JOURNAL OF PROSTHODONTIC RESEARCH 58 (2014) 35–40

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jpor

Original article

Scratch test of thermoplastic denture base resins for non-metal clasp dentures

Misao Kawara DDS, PhD[a,*], Yoshihiro Iwata DDS[b], Masatoshi Iwasaki DDS[b], Yoshihiro Komoda DDS[b], Takashi Iida DDS, PhD[a], Takashi Asano DDS, PhD[a], Osamu Komiyama DDS, PhD[a]

[a] Department of Oral Function and Rehabilitation, Nihon University School of Dentistry at Matsudo, Japan
[b] Nihon University Graduate School of Dentistry at Matsudo, Japan

ARTICLE INFO

Article history:
Received 1 February 2013
Received in revised form
10 October 2013
Accepted 15 October 2013
Available online 9 December 2013

Keywords:
Scratch test
Surface roughness
Vulnerability
Non-metal clasp denture
Thermoplastic resin

ABSTRACT

Purpose: Several thermoplastic denture base resins have been introduced for the fabrication of non-metal clasp dentures. Although the surface of these materials is easily damaged, the surface roughness and characteristics of scratches created have not been evaluated. The purpose of this study was to evaluate the surface roughness of thermoplastic resins using a scratch test for the development of future materials.

Methods: Four thermoplastic (polyamide: Valplast®; VLP and Lucitone FRS®; FRS, polyethylene terephthalate: EstheShot®; ES, and polyester: EstheShot Bright®; ESB) and two conventional acrylic (Heat-polymerizing: Urban®; HC, and Pour type auto-polymerizing: Pro-Cast DSP®; PR) denture base resins were examined. Eight specimens, approximately 10 mm × 10 mm × 30 mm in size, of each material were fabricated. Scratch test was performed by a scratch tester with a diamond indenter of 10-μm radius and cone angle 90°, applying a constant load of 500 mN, and 2-mm-long scratches were made. The scratch marks were studied under 3D laser measuring microscope and cross-section profiles at approximately 0.5 mm, 1.0 mm, and 1.5 mm from the starting point were extracted and measured with analysis software. Data from 24 cross-section profiles in each denture base material were analyzed.

Results: The maximum depths of ES, ESB and FRS were greater than VLP, PR and HC, and the scratch widths of ES, ESB, FRS and VPL were greater than PR and HC.

Conclusions: The results showed that the surface of thermoplastic denture base resins was easily damaged compared to polymethyl methacrylate.

1. Introduction

Esthetics is an important factor that determines patient satisfaction in prosthodontics [1–3]. Most patients desire removable partial dentures (RPDs) without metal clasps in the visible zone. Thermoplastic resins have thus been used to make the clasp part in recent years instead of metals [4,5]. This means that the denture base and clasps are fabricated with the same material. Several thermoplastic denture base resins have been introduced to make non-metal clasp dentures. Polyamides (Nylon), developed as a denture base in the 1950s,

* Corresponding author at: Department of Oral Function and Rehabilitation, Nihon University School of Dentistry at Matsudo, Matsudo, Chiba 271-8587, Japan. Tel.: +81 47 360 9614; fax: +81 47 360 9615.
E-mail address: kawara.misao@nihon-u.ac.jp (M. Kawara).

1883-1958/$ – see front matter
http://dx.doi.org/10.1016/j.jpor.2013.10.002

Fig. 1 – Upper; polymethyl methacrylate. Lower; polyethylene terephthalate. These dentures were delivered at the same time to a patient.

is still used as it does not induce any allergic reactions and exhibits flexural properties comparable to that of polymethyl methacrylate (PMMA) polymers [6,7]. Polyethylene terephthalate and polyester copolymers are also employed due to their highly elastic nature and superior esthetics [8–10].

As the flexural strength and elastic modulus of these materials are lower than PMMA, the non-metal clasp denture was reinforced with a metal frame to withstand masticatory forces. However, the surface of the denture base became rough with the wearing of several months (Fig. 1). It is supposed that the surface of these materials can be easily damaged [10]. This may affect the denture base color stability [11]. The part which was easy to be damaged seemed to discolor white. Although these limitations have been pointed out, the surface roughness and characteristics of scratches formed have not been evaluated until now. The purpose of this study was to evaluate the vulnerability of thermoplastic resins used for non-metal clasp dentures using a scratch test for the development of future materials.

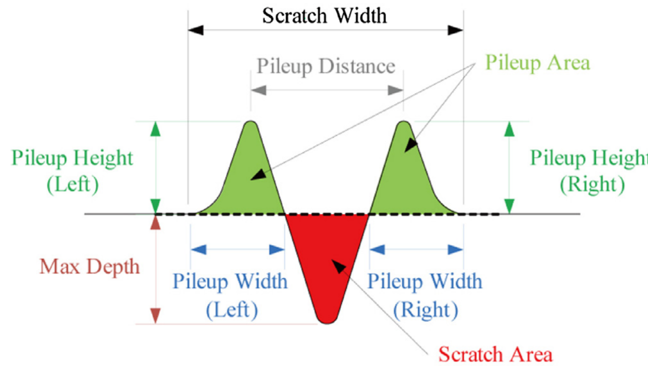

Fig. 2 – Cross-section profile and measured parameters.

2. Materials and methods

Four thermoplastic and two conventional acrylic denture base resins were examined (Table 1). Eight specimens, approximately 10 mm × 10 mm × 30 mm in size, were prepared according to manufacturer's instructions for each denture base resin. After processing, the specimens were abraded on the top and bottom ends with 1500-grid and the top was finished with 10,000-grid silicone-carbide papers. All specimens were then stored in distilled water at room temperature for 2 weeks. The scratch test was performed on the top of specimens using a Scratch Tester (Nano Scratch Tester, CSM Instruments, Peseux, Switzerland). Specimens for each material were mounted on the *X*–*Y* table of the scratch tester and a diamond indenter of 10-μm radius and cone angle 90°, applying a constant load of 500 mN, made 2-mm-long scratches. The scratch marks were then studied under a 3D laser measuring microscope (LEXT OLS4000, Olympus, Tokyo, Japan) using a 20× objective lens. The 3D profile data from the laser microscope were cut out as 2.1 mm × 0.25 mm sections, and the cross-section profiles at approximately 0.5 mm, 1.0 mm, and 1.5 mm from the starting point were extracted and measured with analysis software (a modular program for scanning probe microscopy data visualization and analysis: Gwyddion, Brno, Czech). The roughness parameters assessed are shown in Fig. 2. The data from 24 cross-section profiles in each denture base material were averaged.

All data are presented as mean values and standard deviation (SD). Maximum depth, scratch width, scratch area, and pileup distance were analyzed with one-way analysis of variance (ANOVA). Pileup height and pileup depth were analyzed with two-way ANOVA with side (left and right) and material (ES, ESB, FRS, HC, PR, and VLP). When appropriate, ANOVA was followed by post hoc Tukey tests to compensate for multiple comparisons. *P* values less than 0.05 were considered significant.

3. Results

Table 2 summarizes the results of vulnerability parameters. Fig. 3 shows the average profiles of each material. Fig. 4 shows the typical samples of two-dimensional scratch marks in each material.