the Journal of CONTEMPORARY DENTAL PRACTICE at www.thejcdp.com

# A Comparison of Acrylic and Multilithic Teeth Bond Strengths to Acrylic Denture Base Material

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## Abstract

**Aim:** Debonding of denture teeth from the denture base can be frustrating for both the clinician as well as his or her patients. The wear resistance of composite denture teeth has been well investigated since their introduction, but there have been few studies about the bonding of these teeth to acrylic denture base resins. The aim of this study was to compare the bond strengths of two brands of acrylic and one brand of multilithic denture teeth to acrylic denture base material.

**Methods and Materials:** In this experimental-laboratory study, three types of denture teeth—Yaghoot, Super Brilian, and Major—were used. After grinding the glossy ridge lap surfaces, the teeth were mounted on two sides of triangular-shaped wax models. Then the wax elimination and resin processing laboratory procedures were carried out as is done with the fabrication of a complete denture. Each of the specimens was tested using a universal testing machine with a cross head speed of 5mm/min at an angle of 130 degrees to the long axis of the teeth. The data were analyzed using one-way ANOVA and Chi-square tests.

**Results:** The mean bond strength in the Yaghoot group was 717.43±293.59 N while in the Super Brilian group it was 578.40±395.38 and in the Major group, 547.95±296.75N. However, there was no significant difference between the three groups (p=0.194).

**Conclusion:** Although the mean bond strength in the multilithic group was higher than in the other groups, no significant difference was found between the three groups. There was no significant difference between the three groups with regard to the prevalence and type of fracture site.

**Clinical Significance:** The bonding strength of multilithic denture teeth to denture base resins was found to be comparable to, and even slightly higher than, acrylic conventional denture teeth, making them a promising choice for clinicians in the fabrication of removable dentures.


**Keywords:** Acrylic resins, composite dental resin, dentures, artificial teeth, denture bases, bonding.

**Citation:** Mosharraf R, Abed-Haghighi M. A Comparison of Acrylic and Multilithic Teeth Bond Strengths to Acrylic Denture Base Material. J Contemp Dent Pract [Internet]. 2009 Sept; 10(5). Available from: http://www.thejcdp.com/journal/view/a-comparison-of-acrylic-andmultilithic-teeth-bond-strengths-to-acrylic-den.

## Introduction

Debonding of acrylic teeth from the denture base is a major problem in prosthodontic practice. It has been estimated that 22–30% of denture repairs involve tooth debonding.[1] Consequently composite resin denture teeth were developed in the 1980s in an effort to achieve greater wear resistance and bond strength to denture bases.[2] However, they presented clinical problems such as poor bonding to denture bases,[3] brittle properties,[4] and superficial staining.[5] In an effort to overcome these problems, composite resins have been combined with conventional tooth acrylic resins to create multilithic denture teeth.[6] The polymerization process of methyl methacrylate (MMA) and Bis-GMA follow a similar pattern of activation and cross-linking because the reactive methacrylate groups of their molecules are similar.[7] This has resulted in a denture tooth that offers the abrasion resistance of composite resin and the denture base bonding capabilities of acrylic resin.[5,6] This new type of composite resin tooth is more widely used than porcelain or acrylic resin teeth in the fabrication of removable dentures because of its high fracture toughness and high abrasion resistance.[7-11]

Some research has been done and continues in an effort to study the issue of bonding denture teeth to denture base resin material.[1] Bond failures continue to occur between denture teeth and the denture base.[12,13] This may be related to the basic properties of the materials (teeth or denture base materials), processing factors (such as contaminations or curing cycle duration), and available monomer during processing.[6,14-16] Attempts to increase the strength of the bond between acrylic resin teeth and denture base resin include grinding the glossy ridge lap surface,[14,16-18] painting the ridge lap surface of the teeth with solvents,[15,17,19,20] and cutting mechanical retention features in the ridge lap surface of the teeth.[12-26] However, the literature published on this subject during the last 50 years presents conflicting results.[15]

With the introduction of composite teeth, the wear resistance of these denture teeth has been investigated,[5,8-11,21] but there are only a few studies done on the bonding of composite denture teeth to acrylic resin denture bases. The aim of this study was to compare the bond strengths of two brands of acrylic denture teeth and one brand of multilithic teeth to acrylic denture base material.

## Methods and Materials

As shown in Table 1, 67 maxillary canine denture teeth were chosen for this laboratory study. They were divided into three groups by the chemical composition of the tooth as follows:

- Yaghoot multilithic teeth (Ideal Makou, Tehran, Iran)
- Super Brilian acrylic resin teeth (Ideal Makou, Tehran, Iran)
- Major acrylic resin teeth (Major Dental Production Co., Turin, Italy)

The glossy ridge lap surfaces were lightly ground with a stone lathe (Kavo EWL polishing machine and a #2000 grit grinding disk at 3,000 rpm) to produce a matte finish and then the teeth were mounted on two sides of nine triangular-shaped wax models[12,16] (Figure 1) and covered with Optosile silicone putty (Bayer Dental, Leverkusen, Germany) to facilitate later deflasking.

Each model was flasked and, after the wax was boiled out, MMA monomer was applied on the

**Table 1. Mean fracture force of test groups (N).**

| Group | Manufacturer | N | Mean (S.D.) | Min | Max |
|---|---|---|---|---|---|
| Yaghoot | Ideal Makou, Tehran, Iran | 23 | 717.43 (293.59) | 205.00 | 1432.00 |
| Super Brilian | Ideal Makou, Tehran, Iran | 22 | 578.40 (395.38) | 99.00 | 1635.00 |
| Major | Major Dental Production Co., Turin, Italy | 22 | 547.95 (296.75) | 35.00 | 1635.00 |
| Total | | 67 | 616.13 (334.80) | 35.00 | 1635.00 |
| p=0.194 | | | | | |

tooth bonding surfaces using a cotton bud for 20 seconds.[15,17,19,20] Then the mold was packed with Meliodent Multicryl denture base resin (Heraeus-Kulzer GmbH, Wehrheim, Germany) and cured in an automatic curing machine (KAVO EWL type 5518, Warthausen, Germany) in accordance with manufacturers' instructions. After the curing cycle was completed, the models were deflasked and conditioned at 23°C±1°C and 50%±5% relative humidity for 24 hours.[16] All specimens were adjusted and fixed for a shear compressive testing and tests were performed on a Universal testing machine (TLCLO, Dartec Ltd., Stourbridge, England). All specimens were tested on the same day with the same apparatus.

Force was applied using a stainless steel pin 1 mm in diameter at an angle of 130 degrees to the long axis of the tooth at a crosshead speed of 5 mm/min until fracture occurred. The sheared specimens were examined visually to determine the failure site. The data were analyzed by using one-way ANOVA and Chi-square tests ($\alpha$=0.05).

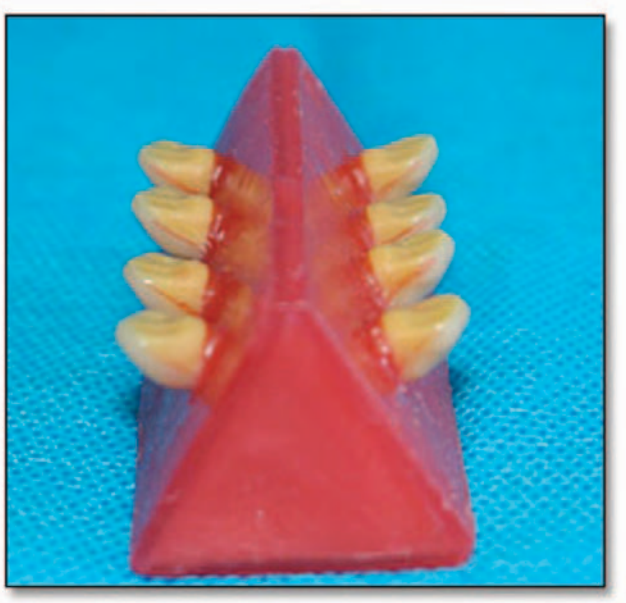


**Figure 1.** The teeth were mounted on two sides of triangular-shaped wax models.

## Results

Mean values for the fracture force of three experimental groups are summarized in Table 1. The ANOVA test result showed there was no significant difference between the three groups (p=0.194), but the highest bond strength was found in the Yaghoot (multilithic tooth) group.

As shown in Table 2, the site of fracture of the tooth from the resin model occurred in three different areas:

1. Through the tooth (cohesive fracture)
2. Through the acrylic denture base resin (cohesive fracture)
3. At the tooth/acrylic denture base interface (adhesive fracture).

The Chi-square test revealed no significant difference between the three groups (p=0.447) with regard to fracture type.

## Discussion

Several studies have been conducted to examine the issue of bond strength between acrylic resin teeth and denture base resins,[2,5,7,11,13-19] but little has been published on bond strength between multilithic denture teeth and polymethyl metacrylate (PMMA) base materials. In the present study, an attempt was made to compare the fracture force of a multilithic and two acrylic

**Table 2. Site of fractures (%).**

| Group | Bond (Adhesive Fractures) | Cohesive Fractures | |
|---|---|---|---|
| | | Tooth | Acrylic Resin |
| Yaghoot | 60.9 | 39.1 | |
| | | 21.7 | 17.4 |
| Super Brilian | 68.2 | 31.8 | |
| | | 18.2 | 13.6 |
| Major | 68.2 | 31.8 | |
| | | 4.5 | 27.3 |
| Total | 65.7 | 34.3 | |
| | | 14.9 | 19.4 |

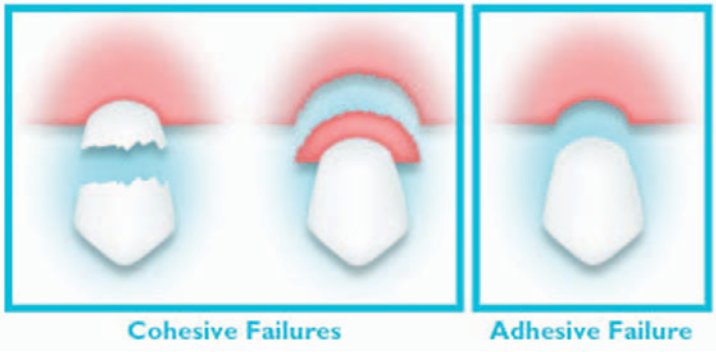
teeth bonded to denture base resin by applying a shear compressive force to the lingual surfaces of the teeth at an angle of 130 degrees to the long axis of the teeth. This angle was chosen to simulate the average angle of contact found in a Class I occlusion resembling the clinical scenario of teeth on a denture base.[15,27]

The glossy ridge lap surfaces of denture teeth were ground to make a uniform flat surface to improve the bond between denture teeth and the heat-polymerized resin denture base[12,21,28] and to ensure a similarity of ridge lap surface texture between all three types of teeth tested. It is common for manufacturers to suggest a ground surface on the ridge lap to improve bond strength.[28]

The initial objective of this research was to test the bond strength of the denture base acrylic resin to the denture teeth. Most (65.7%) of the fractures occurred at the junction between the teeth and denture base resin. This means the bond strength between the teeth and the acrylic resin was not optimum and the finding is in agreement with other investigators who believe grinding the ridge lap area makes cleaning difficult during wax removal after boil out due to surface irregularities.[20,23]

The Yaghoot multilithic tooth consists of a superficial composite layer and an acrylic gingival ridge lap portion of the tooth designed to bond with the acrylic denture base resin. Since the ridge lap portion of the two monolithic teeth tested was composed of acrylic resin, all bonding surfaces of all three types of test teeth were acrylic. This might explain the lack of any significant difference between mean fracture forces among the three groups. However, the highest bond strength and lowest adhesive fractures were found in the Yaghoot (multilithic tooth) group. This may be due to better ridge lap area properties in this tooth.

Unlike the results of this study, the multilithic teeth used in a study by Kawara et al.[6] were not fractured during testing. Instead, adhesive failures were between the acrylic resin ridge lap portion of the denture teeth that was in contact with the denture base resin and the transitional composite



resin portion.[3] This difference may be due to differences either in the testing methods used or in the construction of the denture teeth.

In the Major denture teeth group, only 4.5% of the fractures occurred within the teeth, while in the two other groups most of the cohesive fractures occurred within the teeth (Table 2). This can be due to monolithic structure of the Major artificial teeth. However, there was no significant difference between these three groups. In the Kawara et al.[6] study they used a four-point flexure test and found a significant difference between monolithic and multilithic teeth fracture forces. This difference may be due to differences in testing methods or in the construction of the denture teeth.

## Conclusion

Within the limitations of this study, the three artificial teeth tested were not significantly different in terms of both their bond strength to resin base and prevalence and type of fracture site.

## Clinical Significance

The bonding strength of multilithic denture teeth to denture base resins was found to be comparable to and even slightly higher than acrylic conventional denture teeth, making them a promising choice for clinicians in the fabrication of removable dentures.

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