J Indian Prosthodont Soc (July-Sept 2010) 10(3):176–181
DOI 10.1007/s13191-010-0039-4

ORIGINAL ARTICLE

A Study to Evaluate the Retentive Ability of Different Denture Adhesive Materials: An In Vitro Study

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Received: 21 July 2010 / Accepted: 27 December 2010 / Published online: 13 January 2011

Abstract Denture Adhesives are commonly used by denture wearers to enhance the retentive ability of their dentures however, little is known about the efficacy of these materials. To compare the retentive ability of three different commercially available denture adhesives. To find out the best available denture adhesive material. An in vitro investigation to evaluate the retentive ability of three commercially available denture adhesive powders and two adhesive pastes was conducted. The adhesion and cohesion that developed between the glass surface and acrylic resin samples when the various materials were interposed between them was evaluated by means of a testing apparatus. Denture adhesives increase the adhesion of resin samples to the glass surface. Fixon powder showed the highest resistance to dislodgement. The paste forms were found to be more retentive. Denture adhesives when used in combination with synthetic saliva showed the maximum value.

Keywords Adhesion · Retention · Cohesion

Introduction

Dental professionals have been slow to accept denture adhesives as a means to enhance denture retention, stability and function. Despite considerable documentation advocating patient's use of adhesives many dentists view adhesive usage as a poor reflection of their clinical skills and prosthetic expertise.

Clinical procedures during impression making are designed to obtain a maximum area of coverage, an intimate tissue/denture contact, and an effective border seal. However, in occasional situations, patients frequently resort to the use of denture adhesives for e.g., in conditions such as immediate restorations, complicated prostheses—obturators, dry mouth, the difficult and demanding patient, poor ridge anatomy and relations, a single complete denture or in public like attorneys, actors, and politicians. They can also be used as an aid in retention during the fabrication phase of a denture and as a vehicle to aid in the application of drugs to the oral mucosa.

Shay [1] described the mechanism of action of adhesives in 1991. These materials swell 50–150% by volume in the presence of water, filling the spaces between the prosthesis and the tissues. The properties of current adhesives depend upon the combination of both physical and chemical properties, saliva increases the viscosity of the adhesive thereby increasing the force required to separate the prosthesis from the tissue surface.

The current dental literature supports the use of denture adhesives and dispels some of the negative opinions that originate with them. A number of denture adhesives are currently in use, however their efficacy is questionable.

Hence, the present study was undertaken to evaluate the efficacy of various commercially available denture adhesives in relation to their retentive ability under controlled laboratory conditions.

Aims and Objectives

The aim of the present study was:

1. To compare the efficacy of three different commercially available denture adhesives in relation to their retentive ability.
2. To find out the best available denture adhesive material.

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Materials and Methods

Fabrication of Master Die

To control the diameter and the thickness of the test samples, a standard metal die was used which consisted of a stainless steel ring with a bronze insert designed to fit exactly to the internal diameter of the die. The internal diameter was 4 cm and the height of the bronze insert was kept 2 mm less than the height of stainless steel ring. Two bronze disks 5 cm in diameter and 1.5 cm in thickness were used as base and cover for the ring (Fig. 1).

Preparation of Acrylic Resin Samples

Fifteen Samples were prepared, 4 cm in diameter and 2 cm in thickness (Fig. 2) using the above mentioned die. High impact heat cure acrylic resin (Acaryln-H-Asian Acrylates) was used to prepare the specimen. Acrylic resin polymer and monomer were mixed according to the manufacturers instructions and packed directly into the metal die with a bronze disk cover. The entire apparatus was held together under pressure with a metal press for all the specimen (Fig. 3). The flask assembly was cured at 740°C for 90 min with a terminal boil for 60 min and then left to bench cool for 30 min.

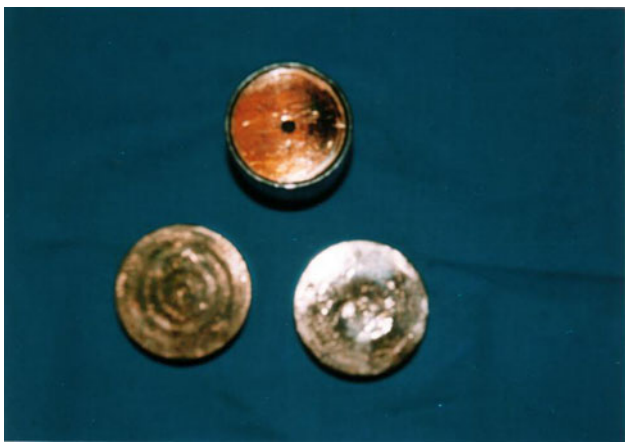

Fig. 1 Metal die with the bronze disks

Fig. 2 Samples 4 cm in diameter and 2 cm in thickness

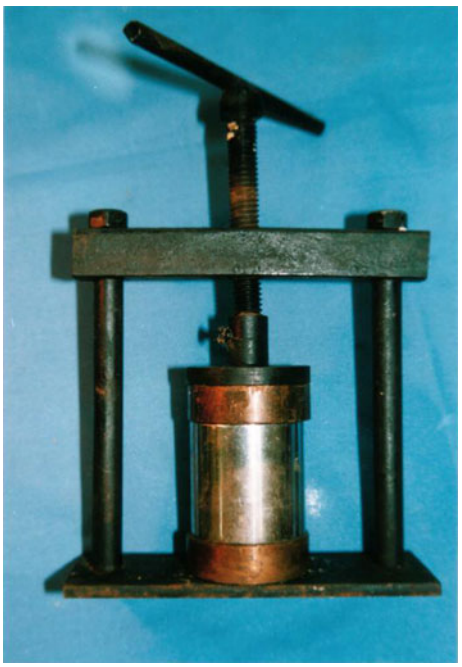

Fig. 3 The flask assembly

Evaluation of the Test Materials: (Fig. 4)

Three commercially available denture adhesive materials were tested for their retentive ability.

1. Fittydent (Powder and paste)
2. Fixon (powder and paste)
3. Dentiro (powder)

The adhesive action of the acrylic resin disk samples to clean glass surface wetted with 0.5 ml liquid was tested by means of the testing apparatus (Figs. 5, 6). The liquids tested were distilled water and synthetic saliva. The composition of synthetic saliva used is given in the following table.

Composition of synthetic saliva

Carboxymethyl cellulose (g/l)	10.000
Sorbitol (g/l)	30.000
Potassium chloride (g/l)	1.200
Magnesium chloride (g/l)	0.843
Calcium chloride (g/l)	0.146
Dipotassium hydrogen phosphate (g/l)	0.342
pH	7.2

Fig. 4 Various materials used in the study

Fig. 5 Testing apparatus used to evaluate the adhesion of distilled water and artificial saliva

Fig. 6 Testing apparatus used to evaluate the adhesion of various test materials with and without artificial saliva

Fig. 7 Adhesive powder applied on the disk surface

A total of 180 samples were tested. These samples were divided into three groups as

1. Group 1 consisted of 15 samples each tested using 0.5 ml of synthetic saliva and distilled water as the interface medium. A total of 30 samples constituted this group.
2. Group 2 comprised of 15 samples each tested for all the five adhesive materials evaluated in this study. A total of 75 samples constituted this group. The materials were used according to the manufacturers instructions, i.e. adhesive powder was applied on a wetted disk specimen (wetted with water) (Fig. 7), whereas pastes were applied on dry disk specimens (Fig. 8).
3. Group 3 included 15 samples each tested for all of the five adhesive materials when used in conjunction with 0.5 ml saliva. Thus, this group also comprised of 75 samples in all.

Fig. 8 Adhesive paste applied on the disk surface

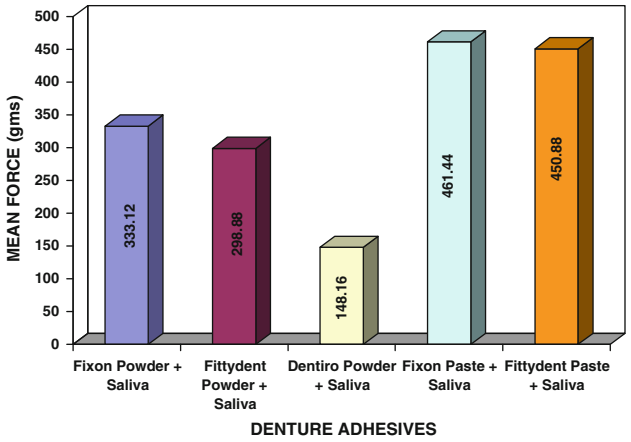

Fig. 9 Retentive force offered by various denture adhesive materials when used in combination with saliva

Adhesion was expressed in terms of the force required to separate the specimen from the glass when the test material was interposed. A load was applied slowly at the rate of 20 ml/min by addition of water into the plastic container suspended.

A controlled experimental procedure was followed. Each procedure was repeated fifteen times by using a different disk sample each time. The glass surface and the samples were cleaned after each experiment with an aqueous solution of detergent followed by distilled water and then dried with absorbent tissue, so that the procedure would be free of any effects between the treatments.

The overall experimental procedure was conducted at a room temperature of 23 ± 20°C (73.40 F) and relative humidity of 50 ± 10%.

The following parameters were controlled and kept constant for each test (Fig. 9):

• Insertion force (kg)	3
• Duration of insertion force (min)	1
• Time lapse from insertion to removal (min)	2
• Volume of interface saliva (ml)	0.5
• Quantity of adhesive powder (g) (Fig. 8)	0.30
• Wetting time of adhesive powder (min)	5
• Quantity of adhesive cream (cm) (Fig. 9)	1
• Cleaning technique in between the tests	Same technique for all specimens
• Rate at which the removal force is applied	Constant (as mentioned)

Results

The retention of various commercially available denture adhesive materials was tested. Adhesive materials when used alone or in conjunction with saliva increased the retention exponentially. Synthetic saliva was found to be significantly more retentive than distilled water (Table 1). However, these values were found to be very small, therefore, the plastic container that held the water was replaced by a poly bag, whereas for the other materials, the plastic container was used and its value added to the final reading (Fig. 5).

A highly significant difference was also observed when values of various test materials were compared to that of synthetic saliva. The test materials were found to be much more retentive then when saliva was used alone.

Amongst the adhesive powders used, fixon powder showed maximum retention whereas the paste forms showed comparable values (Table 2). However, the paste forms were more retentive than their powder counterparts (Table 3).

Table 4, shows a marked difference in the retentive ability between the denture adhesives when used in presence of saliva and the same materials when used alone.

Table 1 *P* values to compare the retentive ability of various materials with respect to synthetic saliva

Interface medium	*P* value	Inference
Water and synthetic saliva	8.85099E	Highly significant
Synthetic saliva and fixon powder	1.57911E-21	Highly significant
Synthetic saliva and fittydent powder	1.22245E-24	Highly significant
Synthetic saliva and dentiro powder	4.6946E-18	Highly significant
Synthetic saliva and fixon paste	1.56296E-21	Highly significant
Synthetic saliva and fittydent paste	5.96049E-30	Highly significant

Table 2 *P* values to compare the retentive ability of various denture adhesive materials tested

Interface medium	*P* value	Inference
Fixon powder + fittydent powder	0.002041	Very significant
Fittydent powder + dentiro powder	0.1012745	Not significant
Fixon powder + dentiro powder	0.0002875	Highly significant
Fixon paste + fittydent paste	0.011089	Not significant

Table 3 Comparison between the retentive ability of denture adhesive powders with their paste forms

Interface medium	Inference
Fixon paste versus fixon powder	Highly significant
Fittydent paste versus fittydent powder	Highly significant

Table 4 *P* values of the retentive ability of various denture adhesive materials versus the same materials in presence of saliva

Interface medium	Inference
Fixon (powder) versus fixon powder + saliva	Highly significant
Fittydent (powder) versus fittydent powder + saliva	Highly significant
Dentiro (powder) versus dentiro powder + saliva	Highly significant
Fixon paste versus fixon paste + saliva	Highly significant
Fittydent paste versus fittydent paste + saliva	Highly significant

Discussion

Complete dentures constitute one of the most important treatment modalities in Prosthodontics, an adequate retention and stability form a basic requirement and are crucial to the success of the removable prosthesis. Therefore, improving retention and stability is of considerable interest in Prosthodontics.

Approaches to the problem, over the years have included overdentures, implants, and denture adhesives. Although adhesives are commonly used by denture wearers and advertised commercially, dentists have been slow to acknowledge their place in prosthetic dentistry. However, it is now accepted that denture adhesives if properly used can be an asset to dentists armamentarium. Tarbet and coworkers [2–4] addressed the role of denture adhesives in retention and stability by counting denture dislodgements in patients eating standardized portions of food with and without denture adhesive. Results showed a significant reduction in dislodgement when an adhesive was used. This was also demonstrated in the present study which showed that the use of denture adhesives resulted in a significantly higher retentive force than water or saliva, as shown in Table 1.

The paste form of denture adhesives is more retentive than powder form. This was demonstrated by Chew [5] and was later confirmed by Ghani and Picton [6] who demonstrated that the liquid/paste form of denture adhesive rendered the ill-fitting dentures almost as retentive as well fitting one [5, 6]. The present study further confirms the same, as observed in Table 3. This has been attributed to the increased viscosity of the paste materials as opposed to the powder forms [7].

A survey was conducted among the academic prosthodontists and it was concluded that denture adhesives are a useful adjunct in denture prosthesis service. Education for both dentists and the patients is imperative for the proper use and avoid misuse of the same [8].

In the present study, the retentive ability of three commercially available denture adhesive powder and two pastes was evaluated in vitro. The oral mucosa is different in nature and texture from the glass surface that was used in this study. However, by examining these materials under the same, controlled and constant experimental conditions, an attempt to compare and evaluate their actual retentive ability was made. It is predicted that similar differences will be observed in the oral environment, though the values may differ.

When the retentive ability of the liquid was evaluated, saliva presented greater values of retention as compared to water (Table 1). This can be attributed to the higher viscosity of saliva, which is said to range between 3 and 6 centipoise whereas that of water is approximately one at room temperature. Although the surface tension of water is more than that of saliva, the higher viscosity compensates for the difference [7].

The retentive ability of denture adhesives presented a much greater retentive force than that of saliva alone. The paste form of adhesives exhibited a higher retentive force than the powder form even the ones of the same brand. This could again be attributed to the increased viscosity of the paste forms (Table 3). However, the two denture adhesive pastes did not show statistically significant difference in their values (Table 2).

Amongst the denture adhesive powders that were evaluated fixon powder exhibited the highest retentive ability whereas dentiro powder showed the lowest value. Although, the difference between the values of dentiro powder and fittydent powder was not found to be significant (Table 2).

The denture adhesives used either alone or in combination with saliva maintained their relative positions. However, the retentive values observed in the presence of saliva increased many fold and the observed difference were highly significant (Table 4). In the paste forms both

fixon paste and fittydent pastes exhibited comparable values.

Conclusions

The following conclusions can be drawn from the study.

1) All denture adhesives investigated in this study exhibited significantly higher retentive ability than saliva or water.
2) Synthetic saliva used in this study exhibited greater retention as compared to water.
3) Amongst, the denture adhesive powders tested, fixon powder offered the greatest resistance to dislodgement as opposed to dentiro powder or fittydent powder.
4) The paste form of adhesive materials was observed to be more resistant to dislodgement than the powder form.

Thus, in view of the results of this study it can be safely concluded that denture adhesives increase the retentive ability of a removable prosthesis and as such can be recommended to the patients especially in conditions of immediate dentures, systemic diseases like Parkinson's disease, Alzheimers disease, in maxillofacial surgery patients for obturators, in public speakers like attorneys, vocalists etc. However, the patient should be instructed in the pros and cons of using such materials.

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