The effect of three different denture adhesives on the retention of mandibular complete denture
(Comparative study)

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ABSTRACT

Background: Retention is one of the important factors in the success of the prosthodontic treatment. Retention is affected by several factors which are physical, physiological, psychological, mechanical and surgical factors. The use of denture adhesives improved the retention and stability of complete denture. The use of denture adhesives is indicated in several cases, as in an immediate denture, flat ridge, patient with deficits in muscle control, xerostomic patient and patient in need of psychological security. The purpose of this study is to measure and compare the effectiveness of denture adhesives (cushion, powder and cream protefix denture adhesive) in a well-fitting mandibular complete denture for flat ridge at various time intervals and to its relation with surface area of denture bearing mucosa.

Materials and methods: Ten edentulous patients with flat ridge, with age group (50-70) years were selected. New complete dentures were constructed for them. A specially designed strain gauge force transducer and a strain indicator unit were used to measure forces required to dislodge the denture from its foundation. Retention of mandibular complete denture without adhesive and with the use of each type denture adhesives at intervals of 15 minutes, 1 hour and 2 hours were measured. The surface area of denture bearing mucosa was also measured.

Results and conclusion: This study revealed that there is a significant improvement in the retention of mandibular complete denture for flat ridge after using three types of denture adhesives. Denture adhesives start their action immediately and decreased with time. Powder was the most effective denture adhesives than cushion and cream.

Key words: Flat ridge, Denture adhesive, Strain gauge measuring device.

INTRODUCTION

The performance of the denture is determined in large part by the degree of retention (resistance to dislodgment in the vertical plane), stability (resistance to movement in the horizontal plane), and support (the foundation area which resists movement toward the tissue) so that sufficient retention constitutes a basic and important requirement for the acceptance of complete denture by the patient.

The Retention of Complete Denture

The term of retention is used to mean that combination of forces which hold the fitting surface of the denture base in contact with the denture mucosal supporting tissues. In the glossary of prosthodontic terms (2005), denture retention has been defined as the resistance to the movement of a denture away from its tissue foundation especially in a vertical direction.

The retention of complete denture may be influenced by a number of variables classified by Hardy and Kapur (1958) as physical, physiological, psychological, mechanical and surgical factors.

These factors have a significant influence on conventional complete denture treatment. Factors of retention do not all act at the same time where some may act only where they are needed to meet certain dislodging forces.

The physical forces are those forces operating through a salivary film between the fitting surface of the denture and the surrounding mucosal supporting tissues. The physical forces and factors that have been credited will cause or enhancing denture retention is: surface tension, cohesion, adhesion, wettability, viscosity, atmospheric pressure and gravity.

Physiological forces are mainly muscular and re exerted by cheeks, lips and tongue. Physiological factors include the patients neuromuscular control, the ridge characteristics and the nature of supporting tissues.

Occasionally, it is not possible to achieve retention and stability because of factors not influenced by adequate denture fabrication alone. These factors include: Poor jaw and Ridge relationship, lack of neuromuscular coordination, inadequate quantity of available bone (normal residual ridge resorption or a flabby ridge), improper condition of the denture bearing mucosa (atrophic, poorly resilient and readily traumatized...
mucosa), inadequate vestibular depth, inadequate quantity and quality of saliva, and the psychological conditions.\(^\text{4,10}\)

There are treatment alternatives that aid in increasing retention and stability when conventional denture therapy is inadequate. These include: Dental implants: that provide anchorage for all implants-supported prosthesis, Surgery: to augment the alveolar ridge or to increase the vestibular depth, Denture adhesive, and Surface treatment of (poly methyl methacrylate) denture base material\(^\text{4}\).

**Denture Adhesive**

Dentists need to know about denture adhesives for two reasons:

1. To be able to educate all denture patients about the advantages, disadvantages and uses of the product, because adhesives are widely used dental material and patient rightfully expect their dentists to be accurately informed about over-the-counter oral care products.
2. To identify those patients for whom such a product is advisable and/or necessary for a satisfactory denture-wearing experience\(^\text{11}\).

Prosthodontists have a negative attitude towards the use of denture adhesives and assume that to advocate their use is a mean of compensating deficiencies in clinical and technical procedures. Denture adhesives increase denture retention and there by improve chewing ability, reduce denture wobble, improve comfort and confidence, and reduce amount of food particles collecting under the dentures, and undoubtedly provides the patients an increased sense of security and satisfaction, but they should use denture adhesives only on the advice of their dentists. Patients should be instructed about the proper use and caution against misuse as apart of denture post delivery instruction\(^\text{12}\).

**Characteristics of An Ideal Denture Adhesive:**

An ideal denture adhesive should be non-toxic, non-irritating and biocompatible with the oral mucosa. It should not promote microbial growth. The products should be odorless, tasteless, easy to apply and to remove from the tissue-bearing surface of dentures. The adhesive should retain its adhesive properties for 12 to 16 hours before other need for application occurs. The ideal adhesive should provide comfort, retention (adhesion, cohesion) and stability to the denture, ensuring the patient's ability to function with security and effectiveness during speech, mastication, yawning and smiling\(^\text{13}\).

**Composition:**

The major constituents of denture adhesive may be divided into three groups:

- **Group 1:** Consist of materials responsible for the adhesive properties such as Karaya gum, tragacanth, acacia, hydroxymethyl cellulose, sodium carboxymethyl cellulose (CMC), and poly[viny] and polyvinyl\(^\text{11,14}\).

- **Group 2:** Contains antibacterial/antiseptic agents, which are added by some manufacturers, such as methyl salicylate, sodium tetraborate\(^\text{13-15}\).

- **Group 3:** Contains the additional materials which are added by some manufactures, such as sodium lauryl sulphate reduces surface tension and acts as a wetting agent; magnesium oxide is a filter; petrolatum, mineral oil, polyethylene oxide which are included in creams to bind the materials; menthol and peppermint oils are used for flavoring; red dye for color and sodium borate and methyl paraben or polyparaben as preservatives\(^\text{13,14,16}\).

**MATERIALS AND METHOD**

**Materials instruments and equipment**

A – The conventional materials instruments and equipment used in the fabrication of complete denture.

B – A specially fabricated device for the measurement of retention force (strain gauge force transducer and strain indicator unit) which consist of: as in figure 1.

1. Load application apparatus (cantilever beam, the hook assembly, load application screw).
2. The supporting structure (the platform).
3. Load indicator unit.

**Accessories** (watch, weights, string, scissor, tweezers, ruler, cotton, adhesive tape, battery, vernier caliper).

**Figure 1:** Strain gauge measuring device

C – Three types of denture adhesive (powder, cream and cushion protefix D.A.)
Patient criteria

Ten edentulous patients, age range between 50-70 years, having lower flat ridge with good oral and general health and all patients should be cooperative.

Clinical testing

After construction of new complete denture for each patient, at the day of denture insertion border extension and occlusion would be checked. A string of about 2 inch length would secure on the lingual surface of the denture at the mid way between the anterior and posterior limit of the denture with cold cure s a mean of hanging of the denture to the hook assembly. Calibration test was done before each measurement for all patients to avoid any kind of error by using (1-5kg). The load will be recorded directly on the load indicator unit.

At the first day of testing, patients were seated comfortably in upright position and rinse his mouth with water. Denture was inserted and patient close in centric occlusion for 5 sec. and left in position for 2 min. then after calibration of the device ,the patient opened his mouth sufficiently comfortable distance and hook of the device engaged in the string then the measurements were taken. The cantilever beam was elevated and denture was dislodged with steadily increasing force until it was completely detached from the mandible, the highest force value at which the denture was dislodged would appear directly in the load indicator unit which acts as the retention force of the denture without the use of any denture adhesive as in the figure 2.

Measurement of the surface area of the denture bearing mucosa:

The surface area was calculated by the following equation:

\[
S.A. = 2[(\Sigma (X_1 + X_2)/2)/\text{no. of } X_i]Y
\]

\[X_1\text{ mean the distance from the crest of the ridge to the edge of the buccal flange.}\]

\[X_i = (X_1 + X_2)/2\]

\[Y\text{ mean the length of the crest of the ridge.}\]

Where the crest of the ridge was divided into 1cm divisions by the use of vernier caliber and place dot at the end of each division and measure X1 and X2 for each division as in the figure 3.

Standardization for powder and cream denture adhesive:

In order to measure the suitable amount of powder and cream denture adhesive for each case apylot study was done. We measure the retention force at definite amount of adhesive then by increasing and decreasing the amount of adhesive until we get the maximum retention with minimum amount of denture adhesive and which cause no trauma to the patient mouth.

Measurement of retention force with denture adhesives:

Patient was seat comfortably, rinse his mouth, the denture adhesives (cushion, powder, and cream) was applied respectively on the denture (according to the manufacturer instruction) in three successive days each type in separate day and in the standardized amount. Then the reading was taken for retention force after 15min., 1hr., and 2hr. for each type. During these periods the patient should not eat or drink anything and not remove the denture from the mouth. Then the denture was removed, cleaned and kept in water every day after taking measurements.

RESULTS AND DISCUSSION

1. The effect of denture adhesives on the retention of well fitting mandibular complete denture with flat ridge.

The descriptive statistical analysis was used and showed that there is an improvement in the
The effect of three different denture adhesives (cushion, powder and cream protefix D.A.).

Table 1: Mean, standard deviation, minimum and maximum values of retention force (in gram) of mandibular complete denture before and after the application of each denture adhesive at three time intervals.

<table>
<thead>
<tr>
<th>Type of D.A.</th>
<th>Mean(gm)</th>
<th>SD</th>
<th>Min(gm)</th>
<th>Max(gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before use D.A.</td>
<td>233.3</td>
<td>208.4</td>
<td>28</td>
<td>700</td>
</tr>
<tr>
<td>Cushion D.A.</td>
<td>484.5</td>
<td>432.8</td>
<td>15</td>
<td>1500</td>
</tr>
<tr>
<td>After 15min</td>
<td>420</td>
<td>295.7</td>
<td>180</td>
<td>1080</td>
</tr>
<tr>
<td>After 1hr</td>
<td>275</td>
<td>161.8</td>
<td>100</td>
<td>520</td>
</tr>
<tr>
<td>After 2hr</td>
<td>670</td>
<td>258.0</td>
<td>320</td>
<td>1300</td>
</tr>
<tr>
<td>After 1hr</td>
<td>580</td>
<td>334.1</td>
<td>280</td>
<td>1300</td>
</tr>
<tr>
<td>After 2hr</td>
<td>502.5</td>
<td>313.8</td>
<td>100</td>
<td>990</td>
</tr>
<tr>
<td>After 1hr</td>
<td>637.5</td>
<td>302.9</td>
<td>260</td>
<td>1150</td>
</tr>
<tr>
<td>After 2hr</td>
<td>546</td>
<td>260.6</td>
<td>240</td>
<td>1000</td>
</tr>
<tr>
<td>After 2hr</td>
<td>439</td>
<td>274.8</td>
<td>100</td>
<td>1050</td>
</tr>
</tbody>
</table>

The result of one way ANOVA for retention before and after the application of denture adhesive revealed that there is a significant difference at all time intervals. (p<0.05). This result agree with Kapur. (1)

Table 2: One way ANOVA for retention force before and after application of each type of denture adhesive at different time intervals.

<table>
<thead>
<tr>
<th>Type of D.A.</th>
<th>F-test</th>
<th>P-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cushion D.A.</td>
<td>2.82</td>
<td>0.014</td>
<td>S</td>
</tr>
<tr>
<td>Powder D.A.</td>
<td>4.44</td>
<td>0.009</td>
<td>S</td>
</tr>
<tr>
<td>Cream D.A.</td>
<td>4.34</td>
<td>0.010</td>
<td>S</td>
</tr>
</tbody>
</table>

2. Comparison of the effectiveness of the denture adhesives
The histogram in figure 4 showed that the effect of three types D.A. started immediately 670gm and decreased with time 275g.

Table 3: T-test between retention force (in gram) before and after the application of each denture adhesive with surface area at different time intervals.

<table>
<thead>
<tr>
<th>Type of D.A.</th>
<th>t-test</th>
<th>P-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before use of D.A.</td>
<td>2.681</td>
<td>0.025</td>
<td>S</td>
</tr>
<tr>
<td>After use of cushion D.A.</td>
<td>After 15 min</td>
<td>2.572</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>after 1 hr</td>
<td>2.618</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>after 2 hr</td>
<td>2.671</td>
<td>0.026</td>
</tr>
<tr>
<td>After use of Powder D.A.</td>
<td>after 15 min</td>
<td>2.530</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>after 1 hr</td>
<td>2.563</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>after 2 hr</td>
<td>2.586</td>
<td>0.029</td>
</tr>
<tr>
<td>After use of Cream D.A.</td>
<td>after 15 min</td>
<td>2.557</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>after 1 hr</td>
<td>2.590</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>after 2 hr</td>
<td>2.624</td>
<td>0.028</td>
</tr>
</tbody>
</table>
3. The correlation between the adhesive effectiveness and the surface area of the denture bearing mucosa

Student's paired t-test between the effectiveness of denture adhesive and surface area showed that there is a significant correlation between them (p<0.05) and coefficient of correlation showed a positive correlation between them. This result agrees with Shay (11).

REFERENCES