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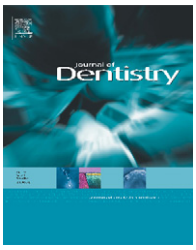

Bonding of acrylic denture teeth to MMA/PMMA and light-curing denture base materials: The role of conditioning liquids

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ABSTRACT

Objectives: The connection between resin denture teeth and the denture base is essential for the integrity of partial and full dentures. The aim of the present study was to analyse the bond strength of acrylic denture teeth to two light curing denture base materials compared to the gold-standard (MMA/PMMA) using different conditioning liquids.

Methods: The ridge laps of 220 identical denture teeth were ground and pre-treated using different conditioning liquids (MMA, an experimental conditioning liquid as well as the two commercially available liquids Palabond and Versyo.bond). The denture base materials (PalaXpress, Versyo.com, Eclipse) were applied using a split mould to obtain tensile bond strength specimens of identical shape. Ten specimens per test group were either stored in water for 24 h or thermocycled (5000×, 5–55 °C) prior to tensile bond strength testing (cross-head speed 10 mm/min). Data was subjected to parametric statistics ($\alpha = 0.05$).

Results: The three-way ANOVA revealed a significant influence of the material, pre-treatment as well as the storage. PalaXpress showed the highest bond strength (24.3 MPa) of all materials tested after TC, whereas the use of MMA led to the most constant results. Lower values were recorded for Versyo.com (17.5 MPa) and Eclipse (10.4 MPa) bonded with Versyo.bond.

Conclusions: The results indicate that MMA/PMMA based denture base resins provide reliable and durable bond strength to acrylic denture teeth. Using light-curing denture base materials requires the application of appropriate conditioning liquids to obtain acceptable bond strength. The use of MMA affects bond strength to light-curing denture base materials.

Clinical significance: The pre-treatment of denture teeth is critical regarding their bond-strength to denture base materials and in turn for the integrity of removable full and partial dentures. Light-curing denture base resins are more sensitive to the correct tooth pre-treatment compared to conventional MMA/PMMA materials, requiring specific conditioning liquids.

1. Introduction

The adhesion between denture teeth and the denture base is an important factor for the integrity of removable full and partial dentures. This in turn might affect the patient's satisfaction, reflected by quality of life indicators.[1–3]

Most commonly, acrylic denture teeth are used for this purpose.[4,5] Detachment of resin denture teeth from the base is

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a common reason for repairs. The frequency is estimated between 25 and 33% of all failures.[6–8] This event might occur either inside or outside the mouth. The causes are related to handling errors during the fabrication process, material related issues or force overload during the time in service.[8]

Several methods have been described to assess the adhesion between denture teeth and the denture base resin. These methods are (micro) tensile and shear tests,[5,9–17] flexural strength tests as well as finite element analysis.[7,18] Some of the experimental setups employed suffer from wide scattering of the values obtained, which motivated the authors to develop a standardized test method for the current study.[13]The different bonding mechanisms, contributing to a durable connection between a resin denture tooth and the denture base material, are macro-mechanical retentions, micro-mechanical retentions, an interpenetrating network or a covalent bond.[16,19–21]The strength and durability of the connection to denture teeth depends on the type of denture base material and denture teeth used.[5,8,15,20–23] In addition, a couple of factors – related to the fabrication of dentures – might compromise the bond strength at the interface.[4,13,24] They include entrapment of air-bubbles, contamination of the bonding surface with foreign materials (e.g. remnants of wax or tin foil substitutes) and its pre-treatment (e.g. grinding, gross-mechanical retentions, chemicals) as well as processing parameters for the denture base material.[4,5,8,13,16,24–30]

Some manufacturers recommend the use of specific liquids to pre-treat the surface of the denture teeth. The liquids should condition the ground tooth surface to achieve a durable bond.

The most common material used to fabricate full and partial dentures is still a mixture of methyl-methacrylate (MMA) and polymethyl-methacrylate (PMMA). In recent years, light-curing denture base resins have been introduced to the market. These materials are based on di-methacrylates (e.g. Bis-GMA, UDMA and TEGDMA) and are believed to exhibit a lower potential for hyper-allergic reactions and easier processing in the dental laboratory.[31–34] Thus, they are regarded as an alternative to conventional MMA/PMMA denture base resins.

It is generally accepted that, for MMA/PMMA denture base materials, grinding the surface of the denture tooth and wetting it with monomer is a pre-requisite to obtain clinically reliable bond strength.[10,13] The bonding mechanism is believed to be based on an interpenetrating network or a covalent bond.[5,13,35]

In contrast, some investigations indicated that the bond strength between denture teeth and light-curing or microwave-curing resins, respectively, is lower compared to traditional MMA/PMMA based materials.[12,20,21,27,28,36] However, scientific literature is lacking important information regarding the impact of different conditioning liquids (MMA, specific conditioning liquids, Bis-GMA/TEGDMA formulations), which may be used to bond acrylic denture teeth to these materials.

Hence, it was the aim of this study to investigate the influence of different pre-treatment protocols on the bond strength of denture teeth to three different denture base resins after short-term storage and thermocycling, respectively. The following null-hypotheses were tested: The tensile bond strength between a denture tooth and the base resin is independent of (1) the pre-treatment of the denture tooth's surface, (2) the denture base material used, and (3) the storage condition after fabrication.

2. Materials and methods

The denture base materials given in Table 1 were tested. All materials were used according to their respective manufacturer's instructions. The tests were carried out at ambient laboratory conditions (23 ± 1 °C, 50 ± 10% relative humidity).

2.1. *Tensile bond strength testing (TBS)*

Identical denture teeth (Mondial, shape T515-11, Heraeus Kulzer, Wasserburg, Germany) were used for all test groups. According to the manufacturer's information, the teeth are based on PMMA (80 wt.%) and additives (ethylene glycoldimethacrylat, pigments). The degree of cross-linkage in the

Table 1 – Denture base materials investigated.

Product	Manufacturer	Composition	Curing	Batch
Eclipse	Dentsply DeguDent, Hanau, Germany	Acrylated urethanoligomer (TBDMA), urethane dimethacrylate, octadecylacrylate, hexanediol dimethacrylate, photoinitiators, additives, pigments, red resin-fibres	Light-curing and heat-curing	050419 (Setup material) 050628 (Base material)
PalaXpress	Heraeus Kulzer, Hanau, Germany	Powder: PMMA-copolymer Liquid: methylmethacrylate (MMA), dimethacrylate, butanediol dimethacrylate, alcoxylated polyoltetraacrylate, additives	Self-curing	011016 (Powder) 010421 (Liquid)
Versyo.com	Heraeus Kulzer, Hanau, Germany	Dimethacrylate, multifuctional methacrylates, SiO_2, PMMA-copolymerisates, camphorquinone	Light-curing	010112

All data reflect information provided by the various manufacturers.