

In Vivo Evaluation Study of Three Denture Adhesives on Retention of Maxillary Complete Denture

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Abstract

Background Retention is the ability of a dental prosthesis to resist movement after it has been placed; it may be defined as the resistance of a denture to movement after it has been placed. **Objectives** The purpose of this study was to compare the effect of three different denture adhesives directly inside the patient's mouth on the retention force of the maxillary denture base at different time intervals. **Materials and Methods** Fifteen edentulous patients (8 males and 7 females, 58- 70 years old) were involved in the present study. This study was applied only for the maxillary edentulous arch. For each patient, a denture base without the artificial teeth was constructed from the heat-cured acrylic resin using the conventional water-bath processing technique. A digital force gauge was used to record the maximum dislodging forces. The force applied in Newton needed to dislodge the denture base firstly from its basal seat, without adhesives, and then with different adhesive types at different time intervals of 15min, 1h, and 2h. The data were collected and statistically analyzed using ANOVA (LSD) test at a significance level of $p \leq 0.05$. **Results** Significant improvement was observed in denture retention force for all types of denture adhesive materials as compared to the control group at different intervals. The highest mean of denture retention was with Fittydent (strip). The retention value of the strip was significantly higher than those of the cream and powder at 15min, one, and two hours. However, non-significant differences in retention force were detected between the Super Corega cream and that of powder ($p > 0.05$). All the experimental adhesive materials differ significantly from the control group during the whole period of the study **Conclusions** The results of this in vivo study concluded that the denture adhesive tested materials could effectively increase the retention value of the maxillary denture base and the Fittydent denture adhesive strip was the most effective denture adhesive agent.

Keywords: Dentures adhesives; different time intervals; retention.

Introduction

Retention is that quality inherent in the dental prosthesis acting to resist the force of dislodgment along the path of placement; simply it is the resistance of denture to dislodgment, (Ferro et al, 2017). It is an important indicator in estimating the masticatory ability and oral health required quality of life (OHRQoL) of complete denture wearers, (Limpuangthip et al, 2019). Retention of complete denture provides psychological comfort to the patient, if a denture is easily dislodged during speech or eating, the embarrassment experienced can be mentally traumatic, (Jacobson and Krol, 1983). Many factors affect the retention of complete dentures like anatomical factors, physiological factors, mechanical factors, physical factors, and neuromuscular factors, (Hardy and Kapur, 1958). These main factors also subdivide into other factors like adhesion, the cohesion that comes from the saliva quantity and property, also denture bearing area, type of the mucosa, and well-extended flange to the vestibule and getting a marginal seal. So, each step in denture construction in both clinical and lab work should be applied with priority, (Kumar et al, 2016). But still, there are some cases where cannot get enough retention like a highly resorbed ridge, any developmental anomalies, xerostomia either for systemic disease or using a specific drug, neuromuscular problems, (Jagger and Harrison, 1996; Kumar and Thombare, 2011). Clinical prosthodontics has focused on many approaches to improve denture retention and stability. There are other solutions like an implant-supported prosthesis that is either fixed or removed. However, an implant can't seem to be the treatment case for all patients due to inadequate bone or some systemic disease when contraindicated, (Hwang and Wang, 2006), in addition to financial issues. Using commercially available denture adhesive material

could be a good alternative and solution for enhancing denture retention and stability, (Kapur, 1967; Chowdhry et al, 2010; Figueiral et al, 2012; Yegin et al, 2017). According to FDA, Denture adhesives are either in form of pastes, powders, or adhesive pads to help dentures to seated properly, these materials could enhance the interfacial forces by increasing the adhesive and cohesive properties and viscosity of the medium lying between the denture and the basal seat. Also, it may eliminate the voids between the denture base and the basal seat, (Shay, 1991; Smita et al, 2010). Adhesives could improve retention and stability, masticatory function, incisal bite force and also imparted patient comfort physically and psychologically, (Shankar, 2010; Shekar and Mittal, 2016). Millions of denture wearers use denture adhesives as an over-the-counter remedy, and such products are recommended by many professionals. Many controlled laboratory and clinical reports suggested that, in certain cases, clinical outcomes could be improved by the use of denture adhesives, and that instructions on the proper use of denture adhesives which could act as part of post-placement care for patients, (Adisman, 1989; Fløystrand et al, 1991; Slaughter et al, 1999; Koronis et al, 2012; Papadiochou et al, 2015; Lemos et al, 2021). Hasegawa et al used a 3-D optical motion capture system and concluded that denture adhesive contributes to reducing denture movement and therefore, to improving chewing function, (Hasegawa et al, 2003). Psillakis et al, tested different types of denture adhesives and concluded that using denture adhesive subjectively improved both speech and chewing ability, (Psillakis et al, 2004). Ozcan et al, stated also that bite force until denture dislodgment was increased for both old and new dentures after the use of denture adhesive regarding both polymethylvinylether maleate and carboxymethyl cellulose, and

such improvement take place for 6h after the application of the denture adhesives, (Özcan et al, 2005). In a study carried by Kore et al, they evaluated the tensile bond strength of denture adhesives on denture base materials at intervals up to 24 hours. They found that denture adhesives could significantly increase the tensile bond strength and should be considered in that cases when additional retention is needed. The practitioner should prescribe one of the most effective adhesive-base combinations to achieve optimal dentures, (Kore et al, 2013). Gomaa and El-Mekawy also compared the efficiency of four commercial denture adhesives for improving retention of complete denture wearers and their efficacy at 30 min, 2h, 4h, and 8h from adhesives application, (El Mekawy, 2010). They concluded that denture adhesives might improve maxillary and mandibular dentures retention, and protefix paste is strongly recommended as a highly effective type of denture adhesives. In this in vivo study, the study trying to compare three different types of denture adhesive directly inside the patient's mouth to evaluate the force of retention given by different types at different time intervals.

Material and Methods

This in vivo study was conducted for determining the effect of denture adhesives on the retention of complete maxillary denture base at different time intervals. Commercial denture adhesives and their compositions tested in this study are shown in Table 1. A study sample of Fifteen edentulous patients of 8 males, and 7 females (58-70 years old) attended the Shorsh dental center in Sulaimani city for complete denture treatment and to participate in this study. Patients with an upper edentulous arch and healthy mucosa were selected for the study. Patients with a bony undercut, neuromuscular problems, or any injury or recent extraction were excluded

from the study. The patient's consent was reported in advance to take a part in this study.

Construction of maxillary denture base

Primary and secondary impressions were taken for the maxillary edentulous arch in a conventional way for construction of a special tray, a primary impression was taken for each patient using a putty consistency condensation silicone impression material (MAJOR-Prodotti Dentari- Italy), then the peripheral seal tracing was applied and the final impression was taken using zinc oxide eugenol impression material (SS White impression paste-UK). A denture base without the artificial teeth was constructed from the heat-cured acrylic resin using the conventional heat-polymerized water-bath processing technique. The denture base was finished and polished accordingly. Then for the retention test, a hook was fixed at the center of the palatal polished surface denture base using cold-cured acrylic resin and prepared, Figure (1), (Colo'n et al, 1982; Kumar and Thombare, 2011; Chhabra et al, 2018).

Retention evaluation process

A digital force gauge was used to record the maximum dislodging forces in Newton (Nextech DFS500-Nextech-Thailand). This is to dislodge the denture base from its basal seat without using any adhesives, and with three different types of adhesives at 15min, 1h, and 2h. Each patient was seated on the dental chair in a posture with relaxed lips and an open mouth to avoid losing peripheral sealing. The palate is nearly at 45 degrees to the floor, (El Mekawy, 2010). The nylon fishing line pulling the denture base and passes through the pulley to the digital force gauge accurately with a stand fixed base table, Figure (2), (Kumar and Thombare, 2011; Chhabra et al, 2018). The tests took place for each

patient on three different days. On the first day, the denture base was inserted without using any adhesive. After 15 min, the denture base was pulled till dislodgement and the peak dislodging force was recorded in Newton. This procedure was repeated three times to calculate the force average mean value. Then the denture base was removed, washed, and cleaned. Subsequently, the first adhesive material super Corega cream was added according to manufactures' instructions as in Figure (3A). The same quantity was used for all the other tests intervals measured by vernier the length of the extruded paste, (Baat et al, 2007). Then the denture base was seated inside the patient's mouth. The three peak readings were taken by pulling the denture base at 15min, 1h, and 2h after denture placement. The next recall visit, the same procedures were repeated for the patient but by using super Corega powder after sprinkling it over the inner surface of the denture base. The same amount of adhesive material was measured to be used for each test, Figure (3B). While in the third recall visit, the Fittydent adhesive strips were used according to manufactures instruction as shown in Figure (3C).

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 25). One way analysis of variance (ANOVA) the post hoc test (LSD), Paired t-test was used to compare the groups at different study intervals. A p-value of $p \leq 0.05$ was considered statistically significant.

Results

Table (2) shows the means of the retention force of the three denture adhesive materials used in this study. Significant differences in denture retention were detected between the three experimental adhesive

materials and the control group ($p < 0.001$). The highest mean of denture retention was that of the Fittydent strip at 15min (23.3 N), after one hour (22.1N), and after two hours (20.2 N). The retention value of the strip was significantly higher than those of the cream and powder at different intervals, Yet, non-significant differences were detected between the super Corega cream and that of powder ($p > 0.05$), Figure (4). Regarding the cream adhesive, the retention force increased significantly from 10.4N at 15min to 16.6N at one hour ($p < 0.001$), and to 15.8N at two hours ($p < 0.001$) Yet, there were non-significant differences ($p = 0.602$) between both adhesive forces of at 1h and 2h. The denture retention force of the powdered adhesive increased significantly from 12.4N at 15min to 14.3N at 1h ($p = 0.015$) but then decreased after 2h to 12.7N ($p = 0.653$). The differences in force retention between the 1h and 2h were significant ($p < 0.001$). Considering the strip only, its retention force was high (23.3N) at 15min, and became 22.1N at 1h ($p = 0.237$), but decreased significantly after 2h to become 20.2N ($p = 0.005$). Also, the differences in force retention between the 1h and 2h were significant ($p = 0.001$).



Figure (1): Prepared denture base with attached hook.

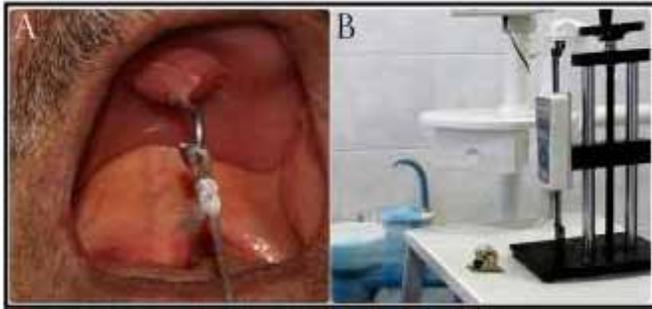


Figure (2): (A), Pulling the denture base inside the patient's mouth with nylon thread; (B), The Force gauge meter with a stand pulley connected to nylon thread.

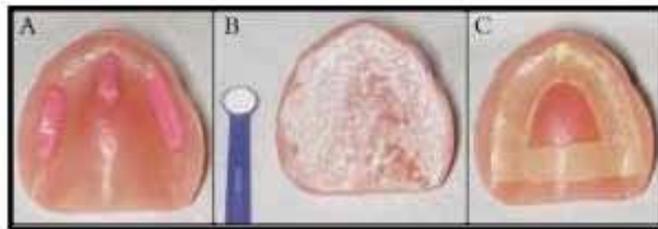


Figure (3): Denture base with different denture adhesive; (A), Corega cream; (B), Corega powder; and (C), Fittydent strip.

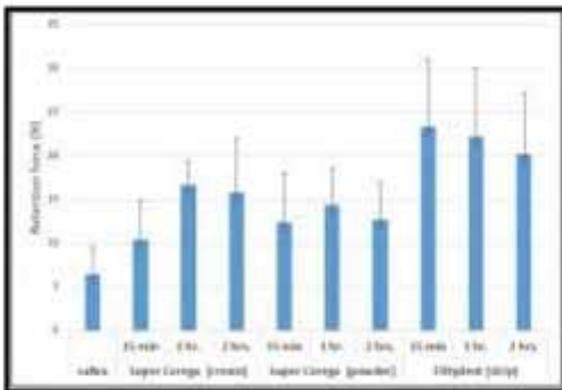


Figure (4): Means and standard deviation of the retention force (Newton) of the study groups at different time intervals.

Table (1): The types and composition of the three experimental denture adhesives.

Type of denture adhesives	Composition
Super Corega cream	Calcium/Sodium PVM/MA Copolymer, Petrolatum, Cellulose Gum, Paraffinum Liquidum, Propylparaben, Aroma, CI 45430.
Super Corega powder	Poly (Methylvinylether/Maleic Acid) Sodium-Calcium Mixed Partial Salt, Cellulose Gum, Aroma.
Fittydent cushions (strip)	Polyvinylacetate, Sodium Carboxymethylcellulose, Glycerintriacetate, Petrolatum.

Table (2): ANOVA (LSD) test showing the study groups force denture retention at different intervals.

Time	Groups	p-value	Sig.
15min	Non-Adhesive		
	Super Corega (cream)	0.053	NS
	Super Corega (Powder)	0.005	S
1h	Non-Adhesive		
	Fittydent (strip)	< 0.001	HS
	Super Corega (cream)	< 0.001	HS
2h	Non-Adhesive		
	Super Corega (Powder)	< 0.001	HS
	Fittydent (strip)	< 0.001	HS

Discussion

Denture adhesives are commercially available materials that are used clinically to increase denture retention, stability, and functional ability. It also improves patients' comfort and confidence and decreases food particle accumulation under the denture, (Figueiral et al, 2012). They act by increasing the adhesive, cohesive properties, and viscosity between the denture base and the oral mucosa. They swell from 50 up to 150 percent of their size when they hydrate and fill space between denture and tissue and eliminate the voids between them, (Shay, 1991). In the present in vivo study, a comparison of three different types of denture adhesive inside the patients' mouth took place to demonstrate the denture retention force objectively. All the three experimental types of adhesives gave a significant increase in retention force compared to the non-adhesive groups as showed in Table (2). Other studies also confirmed these findings, (El Mekawy, 2010; Yegin et al, 2017; Chhabra et al, 2018). Super Corega powder denture adhesive used in this study showed highly force retention than that of Super Corega cream after 15min. Yet, after 1h and 2h Super Corega, cream adhesive gave a higher retention force than Super Corega powder. However, the differences in the force retention between the two forms of denture adhesives are statistically insignificant at different intervals. That may be due to their similar compositions, although; the powder decreases the denture retention force more rapidly with time than the cream, (Chowdhry et al, 2010; Kumar and Thombare, 2011) as it dissolves more easily in the saliva and oral environment, (Chhabra et al, 2018). Mostly, the modern adhesive has active ingredients such as carboxyl group that provide strong bioadhesive and cohesive forces like carboxymethylcellulose (CMC) natural compound and polyvinyl ether-

methylcellulose (PVM-MA) synthetic compound, (Hasegawa et al, 2003; Chhabra et al, 2018). The CMC could provide superior initial adhesion if it is used alone, but it dissolves quickly due to the highest solubility. So, they are used in combination with PVMMA to apply higher cohesive strength for a longer period, (Yegin et al, 2017). These two components are mostly used in the forms of cream, paste, and powder that are considered soluble denture adhesive. Insoluble denture adhesives were also available like pads, strips, wafers, and a laminated fabric with water active components like sodium alginate or ethylene oxide polymer impregnated within fabric's mesh, (Shankar, 2010). In the present study, the Fittydent strip or pad denture adhesive provides superior force retention in all time intervals with a significant difference as compared to the other denture adhesive types. The same result was obtained by Yegin et al, although they used the paste form of Fittydent, it contains the same active ingredients of Polyvinylacetate which is an insoluble compound and not easily washed out by saliva and liquid, (Yegin et al, 2017). So, it provides strong viscosity and adhesion for a longer time. Other studies also confirmed that Fittydent denture adhesive is the most effective denture adhesive type, (Koronis et al, 2012; Yegin et al, 2017; Chhabra et al, 2018). Moreover, Fittydent manufactures claim that Fittydent pads or cushion contain 4 time more adhesive substance than other Fittydent cream and powder denture adhesive, It is mostly advisable to recommend and use Fittydent strip in the severely resorbed mandibular ridge and saliva rich condition. Besides that, Coregas' denture adhesive products seem to be soluble, while Fittydent adhesive products are insoluble. In addition, Coregas' products of bot powder and cream adhesives are CMC free which is important to apply a high initial adhesive property, and this

could be the reason for the lower adhesive property of Coregas' products.

Conclusions

As a conclusion drawn from this study, using the different denture adhesives improved the retention force of the maxillary denture base, and the Fittydent denture adhesive strips are the strongly recommended and effective type of denture adhesives.

Conflict of interest

We are the author's (Dana F Mohammed, Jwan F Abdulkareem) state that the manuscript for this paper is original, and it has not been published previously (or part of MSc. dissertation or Ph.D. thesis) and is not under consideration for publication elsewhere, and that the final version has been seen and approved by all authors.

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