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Is the Bond Between Acrylic Resin Denture Teeth and Denture Base Resin Stronger if They are Both Made by the Same Manufacturer?

Reshma Patil*, Andrzej S. Juszczyk†, David R.Radford‡ and Robert K.F.Clark§

Abstract - *A previous study suggested that a stronger bond may be achieved between acrylic resin denture base material and acrylic denture teeth when both are made by the same manufacturer. Three denture base acrylic resins from three different manufacturers were bonded to three different acrylic resin denture teeth, one of which was manufactured by each of the manufacturers of the base material. In each group there was a trend that the bond strength achieved between the teeth and base material from the same manufacturer was higher than the unmatched pairs but statistical significance was not achieved.*

KEY WORDS: Acrylic resin, denture teeth, bond strength

INTRODUCTION

The bond between acrylic resin denture teeth and the denture base acrylic resin is unreliable, inconsistent and unpredictable[1]. The optimum combination of acrylic resin denture tooth, denture base material and processing method may not yet have been achieved[2]. The strength of the bond between the denture tooth and the base acrylic resin may be influenced by chemical[3,4,] and mechanical[5,6,7] modification of the ridgelap of the denture teeth and the type of acrylic resin base material used[8,9,10,11,] the type of denture teeth[12] and the presence of residual materials such as wax and alginate mould seal on the ridgelap surface[13,14].

Traditionally a long curing cycle has been recommended and has been thought to produce the greatest transverse strength. However, over a period of time manufacturers have developed their materials and it has been suggested that long curing cycles may not be necessary[15,16]. Athar *et al*[17] recommended following the curing cycle suggested in the manufacturer's instructions for specific acrylic resins.

Dalal *at al*[18] investigated the effect of short, medium and long curing cycles on the tensile bond strength between cross linked homogenous acrylic denture teeth and three different brands of heat cured acrylic resin denture base material. The long curing cycle and the manufacturer's recommended medium curing cycle produced the strongest bond. The strongest bond was produced when the base acrylic resin was made by the same manufacturer as the denture teeth. As only one type of tooth was used, with three different acrylic resin base materials, this was a finding that might not be generalisable.

The aim of this investigation was to test the hypothesis that a stronger bond can be achieved when both acrylic resin denture teeth and acrylic resin denture base material are made by the same manufacturer.

MATERIALS AND METHODS

Table 1 lists the three different brands of heat cured poly(methylmethacrylate) denture base acrylic resins and cross linked acrylic resin denture teeth that were investigated.

Dumbbell-shape tensile specimens were prepared in four stages as previously described[18,19]. In brief, the first stage was to produce sections of the selected teeth 2mm thick to be incorporated into the test specimens. The second stage was to invest standard aluminium dumbbells 37.1mm long, 5mm diameter in the test portion and 7.9mm at the dumbbell ends in a standard denture flask. The third stage was remove the aluminium patterns from the flask, position a tooth section in the centre of the dumbbell and pack acrylic resin to produce the experimental dumbbells. After processing and deflasking the fourth stage was to turn the dumbbells to standard dimensions on a lathe. They were milled to the appropriate size (27.5 mm length and 4 mm diameter, the head diameter 7mm). All specimens were stored in water of room temperature 20˚C ± 2˚C for one month before testing for tensile strength.

Nine groups of specimens were made using every combination of base acrylic resin and denture teeth. The total number of specimens prepared was 135. These specimens were classified into groups on the basis of type of polymethylmethacrylate resin used and each sub grouped on the basis of the type of tooth (Table 2).

To ensure uniformity, the manufacturers' instructions were followed through out. For consistency the manufacturers' medium curing cycles were used for each material (Table 3). The flask was assembled and put under a hydraulic press) and closed slowly up to a pressure of 100 kg/cm² for period of 20 minutes. The flasks were then transferred to spring clamps to maintain the pressure.

* BDS MSc
† PhD LCGI
‡ BDS PhD MRD
§ BDS Phd FDS

Table 1. *List of selected denture base materials and acrylic resin teeth used*

PMMA	*Acrylic Resin Teeth*	*Manufacturers*
Pegasus Plus	Enigma	Davis Schottlander & Davis Ltd, Letchworth, UK
Probase Hot	Gnathostar	Ivoclar Vivadent Ltd, Schaan, Liechtenstein
Paladon 65	Basic 8	Heraeus Kulzer GmbH, Hanau, Germany

Table 2. *Specimen groups*

Group	*Type of PMMA*	*Type of tooth*	*No of specimens*
A	Pegasus Plus	Enigma	15
		Gnathostar	15
		Basic 8	15
B	Paladon 65	Enigma	15
		Gnathostar	15
		Basic 8	15
C	Probase Hot	Enigma	15
		Gnathostar	15
		Basic 8	15

Table 3. *Selected processing cycles for denture base materials*

Materials	*Processing cycles*
Group A Pegasus Plus	Raise the temperature to 70°C and maintain for 90 minutes, then final boil for 2 hours. Allow to cool down slowly.
Group B Paladon 65	Heat to 70°C for 30 minutes and hold for more 30 minutes. Heat to boiling point for 20 minutes and maintain. Allow to cool for slowly 30 minutes.
Group C Probase Hot	Heat to 100°C and boil for 45 minutes. Allow to cool down slowly.

Table 4. *Mean (standard deviation) of tensile strength of acrylic resin and tooth type and number of specimens in each group.*

	BASE		
Tooth	*Pegasus Plus*	*Paladon 65*	*Probase Hot Base*
Enigma	39 (3.10) n=15	36 (2.14) n=15	31 (4.93) n=12
Gnathostar	32 (3.42) n=15	32 (4.29) n=15	33 (3.58) n=15
Basic 8	31 (7.47) n=15	37 (3.18) n=11	30 (6.04) n=15

* Base different from other bases within tooth ($p<0.05$)
** Tooth different from other teeth within base ($p<0.05$)

All specimens were then tested on an Instron 1195 testing machine. Individual specimens were placed in to the Instron 1195 testing machine at a cross head speed of 1mm/minute with the integrated chart recorder speed set at 1mm/second. Calibration of the testing machine was carried out before the testing commenced and was checked following every tenth specimen. The full scale of the chart recorder was set at 1000 N. Load was increased to the point of catastrophic failure at which time the test cycle was stopped.

Statistical Method

Data conformed to a Normal distribution. Two-way analysis of variance (ANOVA) was used to determine whether there were differences in tensile strength between levels of [base] and [teeth]. Subsequently a *post hoc* Tukey test was used to test for individual differences.

RESULTS

Table 4 presents the descriptive statistics for all nine groups. The paired resin and tooth Pegasus Plus combined with Enigma tooth gave a higher strength as compared to that when combined with Gnathostar and Basic teeth although there was no statistically significant difference ($p<0.05$). The paired resin and tooth Paladon 65 base showed a higher strength for the combination with Gnathostar tooth compared with combination with the Enigma and Basic 8 teeth ($p<0.05$), although again this did not reach statistical significance different from each other. There was a higher strength for Probase Hot base combined with Gnathostar tooth as compared to combination with Enigma and Basic 8 teeth, but again there was no statistically significant difference.

DISCUSSION

Dalal *et al*[18] investigated the effect of curing cycle on the strength of the bond between homogenous cross linked acrylic resin denture teeth and heat cured acrylic resin denture base material. They found that the strongest bonds were achieved when the manufacturer's recommended curing cycle or a long curing cycle was used. A marginally statistically significant stronger bond was achieved when both the denture teeth and the base acrylic resin were made by the same manufacturer. This present study matched pairs of acrylic resin denture teeth and denture base acrylic resin materials from three separate manufacturers. Although statistical significance was not achieved, a trend was evident in that each of the acrylic resin denture base materials formed a stronger bond with the denture teeth from the same manufacturer.

The ADA specification No 15 asserts that the minimum standard for bond strength should be 31 MPa. In this study one sub group (Probase Hot denture base resin and Basic 8 denture teeth) failed to reach this standard. These materials are produced by different manufacturers.

The overall results go some way to offer limited support for the suggestion of Dalal *et al*[18] that a stronger bond may achieved by materials from the same manufacturer. It may be reasonable to assume that manufacturers design and engineer their products to achieve the best possible bond strength between them.

Many factors have been shown to affect the bond strength of the joint between acrylic resin denture base resin and denture teeth[1-14]. Clearly no particular factor is responsible for weak bonds: rather this is a multifactorial problem. Every possible cause of weak bonds should be minimised. From a practical point of view one might suggest that when choosing and buying materials, irrespective of cost, it may be advantageous to use the materials from the same manufacturer rather than mixing and matching materials from different manufacturers.

CONCLUSION

Although the hypothesis that a stronger bond between heat cured acrylic resin base material and acrylic resin denture teeth is more likely to be achieved when both materials are produced by the same manufacturer was not proven, there was a trend towards support for this practice.

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MANUFACTURERS' DETAILS

- Davis Schottlander & Davis Ltd, Letchworth, UK
- Ivoclar Vivadent Liechtenstein
- Heraeus Kulzer, Hanau, Germany
- Bego hydrolytic Bremer Goldschlagene Wilh Hcrbest Germany
- Colchester Bantam, the Colchester Lathe Company England
- Instron, High Wycombe, UK

ADDRESS FOR CORRESPONDENCE

Professor Robert Clark, Dept of Prosthodontics, Floor 25, Guys Tower, Guys Hospital, London SE1 9RT. E-mail: rkfc@talk21.com

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