Handling efficiency of autopolymerized resin applied using the brush-on technique

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Purpose: The brush-on technique is frequently used for applying autopolymerized resin during chairside denture repair and adjusting individual tooth trays. This study evaluated the handling efficiency of autopolymerized resin applied using this technique.
Materials and Methods: Five autopolymerized resins, Unifast II (GC), Unifast Trad (GC), Provinice (Shofu), Metafast (Sun Medical), and Miky (Nissin), were used in this study. Five operators (one dental technician, two dentists, and two dental students; ages 23-51) fabricated round resin pieces, approximately 6 mm in diameter, from the five autopolymerized resins on a pasteboard in one procedure. Four different brushes were tested; a calligraphy brush (cat hair, Naokatsu), two resin brushes (nylon fiber and horsehair, Seiundo), and a bristle brush (weasel hair, Shofu). After polymerization, the resin pieces were weighed on an electric balance. The handling behavior (n=5) was assessed by the coefficient of variation (%) of the weight and analyzed by ANOVA/Tukey's test (α=0.05). After the test, all the operators completed a questionnaire about fabricating the resin pieces.
Results: Although significant differences were found among the operators ($p<0.05$), there were no significant differences among all the resins and brushes tested ($p>0.05$). However, the horsehair resin brush tended to have greater coefficients of variation. The results of the questionnaire indicated that Unifast II and the calligraphy brush were preferred by the operators.
Conclusion: The handling efficiency of the autopolymerized resin using the brush-on technique depended on the skill of the operators rather than the resins and brushes. **(Int Chin J Dent 2009; 9: 33-38.)**
Key Words: autopolymerized acrylic resin, brush-on technique, coefficient of variation, handling efficiency.

Introduction

Various autopolymerized acrylic resins have been commonly used for chairside prosthetic treatment, such as the fabrication of provisional restorations, repair of denture breakage, additional repair of retainers and artificial teeth, and adjustment of individual tooth trays for abutment impressions.[1-4] Due to the low degree of polymerization, the physical characteristics of hardness, bending strength, color stability, and absorption of autopolymerized resins are worse than those of heat-polymerized resins.[5-8] However, most clinicians have accepted these characteristics because the autopolymerized resins are conventional and indispensable materials for chairside prosthetic treatment.

The brush-on technique for applying autopolymerized resins is frequently used in clinical and laboratory procedures.[9] In our previous study, the hardening time for the brush-on technique was reported to be shorter than for the conventional mixing technique, and there were great differences in the hardening time among the autopolymerized acrylic resins tested.[10] Hanatani et al.[11] reported that the dimensional accuracy of the autopolymerized resin applied using the brush-on technique was better than that of the conventionally mixed polymer and monomer technique because the polymer and monomer ratio using the brush-on technique was lower and polymerization shrinkage was minimized due to this technique. However, the efficiency of the brush-on technique is affected by many factors, such as the size of the polymer particles and their distribution, the quality of the brush, and the skill of the operators.

The purpose of this study was to evaluate the handling efficiency of autopolymerized resins applied using the brush-on technique. The evaluation was performed using the coefficients of variation of the sizes of the resin

specimens and the responses to a questionnaire about the resins and brushes.

Materials and Methods

Fabrication of the resin pieces

Five pink autopolymerized acrylic resins, Unifast II (GC Dental Industrial Corp., Tokyo, Japan), Unifast Trad (GC Dental Industrial Corp.), Provinice (Shofu Inc., Kyoto, Japan), Metafast (Sun Medical Co., Ltd., Moriyama, Japan), and Miky (Nissin, Kyoto, Japan) were used in this study. The colors, the powder/liquid ratios designated by the manufacturers, and the lot numbers are listed in Table 1. Five operators (A, 51-year-old male dental technician; B, 45-year-old male dentist, C, 28-year-old male dentist, D and E, 23-year-old dental students) with varying amounts of clinical and laboratory experience were chosen to participate in this study. Four different brushes were used; a calligraphy brush (cat hair, Naokatsu, Yokohama, Japan), two resin brushes (nylon fiber and horsehair, Seiundo, Osaka, Japan), and a bristle brush (weasel hair, Shofu Inc.). Each operator fabricated round resin pieces (approximately 6 mm in diameter) in one procedure on a pasteboard from each of the five autopolymerized resins using each brush (Fig. 1). Five resin pieces were made for each kind of resin and brush. A total of 500 resin pieces were fabricated.

Table 1. Autopolymerized resins used in this study.

Trade name	Manufacturer	Color	Lot number
Unifast II	GC Tokyo, Japan	#3 Pink	Powder 0503172 Liquid 0504261
Unifast Trad	GC	#3 Pink	Powder 0504261 Liquid 0503221
Provinice	Shofu Kyoto, Japan	U3	Powder 020507 Liquid 030555
Metafast	Sun Medical Moriyama, Japan	#2 Pink	Powder 41101 Liquid 41103
Miky	Nissin Kyoto, Japan	#2	Powder PEIL Liquid ELG

Assessment of handling behavior

After polymerization, the resin pieces were removed from the pasteboard and weighed on an electric balance (Libor AEG-45SM, Shimadzu Corp., Kyoto, Japan). The handling behavior (n=5) was assessed by the coefficient of variation (%) of the weight of each resin piece. All the data were analyzed by an ANOVA and Tukey's multiple comparisons test at a significance level of α=0.05.

SEM observations

The specimens were examined using a scanning electron microscope (SEM JSM5600LV, JEOL, Tokyo, Japan) at magnifications of x300 and x500. Polymer particles of the autopolymerized resins and the used and unused hairs of the brushes were observed on the specimens.

Questionnaire about handling

After the test, all the operators completed a questionnaire about the handling efficiency of the autopolymerized resins and brushes. Their personal opinions were categorized according to a 5-point scale (minimum: 1 point, maximum: 5 points) based on three resin factors (picking up the resin pieces, filling the mold,

and mixing of the polymer and monomer) and on four brush factors (picking up, filling, mixing, and handling after repetitive use).

Results

Figures 2a-2c show the handling efficiency of the operators, the autopolymerized resins, and the brushes, respectively. The weight of the resin pieces ranged from 24 to 39 mg (Fig. 2a). The coefficients of variation (CV) of the resin pieces fabricated by the dental technician (age 51) were the smallest, and significant differences were found among the operators ($p<0.05$). As shown in Fig. 2b, there were no significant differences in the CV among all the resins tested ($p>0.05$). The Metafast resin pieces were lighter than the other resin pieces. Although the horsehair resin indicated a greater CV among the brushes tested (Fig. 2c), there were no significant differences in CV ($p>0.05$).

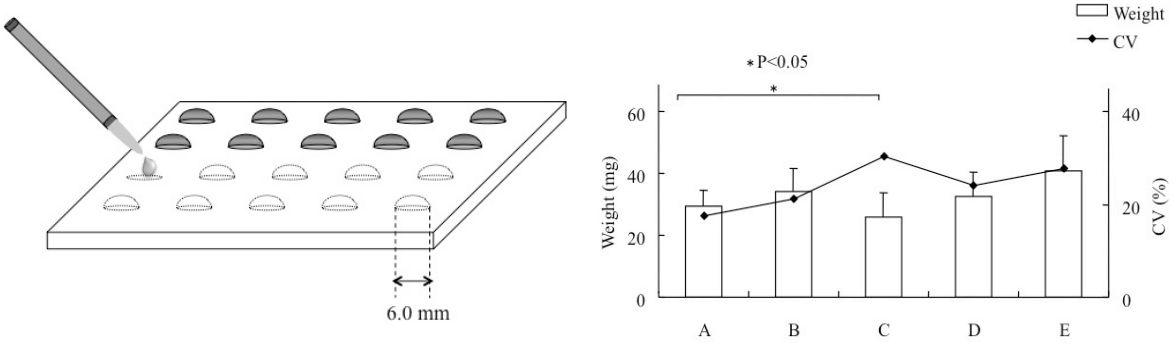

Fig. 1. Round resin pieces 6.0 mm in diameter on a pasteboard made using brush-on technique (left).

Fig. 2a. Weight of resin pieces and their coefficient of variation (CV). Operators (right).

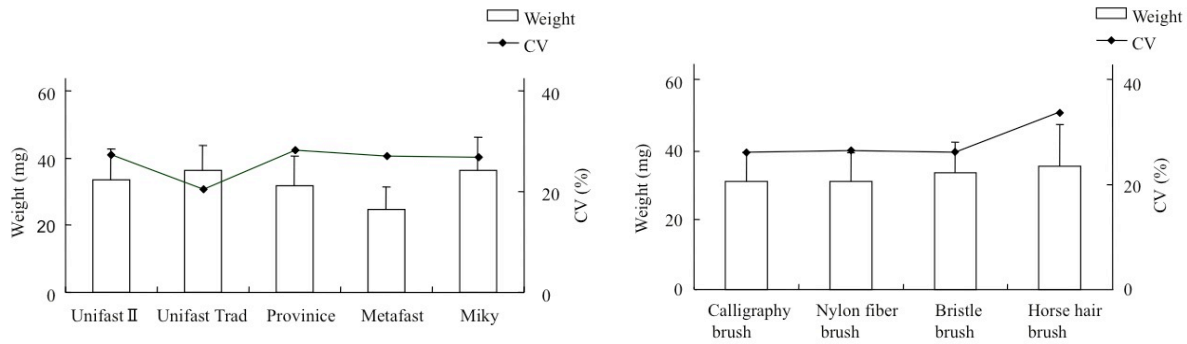

Fig. 2b. Weight of resin pieces and their coefficient of variation (CV). Autopolymerized resin (left).

Fig. 2c. Weight of resin pieces and their coefficient of variation (CV). Brushes (right).

The SEM observations showed that the Metafast polymer tended to be a uniform size compared to the other resins (Fig. 3). In the unused bristles, the hair cuticle was clearly observed on the surface of the three types of animal hairs (Fig. 4). However, the polymer particles were attached, and resin coated the bristles of the used brushes. The low-magnification views showed that the bristles on the nylon brush were of uniform thickness, whereas the bristles on the other brushes were not. The thickness and length of the hairs in the horsehair brush in particular tended to be irregular. The results of the questionnaire indicated that the operators preferred Unifast II and the calligraphy brush (Fig. 5). In contrast, Metafast and the weasel hair brush had a lower score. There were few differences in handling between the used and unused brushes.

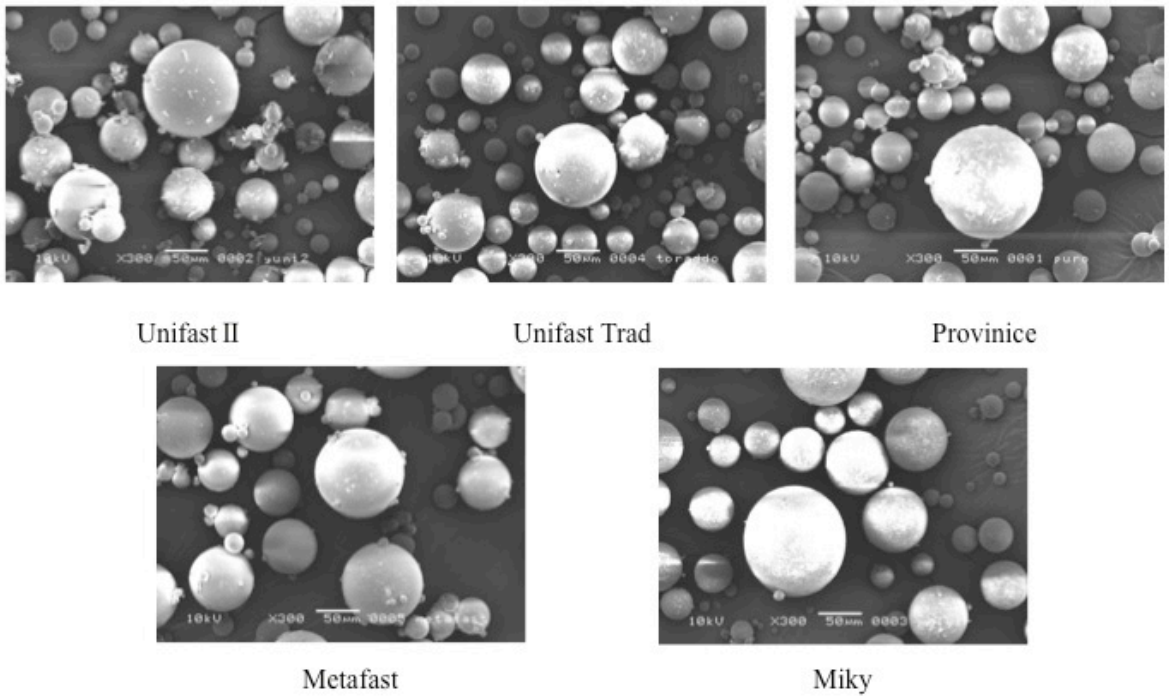

Fig. 3. SEM observations of the polymers of the autopolymerized resins.

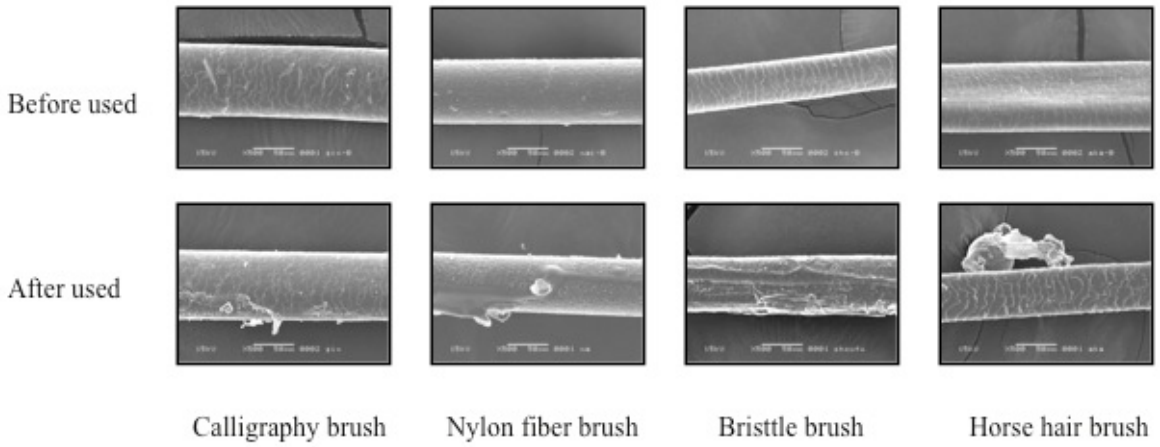

Fig. 4. SEM observations of the used and unused brushes.

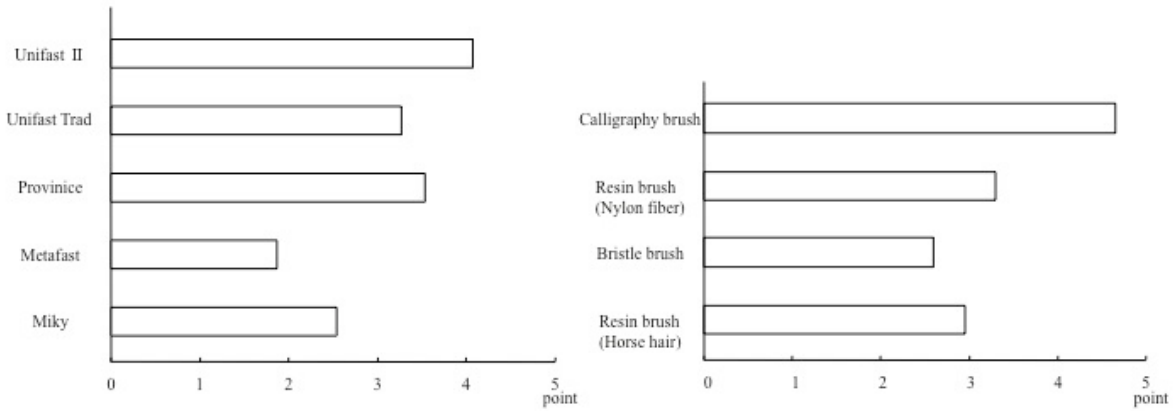

Fig. 5. Results of the questionnaire about handling. Autopolymerized resin (left) and Brushes (right).

Discussion

The handling efficiency of the autopolymerized resins using the brush-on technique depended on the skill of the operators rather than the kinds of resins and brushes. In this technique, the brush is soaked in resin monomer and then dipped in the polymer. Although it is easy to repeatedly form the finely-shaped slurry resin, it is difficult to form a similar size of the resin. Thus, the handling depends on each operator's skill. The shrinkage of the autopolymerized resin using the injection method, brush-on technique, and injection-press-method has been compared *in vitro*.[12] Although the shrinkage using the injection-press method was the lowest, the brush-on technique used by dental technicians in one study was comparable to the injection-press method.[12] This phenomenon confirms that the accuracy of the brush-on technique depended on the skill of the operators.

There were no significant differences among the resins tested although the resin pieces of Metafast were lighter than those of the other resins. The weights of the resin pieces were affected by the size of polymer particles and the standard liquid-powder (L/P) ratio. Since the Metafast polymers tended to be of uniform size compared to the others, fewer polymers were attached to the tip of the brushes. In addition, the standard L/P ratio of Metafast (0.67) is greater than for the other resins (0.50). In the case of greater L/P ratio, the mixed resin pieces would be smaller.

There were no significant differences in the CV among the brushes tested but the horsehair brush tended to make the resin pieces larger. In this study, three brushes were made of animal hair and one was nylon fiber. However, the thickness and length of the hairs on the horsehair brush were not uniform. Therefore, the horsehair brush produced a greater CV of the resin pieces.

The results of the questionnaire indicated that Unifast II and the calligraphy brush were preferred by the operators. However, there was no correlation between the CV and the preferred tendency. The reason why the operators selected Unifast II and the calligraphy brush was probably because they have generally been using Unifast and this particular brush in their practice. In the laboratory and in clinical practice, not only the operator's characteristics but also their familiarity with the materials and equipment may affect the handling efficiency during any type of procedure.

The handling efficiency of the autopolymerized resins using the brush-on technique depended on the skill of the operators rather than the kinds of resins and brushes. Although the effect of the autopolymerized resins on the handling apparently could not be found, the calligraphy brush indicated superior handling efficiency.

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