**Clinical significance**

Although a large number of studies have been made on Autopolymerized acrylic resin, little is known about brush-on technique. Since the hardening time for the brush-on technique was shorter than for the conventional mixing technique in this study, attention should be paid to the handling time during denture repair.

**Abstract**

**Purpose:** The brush-on technique has frequently been used when dentures are repaired with autopolymerized acrylic resins. This study evaluated the fluidity and hardening time of autopolymerized acrylic resin applied using this technique.

**Methods:** Five autopolymerized acrylic resins were tested: Unifast II (GC, Japan), Unifast Trad (GC), Provinice (Shofu, Japan), Metafast (SunMedical, Japan), and Miky (Nissin, Japan). Using both the brush-on and the conventional (L/P: 0.5 ml/g) mixing techniques, all slurry resins were applied on the platform of a rheometer (Seiki, Japan). Fluidity was measured until hardening occurred at room temperature (23±1°C, humidity: 40-50%). To measure the hardening time, the five resins were also poured into silicone tubes (8 mm internal diam., 5 mm long) using the brush-on and the conventional techniques. A thermocouple was placed in the center of each tube to measure the temperature. Hardening time was assessed as the time when the temperature reached the maximum. The data (n=5) were analyzed by ANOVA/Tukey's test (α=0.05).

**Results:** Similar fluidity was found for the brush-on and conventional mixing techniques although the onset of hardening was different. Excluding Provinice, there were significant differences in hardening time between both techniques (P<0.05). The hardening time of Metafast was the significantly longest among the resins tested (P<0.05).

**Conclusion:** The hardening time for the brush-on technique was shorter than for the conventional mixing technique. Because there were great differences in the hardening time of the autopolymerized acrylic resins tested, attention should be paid to handling time during denture repair.

**Key words:** autopolymerized acrylic resin, fluidity, hardening time, brush-on technique

**Introduction**

Autopolymerized acrylic resins have commonly been used for chairside prosthetic treatment, such as repair of denture breakage, extension of denture flanges, additional repair of retainers and artificial teeth, and adjustment of individual trays for abutment impressions. Three colored resins, ivory autopolymerized acrylic resin for artificial teeth, pink resin for denture bases, and clear resin are commercially available. There are some differences in characteristics each resins due to the color pigments they contain.

There are two application methods for autopolymerized acrylic resin, namely, the conventional mixing technique (hereafter called the “mixing technique”) and the brush-on technique. In the former, the polymer and monomer are mixed in a rubber cup at their standard powder liquid (L/P) ratio, and then poured into a repair portion or formed as resin dough. The latter technique was developed by Nealon (1952) to compensate for polymerization shrinkage while autopolymerized acrylic resins are being filled into the tooth cavity. In this technique, an animal hair brush is...
soaked in the monomer and is then dipped in the polymer powder. This finely-shaped slurry resin attached to the end of the brush is then placed in the cavity. Presently, autopolymerized acrylic resins are not used at all as filling materials. However, the brush-on technique is still widely used in clinical and laboratory procedures. The efficiency of the brush-on technique is affected by many factors, such as the characteristics of the resins, quality of the brush, and skill of the operators. The mechanical properties and material characteristics of autopolymerized acrylic resins have been improved by many studies. However, little is known about the characteristics of autopolymerized acrylic resins using the brush-on technique. For satisfactory handling efficiency, the fluidity and hardening time of autopolymerized acrylic resins are especially important. This study evaluated the fluidity and hardening time of autopolymerized acrylic resins applied using the brush-on technique and mixing technique.

**Materials and methods**

Five autopolymerized acrylic resins [Unifast II (GC Dental Industrial Corp., Japan), Unifast Trad (GC), Provinice (Shofu, Japan), Metafast (SunMedical, Japan), and Miky (Nissin, Japan)] were used for this study. The manufacturer, colors, powder liquid ratio were designated by manufacturers, and lot numbers are listed in Table 1.

To measure the fluidity of both the mixing and brush-on techniques, a dental rheometer (amplitude torque 4 kg•cm; swing angles of amplitude 1.5±7.7°; Type B, Seiki, Japan) was used. After the polymer and monomer of each resin were mixed for 10 seconds at the powder/liquid ratio shown in Table 1, the resin slurry (approximately 0.1 g) was applied on the platform of the rheometer for 10 seconds, and the fluidity was measured immediately until hardening occurred at room temperature (23±1°C humidity: 40-50%). Using the brush-on technique, the resin slurry was carried to the platform using 2 brushes. The measurement of the fluidity was begun after 20 seconds. Five measurements were taken for each procedure. The fluidity was evaluated as the decrease in the amplitude of the rheometer angles (the angle created where the tangential line of the amplitude curve intersected the central axis of the amplitude curve) every 30 seconds for 8 minutes. The onset of hardening was determined when each amplitude decreased by 5%.

To measure the hardening time, the five resins were also poured into silicone tubes (8 mm internal diam., 5 mm long) using the brush-on technique (3 brushes) and mixing technique (10-second mixing, 10-second pouring) by a clinician. A thermocouple (K type) was placed in the nearly center of each tube to measure the temperature (Fig. 1). The hardening time was assessed as the time when the temperature reached the maximum. Five measurements were also repeated for each technique.

The data (n=5) were analyzed with the SPSS statistical package (Version 12.0, SPSS Inc., Tokyo, Japan) by two-way analysis of variance (ANOVA) and the Tukey’s multiple comparisons test at a significance level of α=0.05.

| Table 1 Autopolymerized acrylic resins used in this study. |
|----------------|---------------|-----------------|----------------|------------------|
| Manufacturer  | Color         | L(ml)/P(g)      | LOT            |
| Unifast II    | #3 pink       | 0.5             | P 0503172 L 0504261 |
| Unifast Trad  | #3 pink       | 0.5             | P 0504261 L 0503221 |
| Provinice     | U3            | 0.5             | P 020507 L 030555 |
| Metafast      | #2 pink       | 0.7             | P 41101 L 41103  |
| Miky          | #2            | 0.5             | P PEIL L ELG    |

Fig. 1 Illustration of specimens for measuring the hardening time.
Fluidity and Hardening Time of Autopolymerized Denture Repair Acrylic Resin

Results

Fluidity

Figures 2 and 3 show the changes in fluidity curves and the rheometer angles, respectively, of the five resins. Although the fluidity of Unifast II and Unifast Trad decreased almost immediately from the start of the measurements (20 seconds after the start of mixing), the fluidity of Provinice and Metafast decreased from 50 seconds after the start of mixing (in other words, 30 seconds longer than for Unifast II and Unifast Trad) for both the brush-on and mixing techniques. The change in the rheometer angle is shown in Figure 3. Similar fluidity was observed for the brush-on and conventional mixing techniques for all the resins although the onset of hardening was different.

Fig. 2 Fluidity measured by using rheometer.

Fig. 3 Changes of rheometer angles.
Except for Metafast, the four resins exhibited a relatively quick decrease in fluidity the amplitude of fluidity.

**Hardening time**

The hardening times of the five resins are shown in Figure 4. In all resins tested, the hardening time of the mixing technique tended to be longer than for the brush-on technique. In particular, there were significant differences in the hardening time between both techniques among the four resins, excluding Provinice ($P < 0.05$). The hardening time of Metafast was the significantly longest (350 seconds for brush-on and 470 seconds for mixing techniques) among the resins tested ($P < 0.05$). In contrast, Unifast II and Unifast trad had a significantly shorter hardening time (less than 200 seconds in both techniques) compared to the others ($P < 0.05$). Thus, the hardening time of Metafast was approximately two times longer than that of Unifast II.

**Discussion**

The pink autopolymerized acrylic resins were used in this study on the assumption that they would be used for denture repair. As mentioned above, there are few differences in material characteristics between pink and ivory resins although they contain different color pigments.\(^7,8\) Thus, the limitation of this study was that the results were only for the pink resin.

In Figure 2, the differences are shown in the onset time of hardening between the brush-on and mixing techniques. This phenomenon would occur because of the differences in their powder liquid ratios (brush-on technique: 0.31-0.38 L/P; mixing procedure: 0.5 L/P).\(^5\) Therefore, a rapid decrease in fluidity was observed for the brush-on technique compared to the mixing technique. However, a difference in fluidity was not found for either technique after the onset of hardening.

In clinical or laboratory practice, the P/L ratio of the brush-on technique is not constant.\(^5\) When autopolymerized acrylic resins are used for denture repair resins, the L/P ratio tends to be greater. Note that the hardening time decreases if the L/P ratio is greater for each of the resins.

Comparing the hardening times of each resin, Unifast II and Unifast Trad took less time to harden whereas Metafast took longer. These results tended to be similar to the results for fluidity, and were similar to our clinical experience. In contrast, the hardening time of Provinice and Mikey was not similar to their fluidity. Although these phenomenon cannot be explained, the diffusion of polymerization heating may be affected.

Since great differences in the onset of hardening were found between the two techniques in the five resins, attention should be paid to selecting a resin. However, autopolymerized acrylic resins are frequently used in the mouth, and intra-oral polymerization is also performed to complete the hardening during denture adjustment.\(^5,12\) Thus, further study on fluidity at a temperature of 37 °C is needed. In addition, the properties of autopolymerized acrylic resins, such as hardness, adhesive strengths, accuracy, color stability, and bending strengths are also important factors to consider when selecting resins.\(^1-4,9-11\)

**Conclusion**

Within the limitations of this study, the following conclusions can be made:

1. The hardening time for the brush-on technique was shorter than for the conventional mixing technique.
2. Although the onset of hardening was different for both techniques, the changes in fluidity were similar after the onset of hardening.
3. Because there were great differences in the hardening time for the autopolymerized acrylic resins, attention should be paid to handling time during denture repair.

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References