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ORIGINAL ARTICLE

The effect of mechanical and chemical polishing techniques on the surface roughness of heat-polymerized and visible light-polymerized acrylic denture base resins

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KEYWORDS

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Abstract *Objective:* The purpose of this study was to compare the effects of mechanical polishing (MP) and chemical polishing (CP) on the average surface roughness (Ra) of heat-cured (HC) and light-cured (LC) denture base acrylic resins.

Methods: A total of 120 specimens ($30 \times 15 \times 3$ mm) were prepared from one HC and one LC acrylic resin. To remove nodules and gross surface irregularities, all specimens were finished with a lathe-mounted small acrylic bur and 360-grit sandpaper. Ten finished specimens of each acrylic resin were randomly assigned to each of six polishing techniques: Resilit High-luster Polishing Liquid (RHPL), Universal Polishing Paste, Abraso-star K50, pumice, Jet Seal Liquid, or Acrypoint. MP was performed with an automatic polishing machine for 2 min, under 50 rpm and 500 g of load. CP was performed by immersing the HC and LC specimens in preheated methyl methacrylate at 75 ± 1 °C for 10 s. The surface roughness of the acrylic resin specimens was measured with a contact profilometer. The Ra values were analyzed by two-way analysis of variance, post hoc Scheffe's test, and paired *t*-test ($p \leqslant 0.05$). Polished and tested acrylic resin surfaces were evaluated by scanning electron microscopy.

Results: MP was more effective than CP. The smoothest surface was obtained with the use of the RHPL on the LC (0.05 ± 0.01 μm) or HC (0.07 ± 0.01 μm) acrylic resin. Two-way ANOVA showed a statistically significant difference between MP and CP.

Conclusions: MP produced the smoothest surface of denture base acrylic resin. The mean surface roughness values after MP and CP were not influenced by the type of acrylic resin.

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1. Introduction

Acrylic resins and resin-based direct and indirect restorative materials have been used widely in dentistry, specifically in the field of prosthodontics, to fabricate different types of

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prostheses, including complete and partial dentures, temporary fixed partial dentures, implant-supported overdentures, and maxillofacial prostheses (Kuhar et al., 2005). Acrylic resins may be heat-cured (HC), autocured, or microwave-cured (Hong et al., 2009; Rached et al., 2004; Yunus et al., 1994). Conventional resins that are used in dentistry are based on poly-methyl methacrylate (poly-MMA) (Danesh et al., 2012; Hong et al., 2009).

A major breakthrough in the application of acrylic resins in the field of dentistry occurred with the introduction of visible light-cured (LC) acrylic resins, which are urethane dimethylacrylate-based (Danesh et al., 2012; Jorge et al., 2003; Kedjarune et al., 1999; Leggat and Kedjarune, 2003). LC acrylic resins are activated by light in the wavelength range of 460–470 nm. They include larger molecular weight methacrylates and dimethacrylates (Haselden et al., 1998). LC resins have a lower elution rate (0.06 wt%) than MMA-based acrylic resins (0.13–0.054 wt%) (Danesh et al., 2012; Ferracane, 1994). LC resins elicit less soft-tissue irritation, produce less heat during polymerization, and have a relatively pleasant odor compared to MMAs (Al Rifaiy, 2012; Haywood et al., 2003).

The surface finish of any dental prosthesis is an important factor that determines patient's comfort, prosthesis longevity, and esthetics (Rahal et al., 2004; Ulusoy et al., 1986). High values for the free energy (hydrophilicity) (Busscher et al., 1986) and roughness of the prosthesis surface will increase the chances of microbial adhesion and plaque retention, respectively, and reduce patient's oral hygiene (Kagermeier-Callaway et al., 2000; Rahal et al., 2004; Ulusoy et al., 1986). Studies have shown a direct correlation between surface roughness and plaque retention, plaque maturation, *Candida albicans* colonization, and associated denture stomatitis (Barbeau et al., 2003; Berger et al., 2006; Radford et al., 1997).

In vivo studies have suggested that, to be clinically acceptable, prostheses and dental restorations should not have average (mean) surface roughness (Ra) values higher than 0.2 μm (Bollen et al., 1997; Quirynen et al., 1996; Seng-Kyun Kim et al., 2009). Below this value, no further reduction in plaque accumulation can be expected. Above this value, a proportional increase in plaque accumulation occurs (Abuzar et al., 2010; Bollen et al., 1996; Kuhar et al., 2005; Quirynen et al., 1996).

Polishing can be performed through mechanical or chemical methods (Goncalves et al., 2008). Mechanical polishing (MP) methods use abrasives to produce controlled wear of the surface material to reduce surface roughness (Abuzar et al., 2010). Materials used for MP include polishing wheels, felt cones, prophylactic pastes, rubber polishers, abrasive stones, aluminum oxide-based polishing pastes, silicone polishers, pumice, and lathe polishing (Braun et al., 2003; Sofou et al., 2001; Yamauchi et al., 1990).

As an alternative to the conventional method of MP, in 1969, Gotusso introduced a method called superficial chemical polishing (CP) (Al-Rifaiy, 2010; Braun et al., 2003; Gotusso, 1969; Rahal et al., 2004). In this technique, the finished acrylic resin denture is placed in a chemical polisher containing heated monomer at 75 °C for 10 s (Al-Rifaiy, 2010; Rahal et al., 2004). Subsequent studies have proven the biocompatibility of this technique (Nagem-Filho et al., 1973; Rahal et al., 2004).

Although some studies have evaluated the effects of MP and CP techniques on the surface roughness of HC, autocured, and microwave-cured acrylic resins, no study has examined the effects of polishing techniques on the surface roughness of LC denture base resins. Therefore, the aim of this study was to evaluate and compare the effects of MP and CP on the Ra of visible LC and HC denture base resins.

2. Materials and methods

2.1. Preparation of test specimens

In this study, 120 specimens (30 × 15 × 3 mm) were prepared from HC acrylic resin (Lucitone, Dentsply International, Inc., York, PA, USA) and LC acrylic resin (Eclipse, Dentsply International, Inc.). The HC acrylic resin specimens were prepared by investing the wax pattern (30 × 15 × 3 mm) in gypsum plaster by a conventional flasking procedure in dental flasks. After dewaxing the plaster molds, the acrylic material was packed and processed in accordance with manufacturers' instructions.

A Perspex mold with a glass lid was designed to prepare the LC specimens. After applying petroleum jelly, the mold was preheated at 55 °C for 2 min in a special oven (Conditioning Oven, Dentsply Trubyte). The LC acrylic resins were

Table 1 Polishing procedures and products used in the study.

Polishing procedure	Polishing products	Composition	Manufacturer
Mechanical	Resilit High-luster Polishing Liquid	Loose abrasives (aluminum oxide-Al_2O_3) in liquid	Renfert, GmbH
Mechanical	Universal Polishing Paste	Loose abrasives (aluminum oxide-Al_2O_3) in paste	Ivoclar Vivadent, Schaan, Liechtenstein
Mechanical	Abraso-Star K50	Mixture of waxes and abrasives	Bredent GmbH & Co. KG
Mechanical	Pumice	Pumice (coarse CL-60), amorphous silica and quartz	WhipMix Corporation, Kentucky, USA.
Mechanical	AcryPoint	Bonded abrasives (silicon carbide in silicon matrix)	Shofu Inc., Kyoto, Japan
Chemical	Jet Seal Liquid	Methyl methacrylate	Lang Dental Mfg. Co., USA.