasive power of a toothpaste reaches a certain limit, cleaning power increases. However, if this limit is exceeded then abrasion becomes harmful. Toothpastes shouldn't have an abrasive influence on amalgams, composite fillings or crown- bridge prostheses but they should polish and clean them.

When evaluating surfaces features before the experiments it was seen that porcelain had the smoothest surface. The brightness of the surfaces of Dentacolor and Isosit depended on respectively micro fillings available in their structure. After experiments the loss of brightness was observed on their surfaces.

As might be expected, porcelain showed the least surface and volume loss. Wear may have been the result of small fragments being lost during the mounting of the specimens, because not all specimens showed a weight loss. That of Isosit was comparable to the methyl methacrylate resins, which was reported by the manufacturer[32]. However, the findings speak well for Isosit in that it is far superior to the methyl methacrylate resins with regard to abrasion resistance. A comparison with porcelain is relative, since the excessive hardness of porcelain is known to cause substantial wear of opposing natural teeth and metal restorations[33]. Isosit should not produce a significant wearing of opposing natural teeth. Only further research and/ or clinical trials will determine if the abrasion resistance of these materials is acceptable for occlusal applications.

CONCLUSION

This study was carried out with the aim of examining abrasion occurring as the result of toothbrushing and abrasives in aesthetic materials used in prosthetic restorations. It was determined that porcelain had the most abrasive resistance with Dentacolor second. Biodent had to the least abrasive resistance. It was also determined that specimens in the group brushed with paste-water showed much more abrasion.

As a result, it was proved once more that porcelain is the most ideal aesthetic material with the regard to its abrasion resistance.

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