

# The Effect of a New Denture Adhesive on Bite Force Until Denture Dislodgement

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**Purpose:** Denture adhesives are used to improve the denture retention and comfort of complete denture wearers. The purpose of this investigation was to establish the effect of a new denture adhesive on maximum bite force until denture dislodgement (BFDD) after adhesive application.

**Materials and Methods:** Fifteen denture-wearing patients (7 female, 8 male, mean age: 64 years) were involved in the study. The BFDD measurements were performed using a disposable gnathometer with a 1 to 10 scale. During one of the treatment sessions, the maximum BFDD with the pre-existing maxillary dentures using denture adhesive were measured. The measurements were also made at the baseline without adhesive and after the 1st, 2nd, 4th, and 6th hours following the application of the denture adhesive. The same procedure was applied to the new dentures about 2 weeks after the delivery of the dentures. The data were collected and statistically analyzed using ANOVA and Student's *t*-test.

**Results:** Consistent improvement was observed in BFDD when adhesive was used for all time intervals from the baseline (mean: 1.54 units, 3.20 units) to 6 hours (mean: 3.99 units, 4.60 units) for both pre-existing dentures ( $p = 0.003$ ) and new dentures ( $p = 0.05$ ), respectively.

**Conclusions:** The results of this in vivo study suggest that the denture adhesive tested could effectively increase BFDD for up to 6 hours after application.

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**INDEX WORDS:** denture adhesive, bite force

IMPROVING DENTURE retention and stability is of considerable interest in prosthetic dentistry. Approaches to the problem over the years have included overdentures, implants, and denture adhesives.<sup>1</sup> Although clinical trials failed to show adverse effects of denture adhesives on

oral tissues,<sup>2-4</sup> many dentists refrain from prescribing them since patients may continue to wear ill-fitting dentures.<sup>4</sup> Within the last 5 years, literature has revealed a change in the general attitude regarding the use of denture adhesives.<sup>5-7</sup> Improvement in denture stability and retention has been noted with new and experienced denture wearers.<sup>8-12</sup> There are multiple issues related to the clinical significance of a denture adhesive, but the most important is the adhesive's efficacy in improving function and reducing denture movement after the application of the adhesive.<sup>1,5,6,13,14</sup>

It has been shown that a substantial proportion of a population of denture wearers (7% to 33%) had tried or currently used denture adhesives.<sup>5</sup> Tarbet et al<sup>15</sup> investigated the role of adhesives in denture retention and stability by counting denture dislodgement in patients who ate standardized portions of food (celery, taffy, apple, steak, and hard roll sandwich) with and without denture adhesive. All patients had, or were provided with, well-fitting prostheses. The authors found a significant reduction in denture dislodgement when adhesive was used. Objective improvement of retention of dentures using denture adhesives

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has also been demonstrated by *in vitro* tests.<sup>9-12</sup> In order to assess the retention of complete mandibular dentures during chewing, cineradiography was used to disclose a significant decrease in denture dislodgement when a denture adhesive was used.<sup>16</sup> *In vivo* test methods using gnathodynamometry for assessing maximum force required to dislodge a denture also revealed improvement of retention of maxillary dentures using denture adhesives.<sup>13,17-19</sup> When a denture adhesive in the maxillary dentures was used, no significant difference was found in chewing efficacy between the test subjects with dentures and the control subjects having natural dentition.

A denture adhesive interacts with the denture and the underlying oral tissues via physical and noncovalent chemical interactions over a certain period of time. Denture adhesives are effective following initial placement, but these beneficial effects diminish over time as a result of the breakdown of the adhesive by oral fluids. A dilution of the adhesive occurs when it contacts saliva. The viscosity gradually decreases as the adhesive becomes thinned and the retentive qualities are eventually lost over time. These phenomena may also lead to decreased bite force until denture dislodgement (BFDD) and comfort.<sup>6</sup>

Since the introduction of the disposable gnathometer facilitating simple measurement of BFDD of the maxillary denture, it is now possible to predictably demonstrate improvement in retention of maxillary dentures.<sup>7</sup> This gnathometer allows the patient to bite on a small rubber pad with the central and lateral incisors of the maxillary and mandibular denture teeth. When the patient bites on this rubber pad until dislodgement of the maxillary denture, the indicator that is located initially by the clinician at rank 0, moves along the indicator and stops when the denture is dislodged. The range for the force required to dislodge the denture is between 0 and 10. The purpose of this clinical trial was to compare the BFDD required to displace pre-existing and new maxillary complete dentures after the use of denture adhesives in fasting patients.

## Materials and Methods

Participants were 15 volunteer complete-denture-wearing patients in both the mandible and maxilla (7 female and 8 male) who were treated for new



**Figure 1.** Disposable gnathometer.

complete dentures at the Department of Prosthetic Dentistry at Marmara University in Istanbul. Patients' ages ranged from 48 to 78 years with a mean age of 64 years. They were fasting during the period of the study (1 month). All patients were in good health with no medical problems that would contraindicate their participation in the study. The patients were informed about the aim of the study, and informed consent was supplied for the patients according to the ethical commission of the Dental School.

At the start of each testing cycle, the patients were instructed on the use of the adhesives, and demonstrations were given according to the manufacturer's instructions. At the baseline, the principal investigator measured the maximum BFDD with the pre-existing maxillary denture without adhesive. The measurements were performed by means of a disposable gnathometer (Procter & Gamble Co., Rotterdam, The Netherlands) with a scale ranking from 1 to 10 (Fig 1). It measures the force a patient can apply to the anterior teeth until dislodgement of the maxillary denture at the post-palatal seal. If the result of the measurement was between 2 ranking points, the lower rank was registered (i.e., between 3 and 4, 3 was chosen). Three measurements were made, with a 3-minute break to enable the patient to reposition the denture comfortably and habitually. The denture was removed, cleaned, and dried. Denture



**Figure 2.** Denture adhesive application.

adhesive (Kukident, Procter & Gamble Co.) was applied to the maxillary denture—4 strips of 1 cm of adhesive were placed at the front, posterior, right, and left border of the posterior palatal seal (Fig 2). The lengths of the denture adhesive strips were measured with a Boley gauge, and the excess was cut off with a sharp instrument. The denture adhesive selected for this study was a paste containing a calcium/zinc PVM/MA copolymer, paraffinum liquidum, cellulose gum, petrolatum, silica, and aroma. BFDD measurements were repeated thrice after the 1st, 2nd, 4th and 6th hours following the application of the denture adhesive. On each occasion, the subjects were allowed to reseat their denture by bringing their mandibular denture teeth into occlusion with maxillary denture teeth between recordings.

The patients received their new conventional complete maxillary and mandibular dentures fabricated according to a standardized method, including functional impressions with individual trays.<sup>20</sup> The same procedures for BFDD measurements were applied to the new dentures. In order to provide the patients with a period of adjustment to their new dentures, measurements for the new dentures were made at least 2 weeks after insertion. About 2 weeks after the new dentures were inserted, and when the patients were problem free, the same investigator, following the same procedure for the pre-existing dentures at different time intervals, measured maximum BFDD of the new maxillary dentures.

The data were statistically analyzed using ANOVA and Student's *t*-test (StatView 5.0, SAS Institute, Inc., Cary, NC).

## Results

Consistent improvement was observed in BFDD when adhesive was used, for all time intervals from the baseline (mean: 1.54 units, 3.20 units)

**Table 1.** Mean BFDD with Standard Deviations for Old and New Dentures

	<i>Old Dentures Mean (SD)</i>	<i>New Dentures Mean (SD)</i>
Baseline	1.54 (1.1)	3.20 (2.4)
T1	2.12 (1.4)	3.77 (2.7)
T2	3.05 (1.7)	4.22 (2.8)
T4	3.69 (2.2)	4.43 (2.9)
T6	3.99 (2.2)	4.60 (2.9)

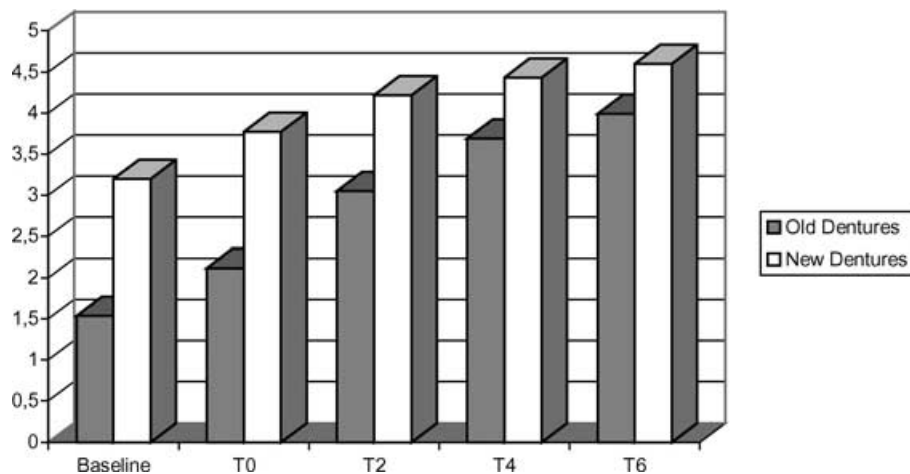
to 6 hours (mean: 3.99 units, 4.60 units) for pre-existing dentures ( $p = 0.003$ ) and new dentures ( $p = 0.05$ ), respectively (Table 1).

Significantly higher ( $p = 0.003$ ) BFDD was generated with new dentures (3.20 units) than with pre-existing dentures (1.54 units) at the baseline. BFDD after the application of adhesive to the dentures was substantially greater at all time intervals (T0–T6) ( $p = 0.001$ ) when compared with the results without adhesive (Baseline) (Fig 3).

In 1 patient, early dislodgement of the mandibular denture before the maxillary denture was noted. This did not allow adequate bite force measurements for that patient.

## Discussion

The main reasons for using denture adhesives are to improve fit, comfort, chewing ability, and patient confidence. Retentive strength of a denture adhesive to polymethylmethacrylate, however, declines as a function of time.<sup>6</sup> A correlation between dissolution of a denture adhesive and subsequent loss of bond strength has been previously reported.<sup>10</sup> Following initial placement, the adhesive slowly absorbs water and starts to swell, resulting in increased viscosity until the hydrophilic polymer particles contact each other. This forms a continuous polymer matrix. Oral fluids subsequently destroy the polymer matrix, decreasing its viscosity. Continued matrix breakdown results in progressively weaker bond strength. The denture adhesive tried in this study was still effective for up to 6 hours. Since this study was performed on fasting patients, the pure effect of adhesive was tested, but normal clinical function was not, since the patients were not eating. One can anticipate that the intake of food and beverages and the daily hygienic care of the dentures might decrease the adhesive properties and, eventually, the retention



**Figure 3.** Maximum BFDD with old and new maxillary dentures in bite force units with no adhesive at baseline and with adhesive at different time intervals.

and BFDD. Other adhesives with different chemical compounds and an extended period of testing (e.g., 10 to 12 hours) could be compared in future studies.

The findings of the present study demonstrate that using denture adhesive increased BFDD not only for the pre-existing, but also for the new dentures. Maximum BFDDs of pre-existing dentures with adhesive were significantly lower than forces with new dentures and adhesive. This could be explained by the loss of adhesive from the denture borders and in decreased retention of old dentures when compared with new ones.

At the 4- and 6-hour time intervals, BFDD of the old dentures was improved nearly 2.5 times, compared with the baseline values. Tarbet et al<sup>15</sup> studied the effect of quality of the denture supporting tissues on biting force in subjects wearing clinically well-fitting maxillary complete dentures. They found that in patients with unsatisfactory denture supporting tissues, the mean value for the bite force in the incisal region was 19 N, compared with 47 N for the patients whose denture supporting tissues were rated as satisfactory. It was also noted that the baseline values of bite forces for the subjects with unsatisfactory denture supporting tissues increased from 19 to 58 N with the use of adhesive. Grasso et al<sup>1</sup> showed that denture adhesives enabled patients to generate significantly greater incisal bite force up to 8 hours after adhesive application (20 to 35 N at baseline and up to maximum 54 N at 8 hours after application). The units obtained with the disposable gnathometers used in this study cannot be

interpreted in terms of N, and therefore a direct correlation with previous studies cannot be made. Although many devices have been developed to measure bite force, many require expensive, technical equipment. The recently introduced disposable gnathometer is a simple and practical instrument. Further research is needed to determine its reproducibility and predictability and to interpret the BFDD units in comparison to the universal units.

In this study the adhesive was applied in the maxillary dentures; however, the patients frequently complained about discomfort from their mandibular dentures. Techniques should be developed in order to measure the retention of adhesives in the mandibular dentures. Bite force devices should be developed to evaluate the effect of adhesives in preventing displacement of the mandibular dentures.

One subject failed to displace his upper denture during the investigation because of the retention developed in the new denture. Early dislodgement of the mandibular denture, then the maxillary prosthesis, did not allow adequate bite force measurements to be made for this patient. Further research is currently being carried out in patients with maxillary dentures against natural dentition, clasp retained removable partial dentures, and mandibular overdentures.

## Conclusions

1. The use of denture adhesive increased the maximum BFDD for both old and new dentures.

2. The increase in BFDD with the use of the denture adhesive in old dentures was found to be higher than that of new dentures.
3. The denture adhesive tested could be effective for increasing BFDD up to 6 hours after application.

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