

Original Article

## Influence of length of food platform on masticatory performance in patients missing unilateral mandibular molars with distal extension removable partial dentures

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Reduction of the size of food platform of a distal extension removable partial denture has been recommended to decrease functional load on the abutment teeth and residual ridges. The purpose of this study was to investigate the influence of shortening food platform on masticatory performance. Eight subjects unilaterally missing mandibular molars participated in the study. A unilateral design was used for the denture framework. The length of the food platform was changed as follows. Initially, (A) was adjusted so that the distal end of the platform was in accordance with the distal end of maxillary second molar. Next, the platform was shortened successively to 15 mm (B) and 10 mm (C). Subjects were asked to masticate 2-colored wax cubes to evaluate masticatory performance. Mixing Ability Index was calculated from the color mixture and the form of masticated cubes. Repeated measures one-way ANOVA indicated significant difference of Mixing Ability Index among platforms ( $P < 0.0001$ ). The Dunnett's test indicated no significant difference between A ( $1.27 \pm 0.29$ ) and B ( $1.36 \pm 0.29$ ), and a significant difference between A and C ( $0.89 \pm 0.30$ ), ( $P < 0.001$ ). Masticatory performance decreased significantly when the length of food

platform was shortened to 10 mm.

**Key words:** masticatory performance, food platform, distal extension removable partial denture

### Introduction

In designing distal extension removable partial dentures (RPDs), it is important to restore masticatory function as well as to preserve abutment teeth and residual ridge. The influence of occlusal factors on masticatory performance and the stability of the denture base should be considered.

To reduce functional load on the denture base during mastication, some authors recommend reducing the size of the occlusal table.<sup>1-3</sup> Additionally, artificial posterior teeth should not be arranged over the incline of the residual ridge.<sup>4</sup> Several studies<sup>5-8</sup> demonstrated that load on the posterior region of mandibular distal extension RPD increased mobility of the denture base and abutment teeth. These studies suggest that shortening the length of food platform in the posterior region may assist in achieving stability of the denture base. On the other hand, various occlusal factors, such as the size of the occlusal table<sup>1,2</sup> and the form of the posterior teeth<sup>9</sup> influence masticatory performance in patients with mandibular distal extension RPDs.

Igarashi<sup>10</sup> and Ohi<sup>11</sup> studied the influence of the removal of the artificial second molar on masticatory performance in patients with mandibular distal extension RPD. They found that masticatory performance

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decreased immediately after removing the artificial second molar. Ohi<sup>11</sup> reported that masticatory performance after one week from insertion of RPD without second molar recovered to the same level prior to the removal of the second molar. These studies suggested that the length of food platform could be shortened without any decrease of masticatory performance. Unfortunately, in these studies the food platform was shortened by removing artificial teeth as a whole, therefore the length of food platform should be shortened without decreasing masticatory performance is not known.

The purpose of this study was to investigate the influence of shortening food platform on masticatory performance in patients with mandibular Kennedy Class II distal extension RPDs. The null hypothesis was that no differences in masticatory performance would be identified among food platforms.

## Materials and Methods

### Subjects

Eight subjects (4 males and 4 females, mean age  $59.6 \pm 8.8$  years) who had mandibular unilateral distal edentulous arch from first molar to second molar were recruited from patients who sought treatment at the Removable Prosthodontic Clinic of Tokyo Medical and Dental University. The opposing maxillary arch was either intact or had fixed prostheses present. Exclusion criteria were: (1) more than the first degree of mobility in abutment teeth and (2) signs and symptoms of TMD. All subjects received a written description of the study and informed consent was obtained from each subject before the onset of the study.

According to the shortened dental arch (SDA) concept,<sup>12</sup> it was not necessary for the patients who participated in study to replace missing molars with an RPD. However, the disadvantages of applying the SDA concept were discussed with each participant.<sup>13</sup> Thus, unilateral missing molars were replaced with removable prostheses in this study.

### Denture Design

A unilateral design was used for the framework of RPD in the study. RPD had the following components (Fig. 1): (1) a back-action clasp and a mesial-occlusal rest on the second premolar, (2) an embrasure hook on the first premolar and the canine, (3) an acrylic resin denture base and (4) a food platform. The frameworks were cast in gold-platinum alloy (Degulor M; Dentsply-

Sankin Corp, Tokyo, Japan).

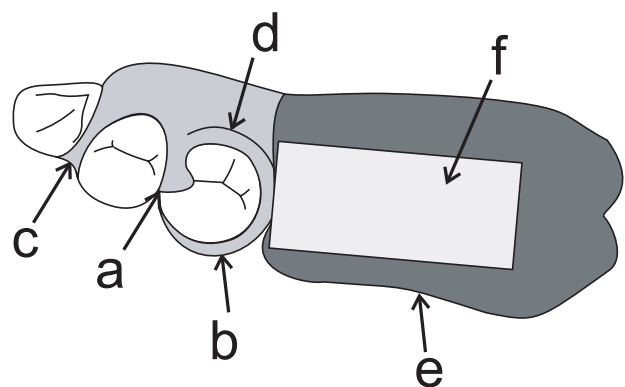
### Food Platform

The food platform was made of a light-polymerized composite (Revotek LC; GC Corp, Tokyo, Japan) on the denture base directly in the mouth. The width of the food platform was trimmed to 7 mm. The anteroposterior length of the food platform measured from the distal end of the second premolar to the distal end of the food platform was modified as follows (Fig. 2). Initially, Platform (A) was adjusted so that the distal end of platform was terminated with the distal end of maxillary second molar (mean 21.8 mm, 19.0-25.0 mm). The food platform was shortened successively to 15 mm (B) and 10 mm (C) by trimming the distal end of the food platform. Platforms A, B, and C simulated an arrangement when missing molars were replaced with commercially available artificial first and second molars (A'), with the artificial first molar and half-sized second molar (B') and with the artificial first molar (C'), respectively.

Occlusal contacts were adjusted intraorally of all subjects so that the opposing functional cusps could make contact with the food platform in the intercuspal position and no contacts were present during eccentric movements.

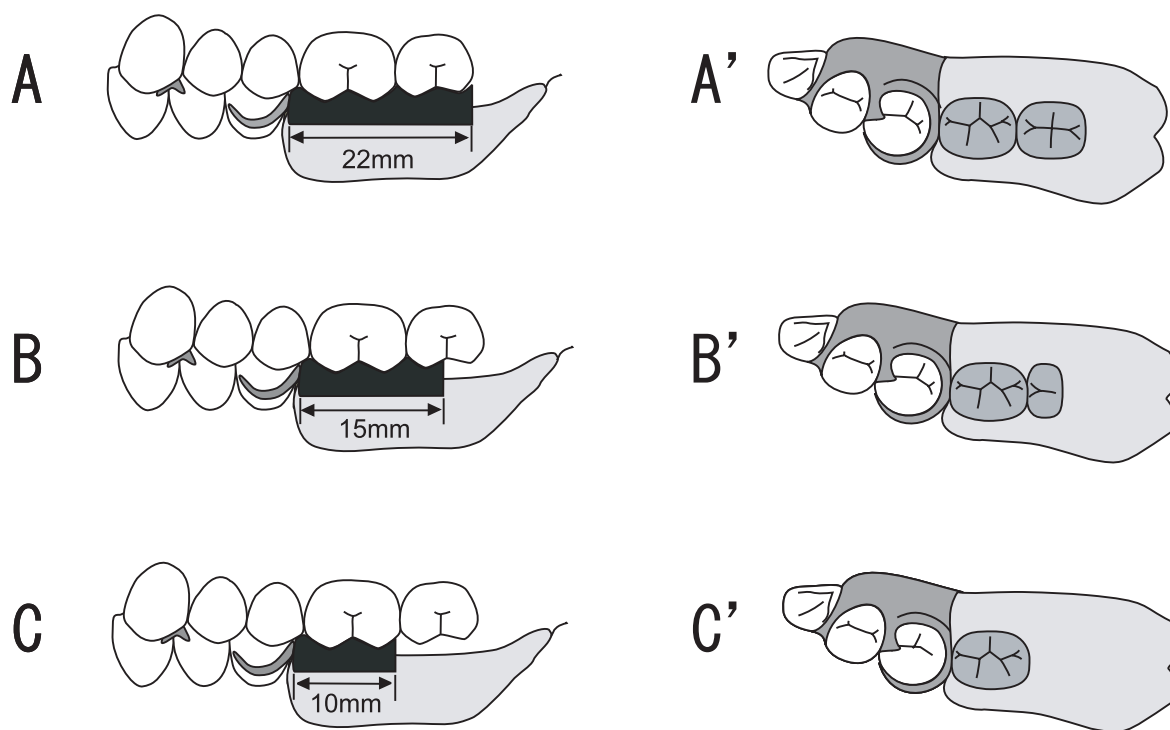
### Masticatory Performance Test

Masticatory performance was evaluated by the Mixing Ability Test.<sup>14</sup> Subjects were asked to masticate a two-colored paraffin wax cube (12×12×12 mm) for 10 strokes on the RPD side of the mouth. Five cubes were masticated immediately after insertion of RPD with platform A, B and C, respectively. The ratio of color



**Fig. 1.** Schematic drawing of removable partial dentures used in the study.

(a) mesial-occlusal rest, (b) back-action clasp, (c) embrasure hook, (d) slit, (e) denture base, (f) food platform



**Fig. 2.** Schematic representations of food platform length in mandibular distal extension RPD. (A), the distal end of food platform was in accordance with distal end of maxillary second molar (mean 22 mm). (B), the platform was shortened to 15 mm. (C), the platform was shortened to 10 mm. A, B, and C simulated arrangement with first and second molar (A'), with first and half-sized second molar (B') and with first molar (C'), respectively.

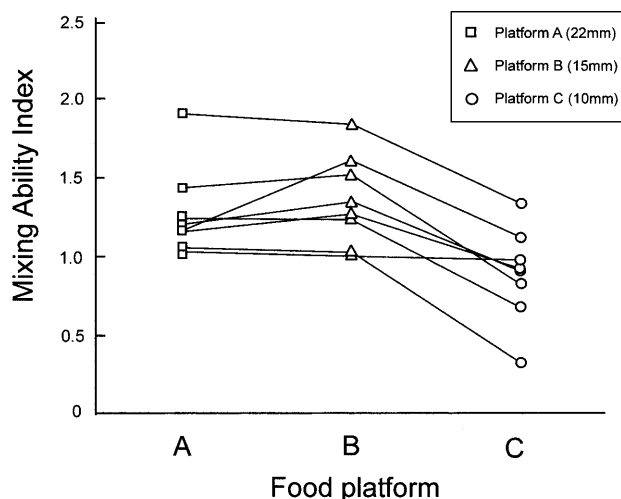
mixing and the form of the masticated cube was measured automatically with an image analyzer (LUZEX-FS; Nireko, Tokyo, Japan). Mixing Ability Index (MAI) of each cube was obtained by inputting measured items into the discriminate function. The mean MAI of five cubes in each platform was used for statistical analysis. Mixing Ability Test was approved by the Ethical Committee at Tokyo Medical and Dental University.

**Statistical Analysis**

The difference of mean MAI among 3 types of platform was tested using a repeated measures one-way ANOVA. The Dunnett's test for pairwise multiple comparisons was used as a post hoc test. A P value less than 0.05 was considered significant. SPSS 10.0J (SPSS Japan Inc) was used for statistical analysis.

**Results**

MAI did not change when the length of the food platform was shortened from A to B, however there was a decrease when shortened from A to C. The mean MAIs



**Fig. 3.** The distribution of the MAI in each food platform (n = 8). ○, △ and □ represent the mean MAI of five cubes in platform A, B and C, respectively.

in each platform of all subjects were illustrated in Fig. 3. The means ± SD of MAI in platform A, B and C were 1.27 ± 0.29, 1.36 ± 0.29 and 0.89 ± 0.30, respectively. Repeated measures one-way ANOVA found a

highly significant difference of MAI among platforms ( $P < 0.0001$ ). Dunnett's test found no significant difference between A and B ( $P = 0.480$ ), significant difference between A and C ( $P = 0.0005$ ).

### Discussion

In this study, masticatory function was evaluated by the Mixing Ability Test,<sup>14</sup> which was developed to carry out masticatory test easily compared with traditional sieving methods.<sup>15</sup> The Mixing Ability Test primarily evaluated the ability to mix food, which was different from the original definition of masticatory performance as the ability of food comminution.<sup>16</sup> In a previous study,<sup>17</sup> it was demonstrated that the correlation coefficient between Mixing Ability Test and sieving method<sup>18</sup> was 0.72 ( $P < 0.001$ ) and the intraclass correlation coefficient in test-retest consistency was 0.89. It suggested that Mixing Ability Test had validity and reliability in assessment of masticatory performance. Thus, the Mixing Ability Test was used in this study.

In this study, subjects were asked to masticate a wax cube for 10 strokes. In the study of Sato,<sup>17</sup> natural dentate subjects and denture wearers were asked to masticate wax cubes for 5, 7, 10, 15, 20, and 30 strokes respectively. The results found that MAI increased gradually when the number of strokes increased from 5 to 10, however MAI increased slightly when the number of strokes was more than 10, which indicated ceiling effect of the number of strokes on MAI. This suggested that minimum number of strokes to reflect the ability of masticatory function on MAI might be 10 strokes.

MAI with platform C was lower than those with platform A. MAI with platform B was not significantly different from that with platform A. These results indicate that masticatory performance immediately after insertion of RPD without artificial second molar is lower than when the first and second artificial molars are present. The mean difference of MAI between platform A and platform C was 0.38. Previous studies of Sato<sup>17</sup> and Sueda<sup>9</sup> suggested that clinically significant difference of MAI was considered to be more than 0.4-0.5. Thus, the result of this study suggested that clinically as well as statistically significant decrease of MAI was found when food platform was shortened from A to C. This result clinically indicates the possibility that distal extension RPD with the arrangement of the first molar and a half-sized second molar can recover masticatory function at the same level when artificial first and sec-

ond molars are arranged. Studies<sup>5-8</sup> investigating the influence of loading position on denture stability suggests that shortening the food platform can increase stability of the denture base. Thus, the posterior food platform with a half-sized second molar in mandibular distal extension RPD would help to achieve stability of the denture base without decrease in masticatory performance.

However, these conclusions have some limitations for generalizing. Our study examined masticatory performance only when changing the length of food platform. Thus, it is unknown how masticatory function might adapt after changing the food platform. Thus, longitudinal influence of length of the food platform on masticatory performance should be examined in future study.

### Conclusions

Within the limitations of this study, it was concluded that masticatory performance of patients missing mandibular molars decreased significantly immediately after the length of food platform of RPD was shortened to 10 mm.

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