New Aspects of the Acrylic Teeth Denture Base Resin Bond Strength

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The purpose of this study is associated to the investigation of the acrylic teeth denture base resin interface with invasive tests such as tensile testing. 30 large size artificial acrylic first upper molars (Spofadent Plus_Spofa Dental) were milled to 30 acrylic cylinders. The cylinders were randomly assigned in three experimental groups, so that 10(ten) cylinders were distributed to each one of the three (3) experimental sample groups. The bonding flat surfaces of the cylinders were submitted to a different treatment: Group 1: (control group_without treatment), Group 2: Benzene, Group 3: Toluene. For the chemical treatment procedures, organic solvents with 98.9% chemical purity were used. The bonding test samples were realized according to ADA specification No. 15, using a self-cured denture base repair resin (Duracryl–Spofa Dental, Kerr Company). Each sample was stored for 30 days in distilled water and in tensile tested at 1 mm/min speed. The mean values of the tensile bond strength test registered were statistically significant among groups, ranging from 26.5 MPa (group 1) to 23.13 MPa (group 3). The results of this study suggest the fact that the chemical treatment with the mentioned organic solvents improves not in a significant manner the adhesion of the acrylic teeth to the denture base resin.

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Keywords: acrylic teeth, benzene, bond strength, methyl methacrylate, poly (methylmethacrylate), tensile testing, toluene

The optical, mechanical and esthetical properties, and also the biocompatibility of acrylic resins, are some of the great advantages that make the acrylic resins the most used resins for complete denture fabrication [1, 2]. But their esthetic, physical, and mechanical properties change fast with time in the oral environment. Typical changes are due to sorption, which depends on liquid absorption and adsorption [3].

Bond failures at the artiûcial acrylic tooth denture base resin interface are overall a common clinical problem [4]. Although artificial acrylic teeth can be chemically bonded to the denture base, previous studies have shown that of all the repairs carried out in dentures, 20 to 33% continue to be related to artificial teeth breaking off or to their detachment from denture bases [4-7]. In the last case, this is caused by a bond failure in the interfacial region between the tooth and denture base resin. Considering the amount of time and money spent on denture teeth repairs, [8] bond failures at the artificial acrylic tooth denture base resin interface must be reconsidered and continuously subjected to bond strength investigation tests [7].

During the years, different attempts have been made to improve the bond interface between acrylic teeth and denture base repair resin: mechanical treatments [9-12], chemical treatments (monomers, organic solvents, [13, 15]), treatments that have been reported as useful for adhesion improvement by some researches [16–18] and as useless by others [19]. In order to improve the acrylic teeth denture base repair resin interface after solvent chemical treatment, the solvent must be carefully selected so that the plastic to be specifically bonded. They must have an accurate, appropriate solvency to soften the plastic surfaces to a proper depth [20, 21]. Benzene (C_6H_6) is an aromatic hydrocarbon pertaining to the functional group of arene, this being the generalized structure of benzene. It is one of the most basic petrochemicals, a highly flammable liquid. It is an important industrial solvent and precursor to basic industrial chemicals. Because of his carcinogenic effect the use of benzene is limited. Toluene ($C_6H_5CH_3$) is an aromatic hydrocarbon, a mono-substituted benzene derivative in which a single hydrogen atom from the benzene molecule has been replaced by CH_3 (methyl). Toluene is an important organic solvent and also an inorganic solvent for a significant number of inorganic chemicals. Toluene is, less toxic than benzene, and as a consequence was/it is largely replaced as an aromatic solvent in chemistry.

The aim of this study is focused on the acrylic resin teeth denture base repair resin tensile bond strength investigation after organic solvents chemical treatment effect on the acrylic teeth ridge lap area, in order to depict if the two solvents improve, or not, the acrylic teeth ridge lap area denture base repair resin bond strength.

Experimental part

Materials and methods

The technical procedure steps followed in order to realize all of the 30 samples of the three investigated groups, were performed according to technological stages that can be found also in another author articles such as [22-24], so that initially from 30 artificial acrylic first upper molars 30 cylinders were obtained, by milling, acrylic cylinders with size and shape equal to those recommended by ANSI/ADA Nr.15, cylinders with which tensile testing samples, also, with a ANSI/ADA No.15 corresponding standard shape and size, were obtained [22-24], as it can be seen in the two figures 1, 2, 4 after the two acrylic cylinders bases of the group 2 samples were submitted to benzene chemical treatment, and the two acrylic cylinders bases of the group 3 samples were submitted to toluene chemical treatment figure 3. The two bases of the acrylic cylinders of the control group (group 1) samples have been left chemically untreated.

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Fig.1.The ANSI/ADA Nr.15 cylinders shape and size

Fig.2. Aspects of the sample pattern mold

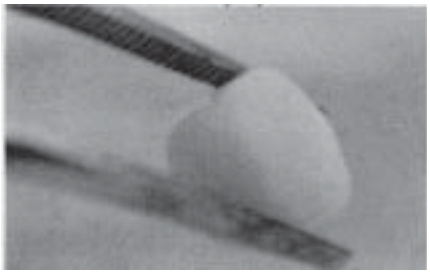

Fig.3. Aspects of the chemical treatment of the cylinder flat surfaces

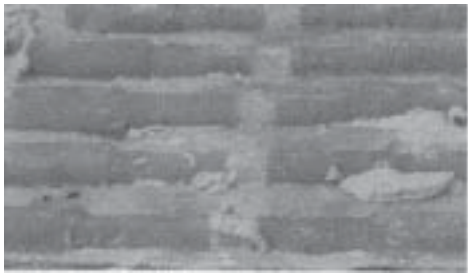

Fig.4. The ANSI/ADA No.15 final shape and size of the samples after being unpacked

Fig.5. Aspects from the polymerization process

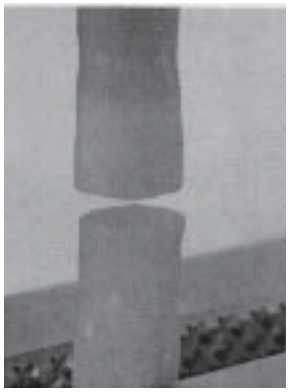

Fig.6. Adhesive fracture of the tensile sample

After the chemical treatment of all the 40 acrylic cylinder flat bases was realized, the next step of the tensile test sample realization was the preparation and the mould stamping of self cured acrylic denture base repair resin (Duracryl SPOFA Plus Dental, Kerr Company) followed by the polymerization process following the manufacturer's directions [22-24] (fig.5)

After the polymerization process all the samples were unpacked.

For 30 days all the samples were kept in distilled water at a temperature of 37 degrees Celsius (37°C).

All the samples were tested in tensile, with Multitest 5i (Mecmesin) at 1 mm /min speed (fig.4).

The MegaPascals tensile strength values from the table 1. Can be obtained with the formula:

R = F / S, where F = force and S = surface

Results and discussions

According to Scheffe post-hoc Test, from table 4 it can be seen the fact that significant differences, ($p < 0.001$), were found between the three groups submitted to tensile strength test. Between Control Group (no treatment) and Group 2 (benzene treated acrylic teeth) significant differences were registered ($p < 0.001$), with other words the control group registered values significant higher compared to those pertaining to Group 2. Comparing the values of the Control group 1 with those pertaining to Group 3 (toluene treated acrylic teeth) not significant differences were registered (0.003^s). Higher values and statistically significant differences were registered comparing the Group 2 (benzene) with Group 3 (toluene) so that significant differences were registered ($p < 0.001$) between the 2 groups.

Table 1

TENSILE STRENGTH VALUES IN MEGAPASCALS

Sample Crt. Nr.	Group 1 *Control*	Group 2 *Benzene*	Group3 *Toluene*
1	26.61	21.82	24.11
2	25.88	26.10	26.62
3	27.66	24.88	22.09
4	26.06	29.08	17.99
5	27.79	26.11	25.01
6	27.08	26.74	21.26
7	26.39	28.67	23.97
8	25.47	26.28	26.42
9	25.88	24.51	18.33
10	26.18	22.45	25.58

The MegaPascals tensile strength values from the table 1. Can be obtained with the formula: R = F / S, where F = force and S = surface

Table 2

COMPARISONS BETWEEN THE VALUES OBTAINED AFTER TENSILE STRENGTH TEST

GROUP	N	Mean	Std. Dev.	Std. Error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
1	10	26.5000	0.78145	0.24712	25.9410	27.0590	25.47	27.79
2	10	25.6640	2.34956	0.74300	23.9832	27.3448	21.82	29.08
3	10	23.1380	3.13129	0.99020	20.8980	25.3780	17.99	26.62
Total	30	25.1007	2.65681	0.48506	24.1086	26.0927	17.99	29.08

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	140.653	2	70.327	72.739	**0.000**
Within Groups	26.105	27	.967		
Total	166.758	29			

Table 3
ONE WAY ANOVA TEST

(I) LOT	(J) LOT	Value p	Sig. level (α
1	2	$< 0.001^{s}$	0.001
	3	0.003^{s}	0.05
2	3	$< 0.001^{s}$	0.001

^{s} – Significant differences
^{ns} – Not significant differences

Table 4
COMPARISON OF GROUPS (SCHEFFE POSTHOC TEST)

Conclusions

Within limitations of this study and considering the fact that the tensile test values of the groups 2 and 3 are lower than the amount stipulated by the ANSI/ADA specification No. 15, value of 31 MPa, it could be considered that the organic solvents used in this study are not specifically indicated for the chemical treatment of acrylic denture teeth in order to improve their bond strength to the denture base resin.

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Manuscript received: 5.02.2015