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In-Vitro Comparison of Tensile Bond Strength of Denture Adhesives on Denture Bases

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In-Vitro Comparison of Tensile Bond Strength of Denture Adhesives on Denture Bases

by

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A thesis submitted in partial fulfillment of
the requirements for the degree
Master of Science in Prosthodontics

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Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

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ABSTRACT OF THE THESIS

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Denture Adhesives on Denture Bases

by

Doris R. Kore

Master of Science, Advanced Specialty Education Program in Prosthodontics
Loma Linda University, September 2012
Dr. Mathew Kattadiyil, Chairperson

PURPOSE: To evaluate the tensile bond strength (TBS) of three cream denture adhesives and one wafer denture adhesive on three denture base materials at five time intervals up to 24 hours.

METHODS: Fixodent® (Proctor & Gamble™), Super Poligrip® (GlaxoSmithKline™), Effergrip® (Prestige Brands, Inc.™), and SeaBond® (Combe™) were tested with the Instron testing machine on three denture base resin cylinder models fabricated from two heat-polymerized (Lucitone 199 and SR Ivocap) and one visible light-cured, shade stable (Eclipse) acrylic resins. Laboratory prepared artificial saliva with mucin was used for the control study. In accordance with ADA specifications, the TBS was tested at 5 minutes, 3 hours, 6 hours, 12 hours and 24 hours after application of the adhesive. Maximum forces before failure were recorded in megapascals (MPa) and data subjected to a Two-way ANOVA (*P*=. 05) using SPSS 19.0 software.

RESULTS: All four adhesives revealed greater TBS than the control. However, Fixodent, Super Poligrip and SeaBond had higher TBS than Effergrip. All four adhesives showed greatest TBS at the 5-minute interval and the least at the 12

and/or 24-hour intervals. The three denture bases were significantly different with each adhesive (P<0.001). Lucitone 199 with the adhesives showed the greatest TBS followed by Ivocap and Eclipse.

CONCLUSIONS: All four adhesives revealed greater TBS than the control and all four adhesives were strongest at the 5-minute interval. On all three types of denture bases Effergrip produced significantly lower tensile bond strength and Fixodent produced significantly higher bond strength. At 24 hours, the greatest TBS adhesive-base material combinations, in this study, were Fixodent on Lucitone 199, Fixodent on Eclipse, Fixodent on Ivocap and Super Poligrip on Ivocap.

CHAPTER ONE

INTRODUCTION

Approximately 37 million people are without their natural teeth in North America.[1] Since the elderly population is increasing, this number is not likely to decline over the next 30 years.[1, 2] Despite improved methods for tooth preservation and caries control, tooth loss is especially common among individuals with lower incomes.[3] It will be the society's poorest and least advantaged who will continue to need assistance with complete dentures.[4]

Epidemiological analysis indicates that the percentage of edentulous patients in the United States has been declining for the past three decades, but the actual number of patients requiring complete denture treatment is expected to increase through the year 2020.[3] Americans are living longer and the number of adults in the 55 to 74 age group is estimated to increase by 86% between 2000 to 2020.[3] Demographic growth is expected to outnumber the decline in edentulism.[5] Therefore, the need for dentures is not expected to drop over the next quarter century.[4] If the anticipated need to replace defective and worn complete denture prostheses is included, the number of new dentures requiring fabrication is estimated to exceed 61 million.[2] To reiterate, the two trends considered responsible for this projected outcome are an increase in the actual number of

complete denture patients (despite a declining percentage) and an aging population with a longer life expectancy.[2]

Denture adhesives are used by more than five million denture wearers in the United States.[6] Because denture adhesives can serve dentists as a valuable adjunct by providing retention to manage and treat more difficult denture patients with severely resorbed residual alveolar ridges, use of adhesives have become popular in complete denture therapy.[7] Some of the advantages of using denture adhesives are that they: 1) reduce the amount of denture movement and increase the bite force,[8,9] 2) promote a faster and more natural rate of chewing,[10] 3) if properly used, can be an asset to the dentist's armamentarium,[7] 4) stabilize denture bases while recording jaw relations, when there is less than adequate retention,[6] 5) increase denture retention, thereby improving incisive ability of denture wearers.[8] 6) have been found to be safe and effective.[11] Some of the disadvantages of using denture adhesives have been reported as: 1) alveolar bone loss as well as papillary hyperplasia,[12] 2) increase in occlusal vertical dimension[13] and 3) short term beneficial effects.[8]

Natural gums such as karaya gum, tragancanth, acacia, and pectin, which are mainly carbohydrates, are some of the organic examples of the ingredients that swell and become viscous and sticky as water is absorbed which is responsible for the adhesive properties.[14,15] There are several synthetic polymers which have been developed to copy the characteristic of swelling.[15] These earlier organic products and their merits concerned the dentists.[16]

According to Adisman et al, with a growing population of longer living citizens with advanced chronic residual ridge resorption, we should be expected to result in an increase in dentures that are unstable with some variables ranging beyond ordinary control by the patient or dentist. Such conditions warrant a new perspective on recommending denture adhesives as a treatment adjunct.[14]

Karlsson found only a limited effect of denture adhesives, at least for denture wearers with moderate resorption of their alveolar ridges. The only positive impact of the adhesives discovered was a limited number of vertical-loosening drops of the distal parts of the denture when the seal was broken.[17] In a study conducted by Tarbet and Grossman, 111 denture wearers tested a natural gum or a synthetic polymer adhesive for 6 months. This was not accompanied by any increase in mucosal irritation of denture bearing tissues. Mucosal irritation present in some of their subjects at the start of the study was eliminated in almost all cases with the continued use of the assigned adhesive during the six-month observation period.[9]

There has been recent interest concerning intake of zinc-containing denture adhesives over several years which can lead to the development of neurological symptoms. Tezvergil-Mutlaay et al reviewed recent literature that documents the serious adverse systemic effects of prolonged, excessive zinc ingestion from the overuse of denture adhesives. Nations et al were first to report these effects in 2008 and then later by Spinazzi et al in 2009 in a letter to the editor.[18] Hedera et al studied a group of 11 patients who had myelopolyneuropathy along with hypocupremia and hyperzincemia. This research showed that all 11 patients had ill-fitting dentures and as a result were using an excessive amount of denture adhesive.

Because the amount and frequency of the use of denture adhesives vary widely, it is very difficult to establish a safe amount to be used. Therefore, some current researchers have suggested recommending the use of zinc-free denture adhesives to denture patients.[19]

Knowing the adhesive qualities of various denture adhesives would give the dentist options for dealing with patients. If a patient required a minimal amount of retention, then an adhesive with milder retentive characteristics could be prescribed. For those patients desiring the maximal amount of retention, an adhesive with the most holding characteristics could be prescribed.

The present study was undertaken to evaluate the TBS of three cream denture adhesives and one wafer denture adhesive on three different denture bases: Lucitone 199, SR Ivocap and Eclipse. The TBS was tested at 5 minutes after application of the adhesive and again at 3 hours, 6 hours, 12 hours and 24 hours. Based on these data a dentist may be able to recommend to the patient which denture adhesive exhibits the most effective retention on which denture base and for approximately how long. The null hypothesis is that there is no significant difference in TBS among the dental adhesives on various denture bases for the first 24 hours.

CHAPTER TWO

MATERIALS AND METHODS

Equipment

TBS testing of the denture base resin test cylinders was in accordance with ANSI/ADA Specification No. 12 for heat-polymerized methyl methacrylate (Lucitone 199 and SR Ivocap) and visible light-cured urethane methacrylate (Eclipse) as follows:

10 Lucitone 199 (methyl methacrylate resin; Dentsply, York, PA)

10 SR Ivocap (methyl methacrylate resin; Ivoclar Vivadent, Amherst, NY)

10 Eclipse (urethane methacrylate; Dentsply, York, PA)

30 common resin test cylinders (polymethylmethacrylate diethyl phthalate; Esschem, Linwood, PA) See Table 1, Table 2 and Figure 1 and Figure 2.

These test cylinders were processed and prepared to dimensions of 2.0 cm height by 2.5 cm diameter, finished flat and perfectly perpendicular to the long axis. Flattened ends were smoothed using 320 grit silicon carbide sandpaper as the final test surfaces. A 0.032 cm hole was drilled in the center of the cylinders using a lathe to assure exact alignment. Stainless steel orthodontic round wire of 0.032 cm x 0.6 cm was permanently luted in place with cyanoacrylate, The Original Super Glue® (Rancho Cucamonga, CA, 1-800-538-3091) placed on the denture base side with 0.3 cm of pin exposed to assure a passive fit into the opposing common resin cylinder

(Figure 3). This was done to ensure that the cylindrical pair could separate only vertically. The TBS was measured using the MTS ReNew Model 1125 upgrade package for the Instron testing machine (Figure 4). Adhesives tested were Fixodent® (Proctor & Gamble™), Super Poligrip® (GlaxoSmithKline™), Effergrip® (Prestige Brands, Inc ™) and SeaBond® (Combe™) (Table 2). Artificial saliva with mucin was used with the same test cylinders and served as the control group (Table 3).[20]

Procedure

Either a denture adhesive cream (0.20 grams) or the wafer (2.0 cm diameter) was sandwiched in between the denture base resin cylinder and the common resin cylinder (Figure 5). For the control group the denture base resin cylinder was coated with a thin layer of artificial saliva and the other side was left dry (Figure 6). For the test groups, the denture base resin cylinders were coated with 0.20 grams of the adhesive the approximate amount required to retain the maxillary denture in accordance with a study by Chew.[16] The wafer was moistened with tap water and the common resin cylinder was coated with a thin layer of artificial saliva (Figure 7). A 1.2 Kg force was applied for 30 seconds to simulate a gentle bite force[20] (Figure 8). Then the cylinders were placed in sealed containers with 100% hydration, which in turn were placed in a humidifier at 37^{o}C for 5 minutes, 3 hours, 6 hours, 12 hours and 24 hours until testing (Figure 9). The specimens were debonded in tensile mode at a rate of 10 mm per minute using the Instron testing machine. The maximum force before failure was calculated in MPa.

The specimens were washed clean with antibacterial soap and tap water then dried by hand with a paper towel followed by wiping with CaviWipes® XL (disinfecting towelettes) and allowed to air dry. The same cylinders were used for all the measurements. Each test was repeated 10 times and a mean value was calculated.

Statistical Analysis

The dependent variable, tensile bond strength (TBS) was measured against independent variables--**a**dhesives, denture bases and time. All statistical tests of hypotheses were two-tail with alpha of 0.05 and performed with SPSS 19.0 software.

The four adhesive groups, control and five intervals of time were evaluated as Repeated Measures ANOVA within-subject factors and the three denture bases were evaluated as between-subject factors. Mauchly's Test of Sphericity (equal variances) was used to measure equal variance and Pillai's Trace was used to correct for significant differences in variability.

Figure 1. Cylinders with the different denture bases – Eclipse (left), Lucitone 199 (center bottom), Ivocap (right) and the cylinder with the common resin (center top).

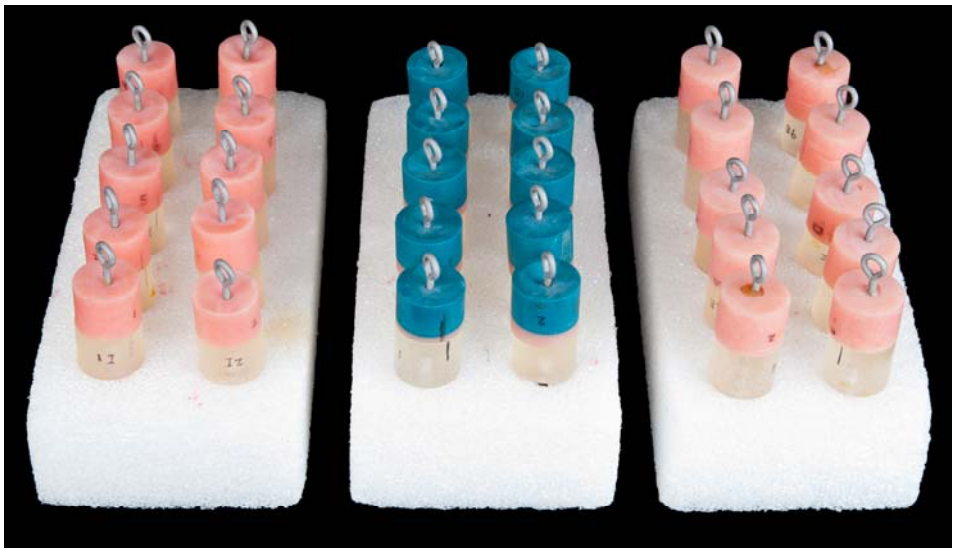

Figure 2. This photograph depicts 30 pairs of cylinders used in this study (Eclipse, Lucitone 199 and Ivocap from left to right).

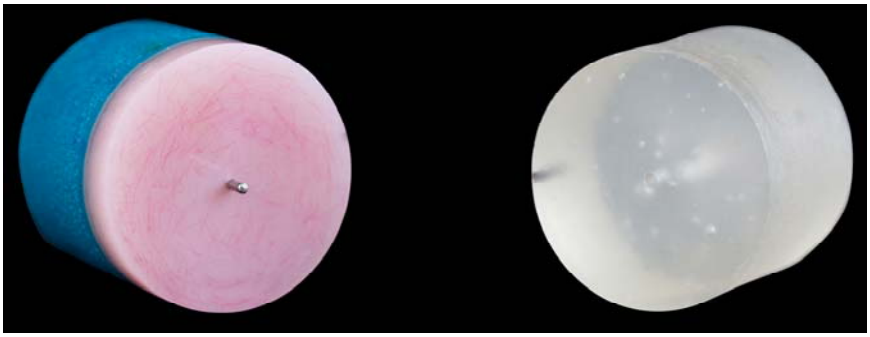

Figure 3. Test cylinders showing the alignment pin and matching 0.032 cm diameter hole arrangement to assure only vertical separation during testing (Lucitone 199 with the pin on the left and the common resin cylinder with the hole on the right).

Figure 4. Test cylinder pair with the adhesive, positioned for testing in the Instron machine.

Table 1. Denture base composition of the three products tested and the common resin cylinder composition (from Material Safety Data Sheet)

Materials Tested	Resin Polymer Composition
Lucitone 199 (Denture Base)	Methyl methacrylate – Polymer Ethylene dimethacrylate - Monomer (Dentsply, York, PA)
SR Ivocap (Denture Base)	Methyl methacrylate – Polymer Ethylene dimethacrylate - Monomer (Ivoclar Vivadent, Amherst, NY)
Eclipse (Denture Base)	Urethane methacrylate – Polymer Stearyl acrylate – Monomer (Dentsply, York, PA)
Common Resin Cylinder	Polymethyl methacrylate – Polymer Methyl methacrylate- Monomer (Esschem, Linwood, PA)

Table 2. Composition of the four denture adhesives that were tested (from Material Safety Data Sheet).

Denture Adhesives Tested	Product Composition
Fixodent	Carboxymethylcellulose sodium Polyvinyl alcohol-methyl acrylate copolymer Silica Zinc (less than 4%) Mineral oil Petrolatum, White USP
Super Poligrip	Poly(methylvinylether/maleic acid) Sodium-calcium mixed partial salt Carboxymethylcellulose Petrolatum, Cellulose gum, Mineral oil.
Effergrip	Gantrez MS-955 polymer Mineral oil Polyethylene oxide Silica, amorphous, fumed, crystalline-free
SeaBond	Non-Woven Fabric (polyethylene oxide) Sodium carboxymethyl cellulose Acrylic polymer Sodium alginate Sodium copper chlorophyllin FD&C Red #40

Table 3. The formula of the artificial saliva with mucin used in the control study.[20]

Ingredients	Weight
1.45 mM Calcium Chloride, Anhydrous (CaCl2), MW 110.99	0.16 g
5.4mM Pot. Phosphate Monobasic. (KH2PO4), MW 136.09	0.74 g
0.1M Tris-HCl, MW 156.60	15.66 g
Porcine Gastric Mucin (*from Porcine Stomach, Sigma #M1778-10G*	2.2 g
Adjust final pH using HCl or KOH	7.0
dH_20	1 Liter

Sequence of Preparing Artificial Saliva[20]

1. Mix 0.16 g CaCl2 and 0.74 g KH2PO4 in 800 ml of dH_2O (if preparing 1 Liter) with magnetic stirrer until totally dissolved.
2. Add 15.66 g of Tris-HCl (Clear)

   Note: The pH of the solution is acidic (~4.11)
3. Adjust pH to 7.1 using Potassium Hydroxide (Add one pellet at a time)
4. Slowly add the 2.2 g of Mucin (from Porcine Stomach, Sigma)) until totally dissolved (Cloudy)

   Note: Takes 1-2 hours to totally dissolve the Mucin
   Mucin is slightly acidic
5. Adjust volume to 1Liter using dH_2O
6. Adjust pH to 7.0 using HCl or KOH

Figure 5. Lucitone 199 and the common resin cylinder pairs demonstrating the cream denture adhesive (left) and the wafer denture adhesive (right).

Figure 6. Control specimen pair shown with artificial saliva on Lucitone 199, denture base cylinder (top) and the dry common resin cylinder counterpart (below).

Figure 7. Test specimens showing denture adhesive, Fixodent, on denture base cylinder, Lucitone 199 (top), denture adhesive, SeaBond, on denture base cylinder, Lucitone 199 (middle) and artificial saliva on the common resin cylinder (bottom).

Figure 8. Cylinder pair with 1.2 Kg. weight assembly , which was applied for 30 seconds.

Figure 9. Test cylinders stored in the VWR 1520 humidifier for the five different time intervals.

CHAPTER THREE

RESULTS

Mauchly's Test of Sphericity for the adhesive was significant ($P< 0.05$) which meant that the Sphericity assumption of equal variances for the adhesive was not met. Since the Sphericity assumption was not met for the adhesives ($P< 0.001$), Pillai's Trace correction was used. Statistically significant differences were observed in TBS between the adhesives ($P<0.0001$) (Table 5). There were significant differences between the adhesives when compared with the control ($P<0.0001$) (Table 6).

The multiple comparisons between the different types of denture bases indicated significant differences among the groups. The three denture bases Lucitone 199, Ivocap and Eclipse at the five-minute interval were statistically similar but continued to decline with increasing time. Ivocap has a severe drop in TBS at the 24-hour interval in comparison to Lucitone and Eclipse. (Figure 10). The three denture bases were significantly different with each adhesive ($P<0.001$). Lucitone 199 having the greatest strength with the adhesives followed by Ivocap and Eclipse (Figure 11).

All four adhesives revealed greater TBS than the control. However, Fixodent, Super Poligrip and SeaBond having greater TBS than Effergrip. All four adhesives showed greatest TBS at the 5-minute interval and the least at the 12 and/or 24-hour intervals (Figure 12).

T able 4. Descriptive statistics of mean plus/minus standard deviations for the different factors

		Time														
		5 Minutes			3 Hours			6 Hours			12 Hours			24 Hours		
	Dentures	Eclipse	Ivocap	Lucitone	Eclipse	Ivocap	Lucitone	Eclipse	Ivocap	Lucitone	Eclipse	Ivocap	Lucitone	Eclipse	Ivocap	Lucitone
Adhesives	Effergrip	6.23	6.25	5.02	5.93	5.73	5.46	5.71	5.78	5.73	6.02	5.43	5.57	6.21	5.74	5.70
		0.71	0.62	0.78	0.44	0.42	0.63	0.95	0.58	0.94	0.69	0.61	1.05	0.73	0.68	1.38
		22.86	30.10	24.14	17.20	17.20	24.36	20.84	15.78	16.19	16.66	15.15	19.39	16.38	8.08	17.75
	Fixodent	5.81	3.59	4.39	2.54	2.54	2.91	5.55	1.35	2.50	2.24	2.93	3.00	2.82	2.12	3.96
		23.88	24.90	25.28	16.06	16.08	16.82	16.80	14.51	14.58	15.38	12.24	16.31	16.25	13.19	15.37
	Poligrip	3.30	0.00	2.38	1.69	1.93	2.06	1.71	2.99	1.45	2.14	2.20	3.17	1.85	2.32	1.95
		23.43	20.55	23.99	16.61	16.32	15.91	14.13	14.71	13.81	13.68	15.19	13.68	13.01	8.36	13.87
	SeaBond	4.58	2.35	3.33	1.31	3.09	3.17	2.28	2.46	2.06	1.77	1.90	1.72	3.08	1.67	2.29
	Artificial Saliva	0.84	1.32	0.74	0.62	0.74	0.68	0.57	0.95	0.67	0.46	0.18	0.18	0.38	0.32	0.33
		0.46	0.54	0.20	0.17	0.21	0.15	0.25	0.33	0.26	0.29	0.04	0.05	0.14	0.14	0.16

Table 5. Repeated Measures ANOVA – Between Subject Factor/Within Subject Factors

	F	P-value	Multiple Comparisons
Adhesives (Within Subject Factor)[a]	24.000	.000	Significant differences between each adhesive type and Artificial adhesive
Time (Within Subject Factor)[b]	201.402	.000	Significant differences between each time point and baseline measurement
Dentures (Between Subject Factor)	11.330	.000	Significant differences among the three groups

a: Pillai's Trace multivariate test

b: Univariate ANOVAs under the assumption of Mauchly's test of sphericity

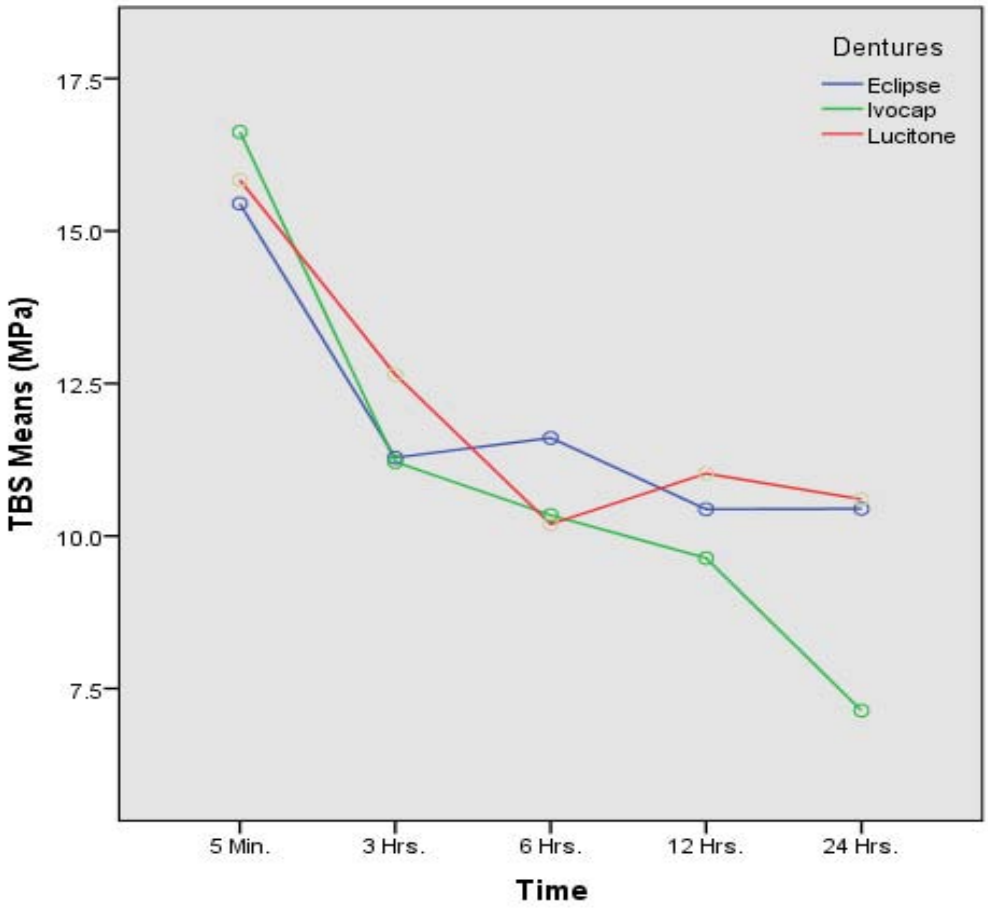

Figure 10. Overall (combined) denture adhesive TBS (MPa) versus three denture base materials over five time intervals for the first 24 hrs.

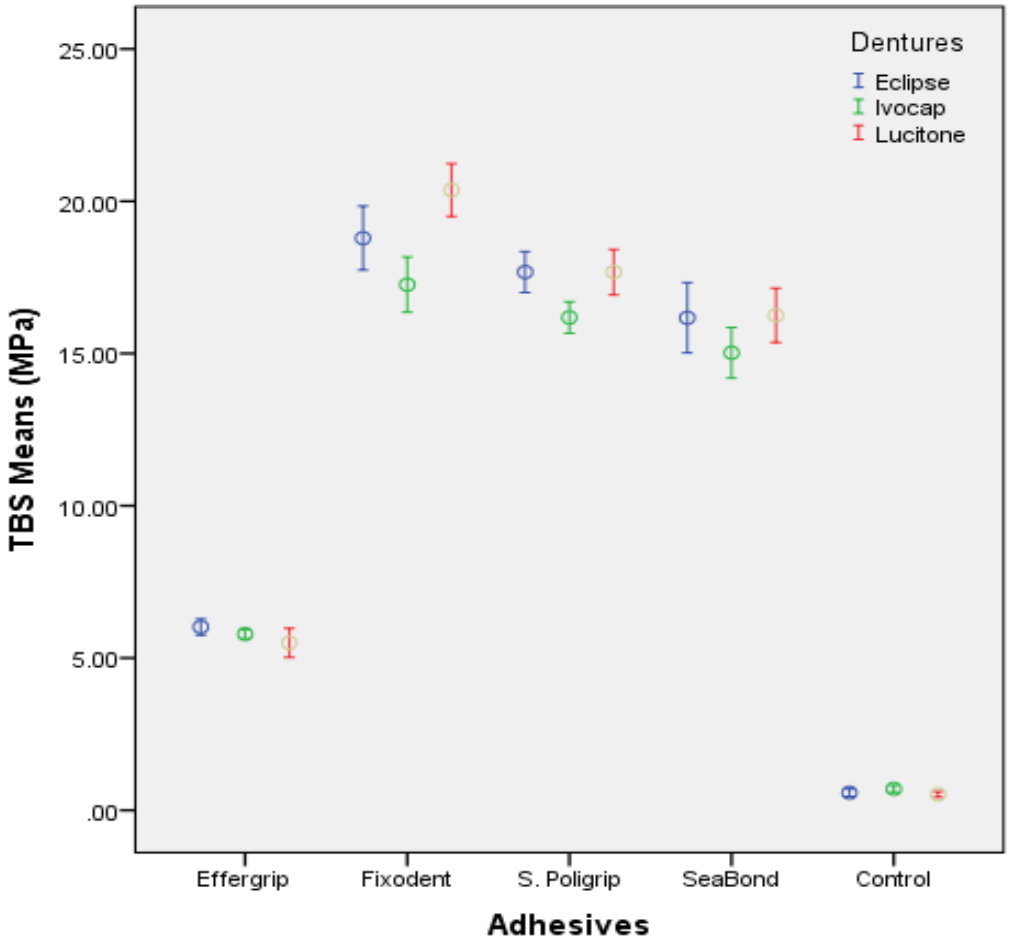

Figure 11. Overall TBS (MPa) means of four denture adhesives and the control against the three denture base materials.

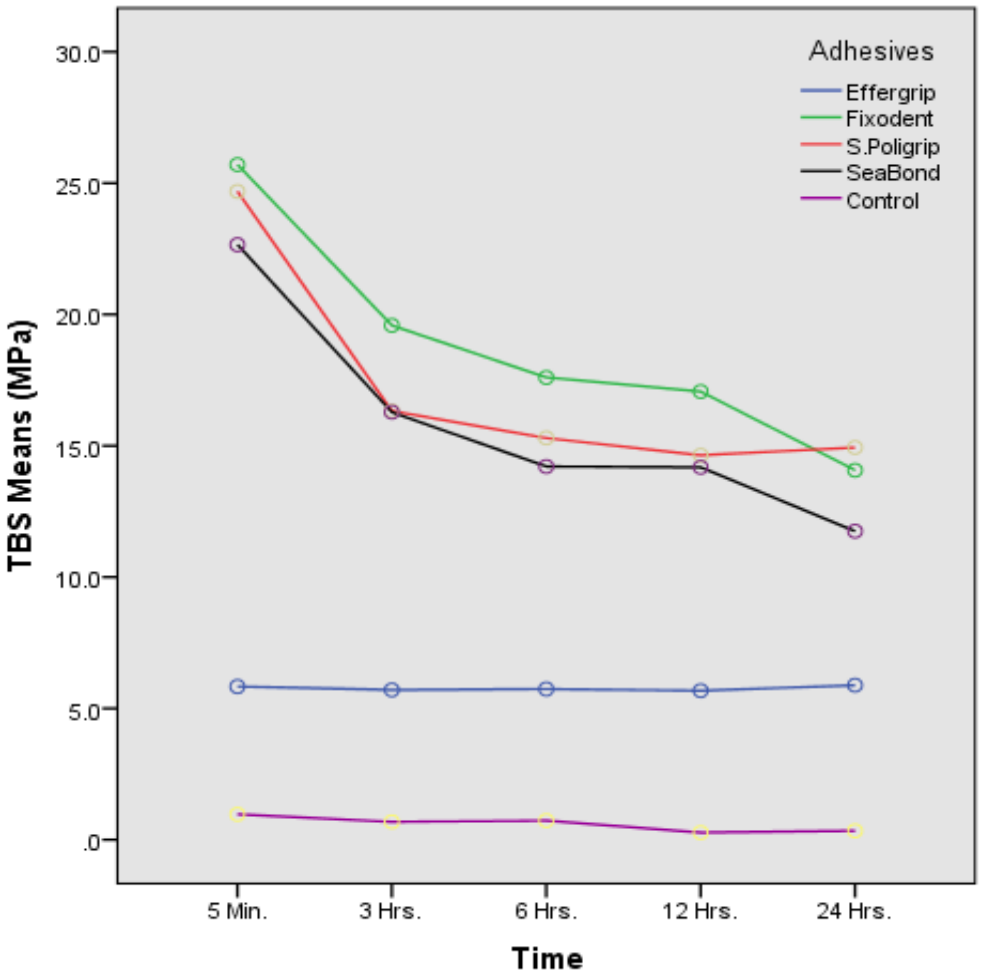

Figure 12. TBS (MPa) means of various denture adhesives against overall (combined) denture base material value over five time intervals for the first 24 hrs.

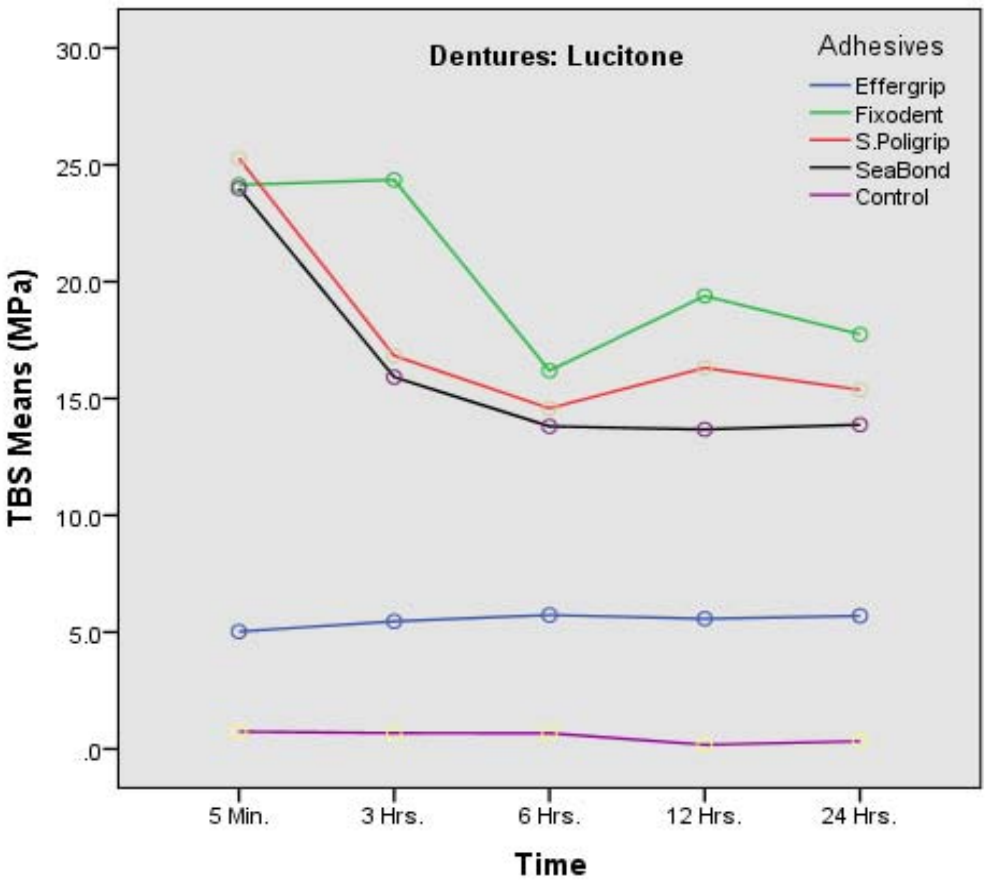

Figure 13. Various adhesive TBS (MPa) means on Lucitone 199 denture base material over five time intervals for the first 24 hrs.

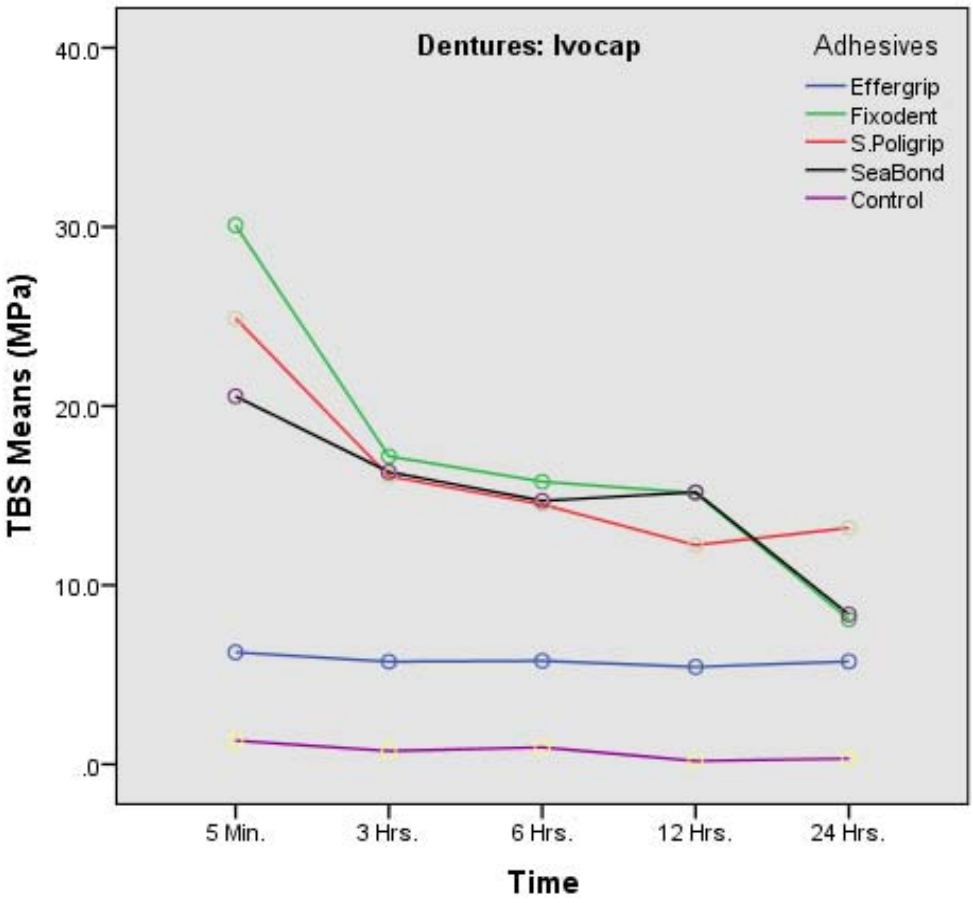

Figure 14. Various adhesive TBS (MPa) means on Ivocap denture base material over five time intervals for the first 24 hrs.

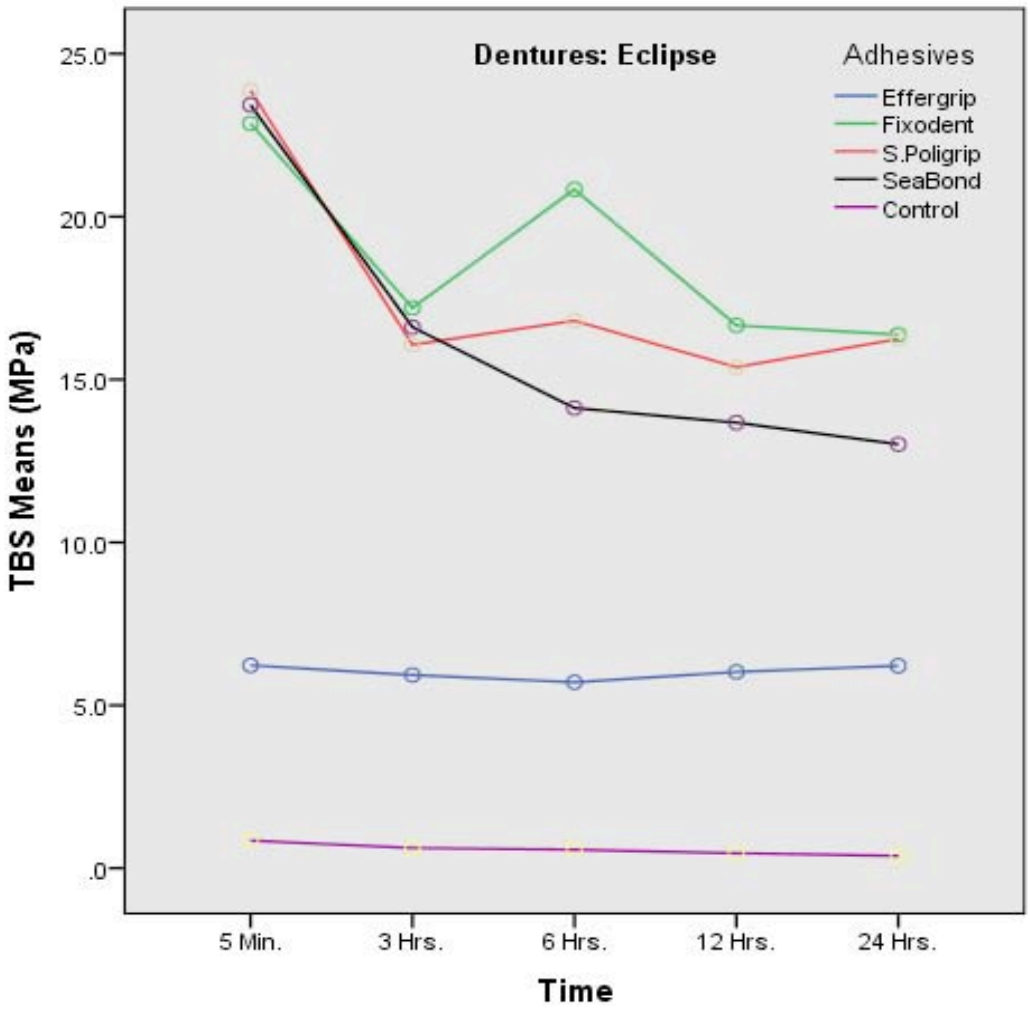

Figure 15. Various adhesive TBS (MPa) means on Eclipse denture base material over five time intervals for the first 24 hours.

CHAPTER FOUR

DISCUSSION

The null hypothesis was rejected because there were significant differences within the four denture adhesives, the three denture bases and the five different times in which they were evaluated. However, these results also demonstrated that all the adhesives tended to lose their effectiveness as time progressed, regardless of the denture base on which they were used. This is in agreement with a study by Chew indicating that, because of a loss of adhesive material over time, effectiveness is reduced.[15] DeVengencie's study similarly showed that at initial placement the adhesive is more effective and then diminishes over time.[15]

A patient continues to wear an ill-fitting denture with the aid of an adhesive at the expense of deterioration of the denture bearing structures. However, many patients with well-fitting dentures also use adhesive because it gives them an added sense of security and increased comfort.[8] A dentist should be open-minded when prescribing denture adhesives. The pros and cons, as well as proper use and abuse of denture adhesives, are some of the areas that the dentist should discuss with the patient prior to prescribing a denture adhesive. A periodic checkup should be highly encouraged to keep the denture well fitting. The dental profession can guide the use of dental adhesive products instead of being overly critical or condemning. Manufacturers can be influenced to improve adhesives for easier application and

removal, fewer taste and texture sensitiveness, and more effective denture hygiene considerations including those of underlying tissues.[8]

At the time of this study, only the zinc-containing adhesive product was available at several stores. Perhaps due to perceived potential zinc toxicity issues, now manufacturers offer both zinc-containing and zinc-free formulas.

In order to provide additional denture retention, adhesives may swell 50 – 150% in volume to fill the tissue/denture interface space. In the process, water and saliva are displaced laterally and surface tension of the resulting fluid film is increased. Additional stickiness occurs from water absorbed by the adhesive to produce anions that are attracted to the cationic mucosal membrane proteins.[20]

The graph in Figure 10 shows the highest mean TBS was at 5 minutes followed by a continual decrease in TBS with increasing time, which DeVengencie attributes to breakdown of the adhesive by oral fluids. On the same graph, Ivocap at the 24-hour interval shows a severe drop in TBS compared to Lucitone and Eclipse. Saliva can dilute the viscosity gradually over time until it becomes thinned and the retentive qualities are eventually lost."[15] Other authors have similarly discussed this relationship between the dissolution of adhesive and the subsequent loss of bond strength. [11, 21, 22]

In the present study factors designed to resemble in vivo conditions were the artificial saliva, denture adhesives and denture base material. Presence of keratinized mucosa, normal saliva, muscle movements, and intaglio surface features of an actual denture base are some of the missing key factors that can strongly influence a clinical denture adhesive bond strength value. It may be safe to say that

denture adhesives do not function the same way when they are bonded to keratinized mucosa as when they are bonded to acrylic resin. Although limited in some aspects, in vitro studies can effectively evaluate and compare currently available denture adhesive products and in the process serve as references for validating future clinical trials.[15]

The most retentive combination pair in the present study was Fixodent on Lucitone 199. The greatest degree of TBS among samples commonly occurred immediately after application of the adhesive and peaked again at 3 to 6 hours after application. This peak effect was consistent with previous reports.[7, 23]

Results of one product, Effergrip, might indicate its primary effectiveness for beginning denture looseness not requiring heavier adhesive thickness. Owing to its very consistent results, Effergrip might be considered as a control product for future studies. Its steady values over the various time intervals added confirmation to the protocol and technique of the present study.

Patient acceptance is an important aspect of the success or failure of any denture adhesive.[15] Patient selection of one product over another is also based on factors such as ease of application, clean-up, taste, and comfort[15] besides strength and the length of time that strength will endure.

If used as directed, denture adhesives can be safe and effective. But actually how effective are they? How retentive would the same denture be without the denture adhesive? The present in vitro study was designed to evaluate the degree of denture adhesive retention at different time intervals as opposed to retention when no denture adhesive is used (only artificial saliva). Cream denture adhesives

and one wafer denture adhesive were selected, as laboratory studies have suggested that they are more effective.

In this study, denture adhesive strengths were measured up to 24 hours. Denture adhesives would not ordinarily be expected to provide significantly different retention and stability over a longer period than this. These results are based on only four products and the data do not necessarily apply to other available products.

A questionable bimodal-appearing distribution occurred in some of the variables of this study and may possibly have shown improved normality of distribution by using a somewhat greater sample size (Figures 13,14 and 15). If this pattern had been expressed within the same time interval, by the same adhesive or on the same denture bases, it might be assumed to be a characteristic of the adhesive. For lack of a systemic pattern, this was accepted as a random change. Mauchly's Test of Sphericity was used to measure equal variance and Pillai's Trace was effectively employed to compensate for these differences in variability.

CHAPTER FIVE

CONCLUSIONS

1) All four adhesives revealed greater TBS than the control and TBS is greatest in Fixodent followed by Super Poligrip and SeaBond and Effergrip. All four adhesives showed greatest TBS at the 5-minute interval and the least at the 12 and/or 24-hour interval.
2) The three denture bases were significantly different with each adhesive (P <0.001), Lucitone 199 having the greatest strength versus the adhesives followed by Ivocap and Eclipse. Even though, Lucitone 199, Ivocap and Eclipse, at the five-minute interval, were statistically similar they continued to steadily decline with increasing time. Ivocap had a severe drop in TBS at the 24-hour interval in comparison to Lucitone 199 and Eclipse.
3) There are significant differences among time intervals with the greatest TBS at 5 minutes and decrease in TBS as time increases.
4) The greatest mean TBS of adhesive-base material combinations in this study at 24 hours are Fixodent on Lucitone 199, Fixodent on Eclipse, Fixodent on Ivocap and Super Poligrip on Ivocap.

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