Received: 18th January 2015 Accepted: 19th April 2015 Conflicts of Interest: None

Source of Support: Nil

Original Research

Evaluation of Bond Strength of Acrylic Teeth to Denture Base using Different Polymerization Techniques: A Comparative Study

Naveen S Yadav[1], Surabhi Somkuwar[2], Sunil Kumar Mishra[3], Puja Hazari[4], Rajkiran Chitumalla[1], Shilpi K Pandey[5]

Contributors:

[1]Professor, Department of Maxillofacial Prosthodontics and Implantology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India; [2]Post-graduate Student, Department of Maxillofacial Prosthodontics and Implantology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India; [3]Reader, Department of Maxillofacial Prosthodontics and Implantology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India;[4]Senior Lecturer, Department of Maxillofacial Prosthodontics and Implantology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India; [5]Assistant Professor, Department of Maxillofacial Prosthodontics and Implantology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India.

Correspondence:

Dr. Mishra SK. Department of Maxillofacial Prosthodontics and Implantology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India. Phone: +91-7697738478. Fax: +91-(0)05414-243407. Email: sunilmsr200@yahoo.co.in

How to cite the article:

Yadav NS, Somkuwar S, Mishra SK, Hazari P, Chitumalla R, Pandey SK. Evaluation of bond strength of acrylic teeth to denture base using different polymerization techniques: A comparative study. J Int Oral Health 2015;S(1):54-56.

Abstract:

Background: Acrylic teeth have long been used in the treatment of a complete denture. One of the primary advantages of acrylic teeth is their ability to adhesively bond to the denture base resins. Although the bonding seems satisfactory, however, bond failures at the acrylic teeth and denture base resin interface are still a common clinical problem in prosthodontics. The purpose of this study was to evaluate the bond strength of acrylic teeth to denture base using different polymerizing techniques.

Materials and Methods: Acrylic resin teeth were bonded to heat cure acrylic resin and were polymerized by conventional water bath and microwave energy. The samples are then retrieved from the flask; trimmed and polished. The samples were then subjected to tensile forces till failure by using the Instron Universal testing machine. The machine used a direct pull on the incisal portion of the lingual surface in a labial direction at a height above the denture base resin bar with a crosshead speed of 0.5 mm/min.

Results: In the present study, it was found that conventionally cured specimens exhibited higher bond strength than microwave cured specimens and majority of fractures occur within the body of the tooth. It was found that debonding occurs within the body of the tooth rather than tooth acrylic interface, so there is no need of surface treatment of ridge lap surface.

Conclusion: Conventionally cured specimens possess statistically higher bond strength than microwave cured specimens.

Key Words: Acrylic teeth, bond strength, conventional cure, microwave cure

Introduction

Acrylic resin teeth should be adequately bonded to denture base resin because it increases the strength and durability of the denture since teeth is an integral part of the prosthesis. Two processes affect the achievement of a bond between the acrylic teeth and denture base resin: (I) the polymerizing denture base resin must come into physical contact with the denture tooth resin, and (II) the polymer network of denture base resin must react with the acrylic tooth polymer to form interwoven polymer network. The most common type of denture failure occurs between an acrylic resin tooth and acrylic resin denture base, accounting for approximately 33% of failure. It has been estimated that between 22% and 30% of denture repairs involve tooth debonding, usually in the anterior region of the denture. This detachment may be attributed to a lesser ridge lap surface areas available for bonding and the direction of the stresses encountered during function.[1]

Failure of the bond between denture teeth and denture base was mainly adhesive or cohesive failure. Adhesive failure occurred when there was no trace of denture base material on the ridge laps of the teeth after fracture. On the other hand, failure of the bond was considered cohesion failure when there were remnants of the denture base material on the ridge laps of the teeth after fracture.[2]

Traditionally, acrylic resin denture bases have been fabricated by compression molding technique and processed in brass denture flasks.[3] The packed denture flasks are placed in a temperature-controlled water bath for a specified time to polymerize the resin. However, microwave irradiation, as developed by Nishii in 1968, is popular alternative for polymerization.[4] Complete polymerization in the microwave produces a smooth denture surface that effectively prevents build-up of plaque; it also greatly reduces the tendency to discolor as a result of water absorption. However, the most common disadvantages of microwave technique were related to the flasks used in processing as they relatively expensive and have a tendency to break down after processing several dentures.[5]

Bond failures at the acrylic teeth and denture base resin interface are still a common clinical problem in prosthodontics, so this study was done to evaluate bond strength of acrylic teeth to denture base using different polymerization techniques and to assess mode of failure of fractured acrylic teeth.

Materials and Methods

Representative brands of acrylic teeth (Vitapan, Vident, California) were bonded to heat polymerized denture base resin (DPI Heat cure, Mumbai, India) for both water bath polymerization and microwave polymerization. Conventional metal flask was used for water bath polymerization, and specially fabricated fiber reinforced plastic flask was used for microwave curing. A total of 40 maxillary central incisors were selected and fixed to a metallic base with wax so that similar angulations were maintained for all teeth. The teeth were surrounded by PVC cylinder of height 7.5 mm and diameter 7.5 mm (according to ADA Specification no. 15 for acrylic teeth) and were bonded to the base with vinyl acetate (Figure 1). Dental plaster was mixed and poured inside the cylinders under vibration. After plaster setting, the each PVC cylinder was separated from the metallic base checked to verify the absence of porosity and residual wax. Using the same PVC cylinders, melted wax was poured to create a virtual space to be filled by denture base resin. The plaster-tooth-wax assemblies were positioned in a muffle base with wax turned upward. The dental plaster was poured up to the plaster-wax border. After mounting specimens were invested in a conventional denture base flask and the microwave flask, respectively, and dewaxing was followed.

Curing cycles followed

- Conventional curing cycle: Heat-polymerized specimens were processed in a heat curing unit at 74°C for 2 h and 100°C for 1 h.
- Microwave curing cycle: Specimens were processed in a microwave oven for 4 min at 500 W.

Specimens were deflasked, and the gross adhering of stone was removed with hand instruments. Gross blebs were removed with a slow speed hand piece and acrylic bur. Specimens were then stored in distilled water before the bond test has been carried out. The testing was performed on a universal testing machine. The machine used a direct pull on the incisal portion of the lingual surface in a labial direction at a height above the denture base resin bar with a crosshead speed of 0.5 mm/min (Figure 2).

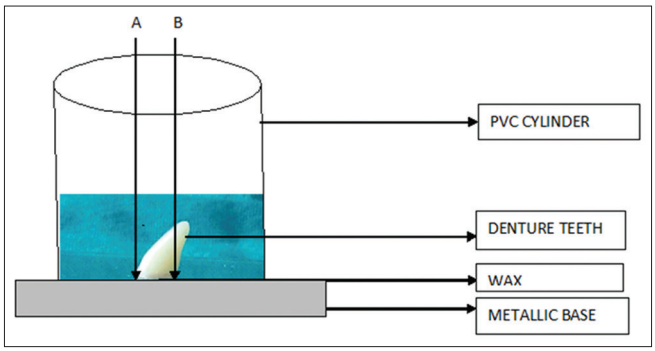
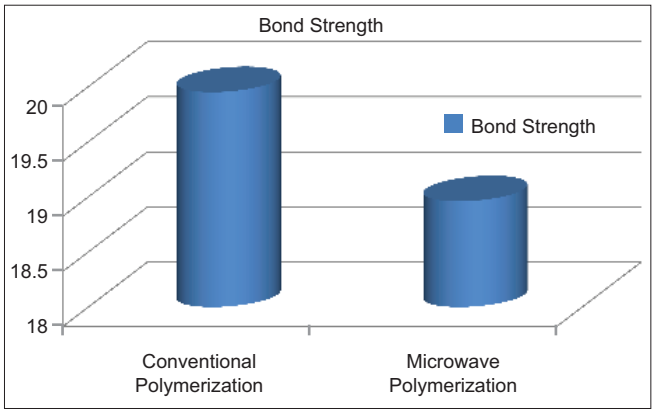


Figure 1: Layout of metallic base and denture tooth placed inside a PVC cylinder, before filling with dental stone. A and B show tooth and denture base interfaces.

Result

Within the limitations of the study, the specimens were prepared, and bond strength of acrylic denture teeth to denture base resin was evaluated. A student t-test was used to test the differences among the groups. Some specimens underwent brittle fracture, and others underwent distortion and rupture. All the failure sites were cohesive, that is, within the body of the tooth. Averages of bond strength (kgf) obtained with vitapan teeth for conventional water bath polymerization and microwave polymerization are given in Table 1. Conventionally cured specimen exhibited statistically significant $P < 0.001$ higher bond strength than microwave cured specimens (Graph 1).



Graph 1: Bond strength (kgf) obtained with vitapan teeth for conventional water bath polymerization and microwave polymerization.

Table 1: Averages of bond strength (kgf) obtained with vitapan teeth for conventional water bath polymerization and microwave polymerization.

Group	Bond strength (mean±standard deviation)
Conventional polymerization group	19.95±3.88
Microwave polymerization group	18.96±1.24

Figure 2: Specimens subjected to bond strength testing in a universal testing machine.

Discussion

Bond failures between tooth and denture base represent a problem for rehabilitation success. In order to minimize these failures, many authors described main factors that can influence in bond strength: Tooth types and brands, resin types and brands, stress distribution, method of processing, temperature of processing, resin stage, and processing variables.[6] There should be good attachment between artificial teeth and denture bases. In case of acrylic teeth bonding between acrylic teeth and denture bases occurs via chemical bond which depends on the softening of the resin at the base of the teeth with monomer from the "dough" of denture base material. When a denture tooth is fractured away from a sample of a denture base, the fracture path must not occur along the interface between the tooth and denture base, i.e. the fracture must be cohesive. Using this criterion, all denture teeth tested in this study polymerized with either heat or microwave polymerization bonded satisfactorily.[7]

Thean *et al.*, compare bond strength between three different brands of resin teeth to denture base using conventional water bath technique and concluded that bond strength is adequate even without mechanical preparation of the surface since majority of fracture did not occur at tooth-bond interface.[8] This finding also seems to concur with Huggett *et al.*, who found that mechanical preparation of bonding surface of tooth did not change the bond strength significantly.[9] Takahashi *et al.,* concluded that conventional resin teeth possessed higher bond strength than cross-linked denture teeth. The heat-cured denture base resin possesses significantly higher bond strength than the microwave-cured denture base resin. Both materials were better than the pour-type resin and the application of dichloromethane improves the bond strength.[10]

By contrast, Greets and Jooste compare bond strengths of microwave and water bath cured material and concluded that microwave-cured poly-methyl-methacrylate (PMMA) demonstrated significantly ($P = 0.0001$) higher bond strengths than conventional PMMA, and application of monomer to tooth surface yields significantly higher bond strengths than other surface treatment.[11]

Present study showed that lower bond strength values were recorded between acrylic resin teeth and denture bases cured by microwave than conventional water bath polymerization method and majority of the fractures occur at within the body of the tooth, indicating that method of polymerization affect the bond strength between tooth and denture base. In fact, microwave polymerization was reported to have uncontrolled temperature rise, causing the denture base components to heat above the boiling point of the monomer and resulting in the formation of pores.[12] Thus, increased number of pores reduces the strength of a denture base, which may be generally found after microwave polymerization compared with water bath processing, especially in the thicker part of the denture. This finding is of clinical importance because the thickness of the denture base material in the tooth-bearing areas might promote pore formation.

Conclusion

Within the limitations of the study, following conclusions can be drawn:

- Polymerization technique affects the bond strength between acrylic teeth and denture base resin
- Conventional water bath polymerization technique possesses higher bond strength than microwave polymerization technique between acrylic teeth and denture base
- Majority of fracture occur within the body of the tooth rather than tooth acrylic interface.

References

1. Amarnath GS, Indra Kumar HS, Muddugangadhar BC. Bond strength and tensile strength of surface treated resin teeth with microwave cured and heat cured acrylic resin denture base: An *in-vitro* study. Int J Clin Dent Sci 2011;2(1):27-32.
2. Khalaf BS, Abdulsahib AJ, Abass SM. Bond strength of acrylic teeth to heat cure acrylic resin and thermoplastic denture base materials. J Kerbala Univ 2011;9(4):35-44.
3. Hayden WJ. Flexural strength of microwave-cured denture base plates. Gen Dent 1986;34:367-71.
4. Nishii M. Curing of denture base resins with microwave irradiation: With particular reference to heat-curing resins. J Osaka Dent Univ 1968;2(1):23-40.
5. Hasan RH. Comparison of some physical properties of acrylic denture base material cured by water bath and microwave techniques. Al–Rafidain Dent J 2003;3:144-7.
6. Saavedra G, Valandro LF, Leite FP, Amaral R, Ozcan M, Bottino MA, *et al*. Evaluation of bond strength of denture teeth bonded to heat polymerized acrylic resin denture bases. Braz J Oral Sci 2004;3:458-64.
7. McCabe JF, Walls AW. Applied Dental Materials, 9th ed. London: Blackwell; 2008.
8. Thean HP, Chew CL, Goh KI. Shear bond strength of denture teeth to base: A comparative study. Quintessence Int 1996;27(6):425-8.
9. Huggett R, John G, Jagger RG, Bates JF. Strength of the acrylic denture base tooth bond. Br Dent J 1982;153:187-90.
10. Takahashi Y, Chai J, Takahashi T, Habu T. Bond strength of denture teeth to denture base resins. Int J Prosthodont 2000;13(1):59-65.
11. Geerts GA, Jooste CH. A comparison of the bond strengths of microwave- and water bath-cured denture material. J Prosthet Dent 1993;70(5):406-9.
12. Consani RL, Pucciarelli MG, Mesquita MF, Nogueira MC, Barão VA. Polymerization cycles on hardness and surface gloss of denture bases. Int J Contemp Dent Med Rev 2014;2014:Article ID 041114. Doi: 10.15713/ins.ijcdmr.8.