

## CLINICAL RESEARCH

# In Practice Evaluation of a Denture Adhesive Using a Gnathometer

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**Purpose:** This study measured the extent to which the performance of a maxillary complete denture can be improved with the use of a denture adhesive. This in-practice evaluation assessed both a quantitative measure (force until dislodgement), without and with the adhesive, and patients' perception regarding the use of adhesive.

**Materials and Methods:** A total of 194 patients (77 men, 117 women) who wore maxillary complete dentures were tested for denture performance both without and with denture adhesive. A simple gnathometer was used. Patient perceptions were also assessed by a questionnaire and analyzed for denture performance as well as the effects on speaking and chewing, fit and comfort, and perceived confidence.

**Results:** There was a 63.4% improvement in bite force dislodgement with the use of a denture adhesive. A total of 79.2% of the patients perceived better denture performance (bite force dislodgement) with adhesive use. A total of 55.7% perceived an improvement in speaking and chewing. A total of 56.2% noticed the fit and comfort were better. A total of 63.9% responded that they had improved confidence.

**Conclusions:** Use of a denture adhesive can improve the incisal (or protrusive) biting force for patients who wear a maxillary complete denture. Subjectively, the patients reported an improved perception of denture performance and that the use of adhesive provided greater confidence when using the prosthesis.

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**INDEX WORDS:** stress distribution, photoelastic analysis, occlusion

IN THE past, denture adhesives were viewed as useful for patients with ill-fitting dentures. Today, however, this conventional perspective is being challenged. Research has demonstrated that denture patients using adhesives masticate in a similar fashion to patients who have natural teeth.

Zarb et al<sup>1</sup> have stated that one of the most important goals of denture fabrication is to restore masticatory function for an edentulous patient.

The performance of the denture is determined in large part by the degree of retention (resistance to dislodgement in the vertical plane), stability (resistance to movement in the horizontal plane), and support (the foundation area which resists movement toward the tissue). Denture retention and stability are improved as a result of the bond created between the denture and the tissues when using denture adhesives.<sup>2-6</sup> This interface between the oral mucosa and denture, provided by the denture adhesive, allows retentive forces to be transmitted between the mucosa and denture via an intermediary film of saliva.<sup>2</sup> Improving denture retention and stability is of significant interest in prosthodontics. Approaches to this challenge include the use of overdentures, implant-retained dentures, and denture adhesives. The selection of the overdenture or implant option is dependent upon many considerations, which are beyond the scope of this manuscript. Millions of denture wearers, however, use denture adhesives as an over-the-counter remedy and these products are recommended by many professionals. Nevertheless, this

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adjunct is not completely accepted by the dental profession.<sup>2,7</sup>

Some dentists and denture wearers feel adhesives can be helpful in regards to denture retention, function, and stability, while other dental professionals view adhesives as a compromise required because of a poorly fitting prosthesis. Furthermore, there has been concern about the adverse effects of denture adhesive usage, specifically adverse tissue changes and increased residual bone resorption.<sup>1</sup>

This study measured the effects a denture adhesive (Fixodent Denture Adhesive Cream, Procter & Gamble, Cincinnati, OH) on denture performance and patient perceptions. Bite force to denture dislodgement was measured before and after the application of a denture adhesive on a maxillary complete denture. Patient perception of performance, speaking and chewing, as well as fit and comfort were evaluated.

## Materials and Methods

This evaluation was performed in private practice locations. Dentists who indicated their willingness to participate (by returning an enrollment card attached to an invitation letter) were mailed individual test kits for their patients. Each patient pack included a pre-packaged and disposable gnathometer (a simple instrument specifically designed to record optimal in situ bite force), instructions regarding the use of the gnathometer (Fig 1), a sample size tube of adhesive (Fixodent, Procter and Gamble), a patient education brochure, and a sheet to record the data (Fig 2). A total of 194 patients were identified on the basis of having a maxillary complete denture opposed by either a mandibular removable complete denture, removable partial denture, implant supported prosthesis, or natural teeth.

The participating dentists were advised to follow a standard protocol.

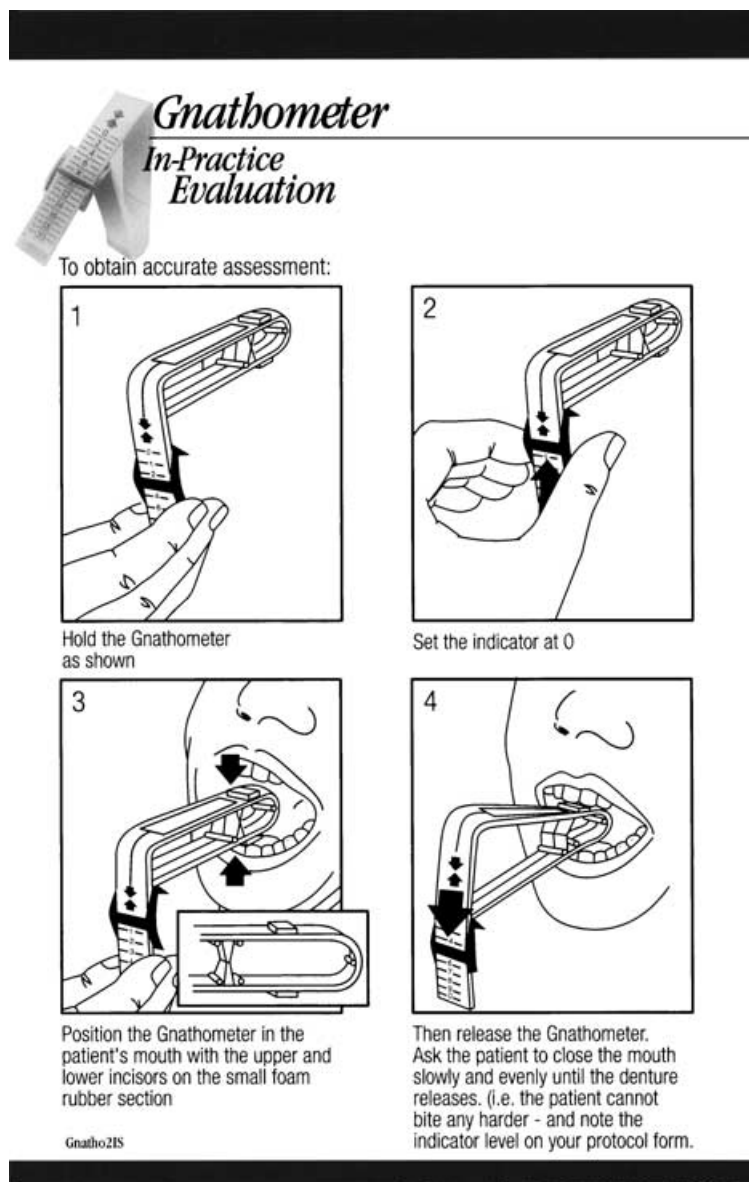
1. Insert the gnathometer between the maxillary and mandibular anterior teeth.
2. Ask the patient to bite down.
3. Record the force (on a 0–10 scale) when the denture was dislodged. (Denture dislodgement occurred when the posterior part of the maxillary complete denture lifted away from the post palatal seal while patients bit down with their anterior teeth.)
4. Remove the gnathometer from the patient's mouth.
5. Repeat steps 1–4 using adhesive.
6. The datasheets were mailed back to a post office box that did not identify the Columbia University School of Dental & Oral Surgery.

Participating dentists completed a questionnaire (Fig 2) with some information about each patient, as well as the bite force at dislodgement both without and with adhesive. At the conclusion of the clinical evaluation, patients were asked to evaluate denture performance, speaking and chewing, fit and comfort, and confidence with the adhesive versus without the adhesive as "better," "same," or "worse."

## Results

The average age of the 194 participants was 66.6 years old (males = 66.9 years, females = 66.3 years). The gender distribution was 39% male and 61% female (Table 1). The average time that a subject wore a maxillary complete denture was 16.2 years and the average age of their current maxillary complete denture was 7.7 years. The percentage of subjects currently using adhesive was 61.8%, and the percentage of subjects who had their maxillary complete denture modified (i.e., relined and/or rebased) was 39.7%. For the patients studied (Table 2), 50.2% (N = 98) presented with a mandibular removable complete denture, 34.3% (N = 67) with a mandibular removable partial denture, and 15.4% (N = 29) with natural dentition and/or implant supported prosthesis in the opposing arch.

Using the gnathometer's scale of 0–10 to measure bite force, the average force at dislodgement for a denture without adhesive was 3.3 and with adhesive, 5.2. Thus, for the population evaluated, a 63.4% improvement in bite force was observed with use of the adhesive. The bite force improvement with use of adhesive was observed with all types of opposing restorations, or natural teeth. Table 2 shows the gnathometer readings in reference to the status of the opposing arch. There was a 70.4% improvement when the maxillary complete denture opposed a mandibular complete denture. There was a 45.3% improvement when the opposing arch was a removable partial denture, and a 49.1% improvement when natural teeth and/or implants were opposing the maxillary complete denture. Figure 3 indicates there was a trend for increased bite force with adhesive when the maxillary complete denture opposed a mandibular



**Figure 1.** Instructions demonstrating use of the gnathometer. (Diagram used with permission from Procter & Gamble.)

complete denture, mandibular removable partial denture, and natural teeth/implants.

For the analysis of the patients' perceptions (Table 3), the use of a denture adhesive was associated with an improvement in their sense of how the maxillary prosthesis was functioning. A total of 79.4% of patients noticed an improvement in denture performance, while 55.9% noticed improved speaking and chewing. A total of 55.9% perceived a better fit and comfort, while 64.0% noticed improved confidence. Not all participating dentists

completed the subject's perceptions aspect of the questionnaire correctly or at all, and those results were not included in the analysis.

For those patients who had a "worse" perception with the adhesive ( $n = 4$ ), all demonstrated less force at dislodgement with use of the adhesive. Those patients who perceived the same (35 patients) or better (150 patients) performance with the adhesive had a positive change in the gnathometer reading (Fig 4). It is interesting to note that whether the patient was familiar with the use

**Gnathometer**

*In-Practice  
Evaluation*

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*Patient Datasheet for the Gnathometer In-practice Study*

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**Patient information:**

Gender:  Male  Female Age: \_\_\_\_\_

No. of years the patient has worn an upper denture: \_\_\_\_\_

No. of years the patient has worn this denture: \_\_\_\_\_

Does the patient currently use adhesive? \_\_\_\_\_

**Denture Information: (complete maxillary denture required for study)**

*Full Maxillary Denture:* Has the denture ever been modified?  
If so, how and when? \_\_\_\_\_

*Supporting Lower Denture/Teeth:*

Full Denture

Removable Partial  
which natural teeth are present? \_\_\_\_\_

Natural Teeth (including full bridge)  
which natural teeth are present? \_\_\_\_\_

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**Stage 1: Denture performance without adhesive**  
*(Denture dislodgement is when the posterior part of the upper denture lifts away from the soft palate while the patient is biting down with their front teeth.)*

Bite Force at denture dislodgement without adhesive \_\_\_\_\_

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**Stage 2: Denture performance with adhesive**

Bite Force at denture dislodgement with adhesive \_\_\_\_\_

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**Patient Perceptions:**

	Better	Same	Worse
With the use of an adhesive, do you note a difference in:			
Denture performance (bite force)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Speaking & chewing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fit and comfort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Confidence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Other remarks:* \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Gnatho2DS

**Figure 2.** Datasheet for the gnathometer in-practice study. (Diagram used with permission from Procter & Gamble.)

of adhesive, an improvement with the initial use of an adhesive was observed (Fig 5).

In this study, the age of the maxillary denture was not related to retention. Without adhesive, if the maxillary complete denture was less than 10 years old, the average bite force was 3.5. If the complete denture was between 10–19 years old, the average bite force was 3.1 and finally, if the complete denture was older than 20 years, the average bite force was 3.3. With adhesive, if the complete denture was less than 10 years old, the average bite force was 5.0. For the 10–

19 year range, the average bite force was 5.1, and for complete dentures in use for more than 20 years, the average bite force was 5.4. This data does, however, support the concept that regardless of the age of the maxillary complete denture, use of an adhesive results in improved resistance to dislodgement.

## Discussion

Zarb et al<sup>1</sup> discussed several factors that account for retention of complete dentures, including

**Table 1.** Gender Distribution, Years Patients Used a Complete Denture, and Previous Adhesive Use for Patients in the Study

Gender	N	Age in years (mean ± SD)
Men	77	66.9 ± 1.4
Women	118	66.3 ± 1.2

Years the subject has worn a maxillary CD (mean ± SD): 16.2 ± 1.0.

Years the subject has worn current maxillary CD (Mean ± SD): 7.7 ± 0.6.

Percentage of subjects using adhesive currently: 61.8%.

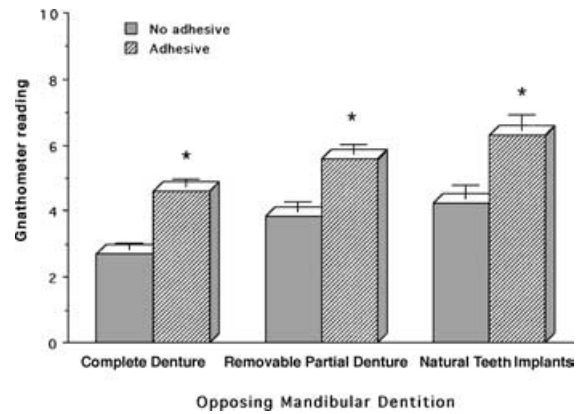
Percentage of subjects who had their maxillary CD modified: 39.7%.

adhesion, cohesion, interfacial surface tension, capillary action, atmospheric tension, and oral/facial musculature. Not all of these factors act at the same time; instead, some act only when needed to meet or resist a certain dislodging force. These factors, along with the appropriate fabrication of the complete denture, combine to retain the prosthesis.

The adhesive studied here improved the retention and stability of the maxillary complete denture for the majority of the patients in the study. The clinical value of a denture adhesive relates to improvement of function and its effect for the underlying tissue health. After the application of a denture adhesive, reduced denture movement has been observed and documented in the literature.<sup>7-11</sup> For instance, in the Chew et al<sup>8</sup> study, the data demonstrated that denture adhesives improved the retention and stability for both well-fitting and ill-fitting maxillary complete dentures. Karlsson and Swartz<sup>9</sup> used cineradiography and demonstrated less loosening of a maxillary complete denture with use of an adhesive. MacKay et al<sup>10</sup> used gnathodynamometry to demonstrate increased retention of dentures with adhesive use. Grasso, Rendell, and Gay<sup>7</sup> showed an improvement in retention and stability of a maxillary

**Table 2.** Gnathometer Readings at Dislodgement of the Maxillary Denture Without and with Adhesive Versus Opposing Dentition

Opposing Arch	N	No Adhesive	With Adhesive	Improvement (%)
CD	98	2.70 ± 0.19	4.60 ± 0.23	70.4
RPD	67	3.84 ± 0.30	5.58 ± 0.31	45.3
Natural teeth	29	4.22 ± 0.42	6.29 ± 0.48	49.1



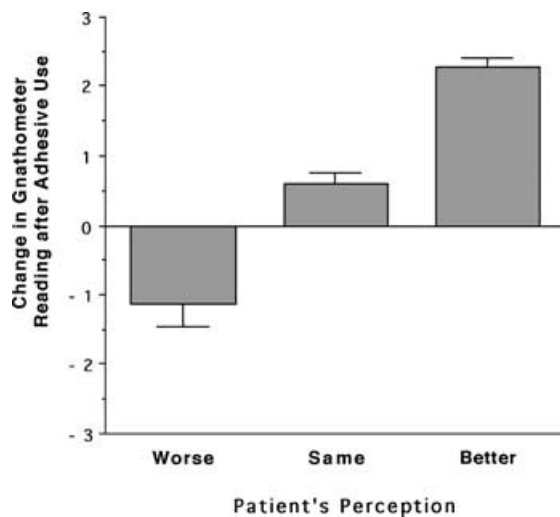
**Figure 3.** Bite force to dislodgement when the maxillary complete denture opposed a mandibular complete denture, mandibular removable partial denture, and/or natural teeth/implants, with and without adhesive.

complete denture for up to 8 hours with use of a denture adhesive.

In 1940, Boos<sup>12</sup> mentioned the use of a gnathometer, calling it a gnathodynamometer, developed to measure intermaxillary biting power. His instrument had a central bearing point, which, when mounted on bases, was able to distribute an equivalent stress throughout. According to Boos, his instrument could evaluate the patient's condition, muscle strength, and tolerance of the tissues, as well as the tissue bearing areas. By establishing biting power, he was able to study the intermaxillary relationship. One of his conclusions was that the biting power in different people varied due to muscular development as well as the tissues' ability to withstand stress. He mentioned that the dental restoration provides the occlusion that determines the intermaxillary relation. It is this biting force which determines denture dislodgement. A major difference between his appliance and the one in this study was that his measured stress from

**Table 3.** Patients' Perceptions Regarding Use of the Denture Both Without and with Adhesive

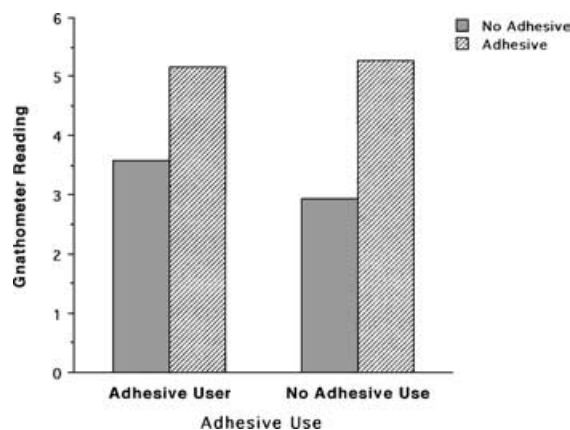
	Improved	Same	Worse
Denture performance (bite force)	150 (79.4%)	35 (18.5%)	4 (2.1%)
Speaking and chewing	104 (55.9%)	80 (43.0%)	2 (1.1%)
Fit and comfort	104 (55.9%)	75 (40.3%)	7 (3.8%)
Confidence	119 (64.0%)	62 (33.3%)	5 (2.7%)



**Figure 4.** Patients' perceptions versus changes in gnathometer reading at dislodgement after use of adhesive.

a central bearing area, while this study's appliance measured the same biting force from the anterior.

Incisal bite force by patients before dislodgement was significantly greater with the use of adhesive. This quantitative improvement may relate to both the effects of the adhesive on the retention of the denture to the mucosa, as well as the more difficult to define effects on patient confidence observed with the use of the adhesive. With the use of adhesives, patients have reported both quantitative and qualitative improvements in the increased ability to chew hard foods.<sup>7</sup>



**Figure 5.** Improvement in force to dislodgement, with and without a history of adhesive use.

Brewer<sup>13</sup> emphasized that when treating complete denture patients, one must treat the patient and not just the dentition. The psychological aspects of treatment are just as important as the actual construction of the prosthesis. For those patients involved in public appearances and public speaking, the reliance on adhesives to augment an already satisfactory denture does not represent a criticism of the treating dentist or the actual fabrication of the denture.<sup>13</sup> Stated differently, the use of an adhesive offers psychological advantages even if the complete denture is properly fabricated.<sup>2</sup> As observed here, there was a positive relationship of patient perception with the improvement in the force needed for dislodgement.

A limitation in this study is that the patients were asked to incise into the gnathometer in the protrusive position, and no measurement was made during chewing. Since the protrusive position is outside the range of chewing function, it does not necessarily follow that the chewing ability of denture wearers is improved with the use of an adhesive. Kapur<sup>6</sup> mentioned that denture wearers may say a denture adhesive helps them to chew better, but his results did not demonstrate that masticatory performance was improved. The adhesive may provide an increased sense of security and added comfort, even though an adhesive is not required for proper denture retention. Therefore, it can be concluded that the psychological benefits of denture adhesive use may, for some patients, be an important benefit.

With the increased stability and retention provided by denture adhesives, denture wearers can apply an increase in force during mastication, thus needing less chewing strokes to reach deglutition.<sup>5,6</sup> Denture adhesives can provide a softening effect, reduce the food particles collecting below the denture (inhibiting the growth of *Candida albicans*), and help in the distribution of occlusal forces over denture bearing tissues, thereby reducing local pressure points.<sup>5,14-16</sup> In addition, adhesives can serve to protect the mucosa<sup>15,17,18</sup> and act as a biocompatible bandage, and improve the proprioceptive stimulus for denture wearers during function. Studies have shown that with proper use of adhesives, excessive bone resorption of the residual ridge, alterations in vertical dimension, and altered muscle activity during chewing do not occur.<sup>14,15</sup> The confidence displayed by new denture wearers improves with the use of a minimal amount of adhesive.<sup>15,17,19</sup> This is particularly true

for new denture wearers in social situations and during eating.

In an ideal situation, an edentulous patient will have prominent alveolar ridges and a repeatable centric relation, and proper clinical/technical procedures for denture fabrication will result in a denture that does not require the use of an adhesive. However, the population is aging, and many fully or partially edentulous patients are affected by chronic illness and have limited access to complete oral health care. Consequently, denture adhesive can be an effective part of denture care and aftercare. With the benefit of improved emotional security, retention, stability, and function (when properly used), denture adhesives can be a beneficial part of oral health care for the partially or fully edentulous patient.<sup>2,17</sup>

### Conclusion

As assessed with a simple gnathometer, a denture adhesive significantly improved the incisal (protrusive) biting force needed to dislodge a maxillary complete denture. Subjectively, use of the adhesive resulted in improved ability to speak and chew, improved fit and comfort, and improved confidence. These improvements were observed regardless of the age of the denture or the opposing dentition. Therefore, a denture adhesive should be considered for patients using a maxillary complete denture.

### Acknowledgment

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