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ANALYSIS OF OCCLUSAL FORCE USING PRESALE FUJIFILM IN COMPLETE DENTURE PATIENTS: AN IN VIVO STUDY

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Abstract

Background: Denture adhesive improves retention, decreases tissue discomfort, prevents strangulation of the mucosal blood supply, and reduces the frequency of adjustments even in a well fitting denture. The occlusal bite force is an important factor affecting the life of the prosthesis and the patient comfort function and esthetics.

Aim: The main purpose of the study was to evaluate the force generated in complete denture patients using the prescale Fujifilm before and after application of 3 different forms of denture adhesives.

Material and Methodology: In this study, the difference in occlusal force was evaluated which are created by different types of denture adhesives. A total of 30 subjects were included and three different denture adhesive viz., powdered adhesives, paste form and adhesive strips were used .The forces were evaluated using a prescale film which can precisely measure pressure and pressure distribution. Red patches appear on the film when pressure is applied and the colour density changes according to the various pressure levels.The variation of occlusal force that were seen on the prescale film that helped in determining if application of denture adhesive increases bite force and hence chewing efficiency. Also in determining which type of denture adhesive was more efficient in increasing bite force and more patient friendly.

Conclusion: It was concluded that application of denture adhesives increased bite force due to increase in the stability of the complete denture. It was concluded that denture adhesive strips generated more force than the denture adhesive paste and that the paste generated more force than the denture adhesive powder. FORCE generated (STRIPS > PASTE > POWDER) Keywords: Denture adhesive, prescale fuji film, bite force, adhesive powder, paste and strips.

Introduction

Complete denture treatment must be customized for every patient's particular needs. Successful treatment combines exemplary technique, effective patient rapport and education, and familiarity with all possible management options so as to produce the best degree of patient satisfaction.

Retention and stability factors that influence denture function are limited as compared with the natural structure that denture replaces where the remaining anatomic structure limits denture success, then pre-prosthetic corrections may be for Prosthodontic rehabilitation. But limited success is seen in some patients after pre-prosthetic corrections so, during this situations denture adhesives could also be used.1

Commercially available denture adhesives are products that have the capacity to reinforce treatment outcome.

Denture adhesives can improve patient acceptance towards the denture as suggested in various studies.2,3 Most of practicing dentists features very negative attitude towards denture adhesives. They regard the employment of those agents as a deficiency in their clinical and technical procedure.

Although, the precise figure in our country is unknown, about 33% denture wearer in U.S.A purchase denture adhesives in given year.4 So, it's necessary for dentists to be well versed about denture adhesives because to educate denture wearers about advantages, disadvantages, uses, of the merchandise, to identify those patients for whom such product is advisable or necessary for a satisfactory denture wearing experience.

Denture adhesive is referred to a commercially available, non-toxic soluble material that's applied to the tissue surface of the denture to reinforce retention, stability and performance. Denture adhesives are classified according to manufacturing type, i.e., powder, paste, tape or cushion.5

The usage of denture adhesives can traced back to the 18th century but they had been reported in dental literature only in 1935.McKevitt believed that a pair of well-fitting dentures wouldn't require the employment of denture adhesives. However, Tarbet et al and Shay K reported that the employment of those adhesives improves retention, decreases discomfort, prevents compression of blood vessels and reduces the necessity for denture adjustments. Chew et al. used a Kinseographic technique to determine the effectiveness of denture adhesives in improving the retention and stability of the complete maxillary denture in vivo.3,6

This study aims to 1) evaluate the force generated in the posterior region in complete denture patients 2)To evaluate the force generated in the posterior region in complete denture patients after application of different denture adhesives and 3)To compare the force generated between 3 different denture adhesives in complete denture patients after application of different denture adhesives.

Materials

The various materials used in the study are as follows: -

1. Prescale Fuji film
2. Secure denture adhesive powder (Group pharma , Bangalore ,Karnataka)
3. Secure denture adhesive paste (Group pharma , Bangalore ,Karnataka)
4. Secure denture adhesive strips (Group pharma , Bangalore ,Karnataka)
5. Articulating paper holder (FIG1)

FIG1- ARMAMENTARIUM

Prescale film can precisely measure pressure, pressure distribution, and pressure balance.Fujifilm's advanced technology in color film manufacturing enables Fuji to produce extremely thin and stable Prescale films of less than 200μm(100μmx2). (FIG2)

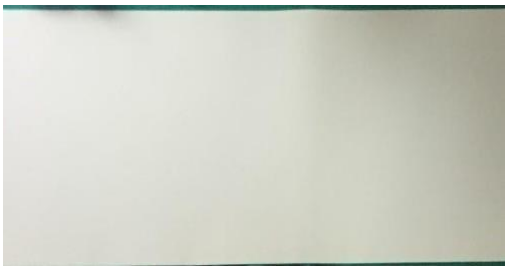

FIG2-PRESCALE FUJIFILM

Red patches will appear on the film when pressure is applied and the color density changes according to the various pressure levels.

Structure

There are two types of Prescale. Mono-sheet type is composed of a polyester base on which the color- developing material is coated, with the micro-encapsulated color-forming material layered on top.

Two-sheet type is composed of two polyester bases. One is coated with a layer of micro-encapsulated color forming material and the other with a layer of the color-developing material. Use two films facing the coated sides each other.

How it works:-When pressure is applied, the microcapsules are broken and the color-forming material reacts with the color-developing material. Red patches appear on the film.

Two-sheet type

Two Prescale films were cut appropriately. (A-film in black poly sack and C-film in blue poly sack) Face the rough surfaces of each film and insert the films where you want to measure pressure. Apply pressure. Red patches appear on the film and the color density changes according to pressure level. Take out the C-film, see and check the pressure distribution. For further precise pressure values, please use the pressure analyzing system. (FIG3)

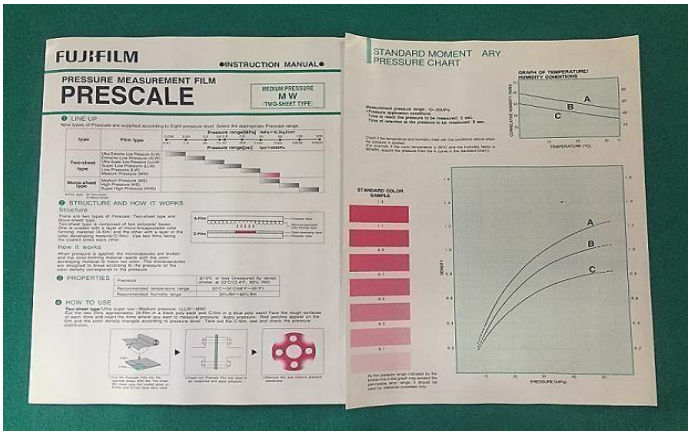

FIG 3 PRESSURE ANALYZING CHART

Denture adhesives that were used in the study were of the brand “SECURE”.

- Secure denture adhesive powder is a commercially available product that holds dentures strong & long. It is insoluble in liquids or saliva and hence completely free of taste.
- Discovered by an Austrian dentist for his patients with loose fitting dentures Secure Denture Adhesive Cream works in a completely different way.
- Conventional adhesives work by thickening saliva to improve suction between the denture and the gum. The dentures hold only by suction. Being water-soluble, these fixatives can dissolve and wash away when you're eating and drinking, causing dentures to slip and slide.

- Secure Denture Adhesive Cream is different. Its patented waterproof adhesive doesn't wash away while you are eating or drinking. Instead, it creates a strong, long-lasting bond between the denture and the residual ridge.
- SECURE Denture Adhesive Cushions assure a strong bond between lower denture and gum for denture wearers with flat and/or narrow mandibular ridge you get firm all-day cushion grip hold combined with cushion comfort.
- SECURE Cushions provide this extraordinary hold for the lower dentures because of its patented non water-soluble formula that does not wash away while you are eating or drinking.
- The SECURE Cushion is not soluble in water, so it is effective even for patients with excess saliva.

Methodology

30 patients were finally selected for the study on the following basis.

- **Inclusion criteria:**

1. Complete denture patients with the complete denture prosthesis made within the past 6 months.
2. Patients having tight cuspal contact in dentures.

- **Exclusion criteria**

1. Patients with monoplane occlusion
2. Patients with worn off dentures.

Four groups were created for the ease of the study.

Group 1	Control group (no adhesive)
Group 2	Powder group
Group 3	Paste group
Group 4	Strip group

The prescale Fujifilm was cut into dimension of standard articulating paper i.e. 6 x 1.5 cm & (FIG 4) the thickness of prescale Fujifilm is 200 um as mentioned earlier. Sleeves were prepared for the strips of prescale Fujifilm and then they were sealed.

FIG 4 SLEEVES OF PRESCALE

The patient was asked to bite on the strips of Prescale Fujifilm held with articulating paper holder for 30 seconds.(FIG5 a,b,c) This was repeated after applying the 3 forms of denture adhesives on the lower denture.(FIG6 a,b,c) Red marks appeared on the strips (FIG7) and they were then matched with the visual color scale provided by the manufacturer (FIG8) & force was calculated. This was repeated after applying the 3 forms of denture adhesives on the lower denture. A rest of 10 mins7 was given to patients to prevent muscle fatigue. Mouth of the patient was thoroughly cleaned with gauze and patient was asked to rinse with warm water. The dentures were thoroughly cleaned under running tap water and then wiped clean with gauze. The readings of all four groups were then analyzed.

(a) Subject, (b) Strips of Fujifilm prescale, (c) Subject biting on Strips of FujifilmFIG 5-a,b,c

FIG 6 a-Application of denture adhesive powder; b-Application of denture adhesive paste; c- Application of denture adhesive strips

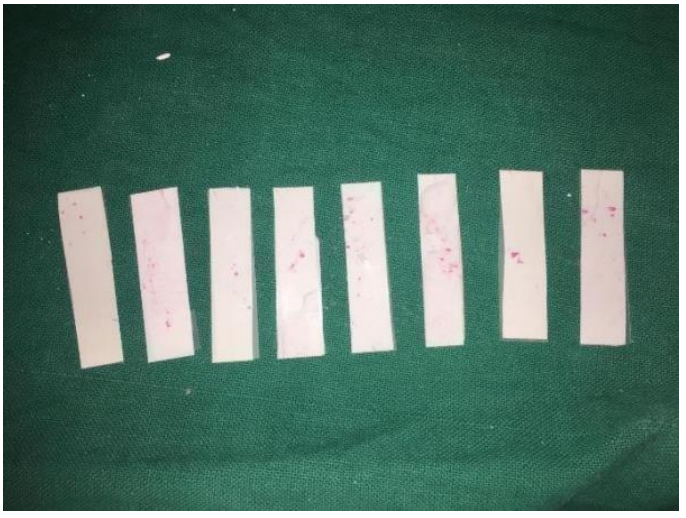

FIG 7-Prescale Fujifilm showing colour changes after biting.

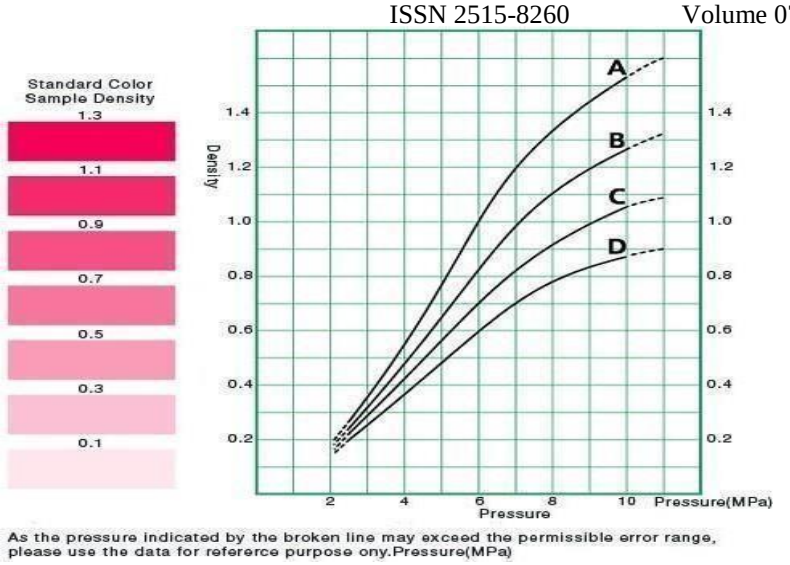

FIG 8-VISIAL COLOUR SCALE

Results

Thirty participants took part in the study 60% of them being male and 40% being female.

•Table 1 shows that force significantly increased on the right side from Group 1 to group 4.

•Table 2 shows that force significantly increased on the left side from Group 1 to group 4.

•Table 3 shows that force applied among all four groups on Right side increased from Group 1 to group 4.

•Table 4 shows that force applied among all four groups on left side increased from Group 1 to group 4.

•The results from table 5 and 6 are as follows

1. It was inferred that there was no significant difference between force generated in GROUP 1 & GROUP 2.
2. It was inferred that there was significant increase in force generated in GROUP 3 & GROUP 4 as compared to GROUP 1.
3. It was inferred that there was significant increase in force generated in GROUP 3 & GROUP 4 as compared to GROUP 2.
4. It was inferred that there was significant increase in force generated in GROUP 4 as compared to GROUP 3.

S.N.	Study group	Force in mega pascal (Mean ± S.D.)	p value
1.	**Group R1**	**26.1 ± 5.26**	**0.000(P<0.001)**
2.	**Group R2**	**31.2 ± 5.83**	
3.	**Group R3**	**36.6 ± 7.75**	
4	**Group R4**	**44.4 ± 8.9**	

Table 1: Comparison of force applied among all four groups on Right side

S.N.	Study group	Force in mega pascal (Mean ± S.D.)	p value
1.	**Group L1**	**27.9 ± 6.92**	**0.000(P<0.001)**
2.	**Group L2**	**30.7 ± 7.1**	
3.	**GroupL 3**	**34.9 ± 5.77**	
4	**Group L4**	**43.6 ± 11.3**	

Table 2: Comparison of force applied among all four groups on Left side

Comparisons	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3693.5	3	1231.195		0.000(P<0.001)
Within Groups	3849.5	76	50.652	24.3	
Total	7543.1	79			

Table 3: One way ANOVA test results for comparison of force applied among all four groups on Right side

Comparisons	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2819.9	3	939.9		0.000(P<0.001)
Within Groups	4965.1	76	65.33	14.3	
Total	7785	79			

Table 4: One way ANOVA test results for comparison of force applied among all four groups on Left side

Groups Comparison		Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Group R1	Group R2	-5.05000	0.121	-10.9619	.8619
	Group R3	-10.50000*	0.000	-16.4119	-4.5881
	Group R4	-18.32500*	0.000	-24.2369	-12.4131
Group R2	Group R1	5.05000	0.121	-.8619	10.9619
	Group R3	-5.45000	0.082	-11.3619	.4619
	Group R4	-13.27500*	0.000	-19.1869	-7.3631
Group R3	Group R1	10.50000*	0.000	4.5881	16.4119
	Group R2	5.45000	0.082	-.4619	11.3619
	Group R4	-7.82500*	0.005	-13.7369	-1.9131
Group R4	Group R1	18.32500*	0.000	12.4131	24.2369
	Group R2	13.27500*	0.000	7.3631	19.1869
	Group R3	7.82500*	0.005	1.9131	13.7369

Table 5: Multiple comparisons of Bite Force value based on TUKEY post hoc test with respect to right side

Groups Comparison		Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Group L1	Group L2	-2.82500	0.687	-9.5391	3.8891
	Group L3	-6.95000*	0.040	-13.6641	-.2359
	Group L4	-15.72500*	0.000	-22.4391	-9.0109
Group L2	Group L1	2.82500	0.687	-3.8891	9.5391
	Group L3	-4.12500	0.377	-10.8391	2.5891
	Group L4	-12.90000*	0.000	-19.6141	-6.1859
Group L3	Group L1	6.95000*	0.040	.2359	13.6641
	Group L2	4.12500	0.377	-2.5891	10.8391
	Group L4	-8.77500*	0.005	-15.4891	-2.0609
Group L4	Group L1	15.72500*	0.000	9.0109	22.4391
	Group L2	12.90000*	0.000	6.1859	19.6141
	Group L3	8.77500*	0.005	2.0609	15.4891

Table 6: Multiple comparisons of Bite Force value based on TUKEY post hoc test with respect to Left side

Discussion

Reduction in denture movement due to applying denture adhesive has been documented in certain

literature.8; 9,10The results of this study suggest a direct relation between the application of denture adhesive and increase in the stability and retention of the denture.

Mechanism of action: Denture adhesives augment the same retentive mechanisms already operating when a denture is worn. They enhance the retention through optimizing interfacial forces by:

1] Increasing the adhesive and cohesive properties and viscosity of the medium lying between the denture and the basal seat, and

2] Eliminating voids between the denture base and basal seat.

Adhesives are agents that stick readily to the denture base and the basal tissues. As the hydrated adhesives are more cohesive then saliva, physical forces intrinsic to the interposed adhesive medium resist the pull more successfully than would the similar forces within the saliva. The material swells of 50-150% by volume in the presence of water, filling in spaces between prosthesis and tissues. The forces required to pull 2 disks apart is directly proportional to the viscosity of the liquid between them. Saliva increases the viscosity of the adhesive.11

As the Adhesive powders absorb water, they swell to many times their original volume and the anions so formed, interact with cations in the proteins in the oral mucous membrane. The viscosity of the adhesive is increased by the thick saliva formed, thereby increasing the denture retention.

Free carboxyl groups formed by the hydration of adhesive such as methyl cellulose, hydroxyl methyl cellulose, sodium carboxylmethyl cellulose etc form electrovalent bonds that produce stickiness or bioadhesion.12, 13

Denture adhesives have been classified into two groups namely: 6

1. Soluble group
2. Insoluble group

Soluble group

- Initially gum based adhesives were used; these were replaced with synthetic adhesives which depend on their chemical properties to provide adhesion.
- The basic mechanism of action of these adhesives is that when the active ingredients which are present in the adhesive come in contact with water or saliva they swell up filing the space between the tissue surface and the denture.
- Shay reported that the adhesives swell by about 50-150%.

Adhesives used today are basically a blend of polymer salts which differ in their degree of solubility which affects their activation phase.

They use a combination of active components one showing a short term adhesive effect and the other showing a long term effect. Carboxymethyl cellulose (CMC) is a salt showing a strong initial adhesion but a short term action due to its high level of dissolution. The occlusal bite force is an important factor affecting the life of the prosthesis and the patient comfort function and esthetics. Polyvinylether methyl cellulose (PVM-MA) has a long term action due to its lower rate of solubility. The earlier fixatives were formulated using vegetable gums such as acacia, tragacanth or karaya that absorb water to form a mucilaginous layer between the denture bearing tissue and the denture base. As these were highly soluble in water and oral fluids the longitivity of their action was decreased.6, 14

Insoluble group

The insoluble group includes pads and synthetic resins. The ingredients which have remained constant in this group are a fabric carrier and a component that becomes sticky when hydrated. These include pads and wafers. Laminated fabrics are impregnated with adhesive agents like Sodium alginate and ethyl oxide polymer. These fabrics contain a water activated component within the fabric mesh which becomes sticky upon absorbing saliva. The difference between the pad and wafer is that the former is thicker than the later and is sometimes known to perform a dual function of relining andacting like a denture adhesive.6, 15, and 16

In this study, the difference in occlusal force was evaluated which are created by different types of denture adhesives. A total of 30 subjects were included and three different denture adhesives viz., powdered adhesives, paste form and adhesive strips were used. The variation of occlusal force that

were seen on the prescale film that helped in determining application of denture adhesive increases bite force17,18 and hence chewing efficiency15. Also in this study determination was done as to which type of denture adhesive was more efficient in increasing bite force and it was found that the bite force was found minimum with the powder type of adhesive and it was maximum with the adhesive strip with the bite force due cream type adhesive ranging between the two. Various studies have been conducted to compare adhesive powder and cream. Han et al19 in their study concluded that cream type denture adhesives have lower initial viscosity and higher adhesive strength than powder-type denture adhesives, which may have better manipulation properties and increased efficacy during application. Literature concerning evaluation of insoluble denture adhesive cushions is inadequate. Studies by Fellar et al, Uysal et al20, Koronis et al 16 compared different adhesive cushions but literature on comparison of cushions with powder and paste is scarce. In this study comparison between all three types was done and it was found that adhesive strips were more retentive and bite force generated was maximum. [FORCE generated= (STRIPS > PASTE > POWDER)]

Limitations

- Changes may have occurred in vertical dimension due to placement of secure denture adhesive strips. But the effect of secure denture adhesive strips on vertical dimension has not been reported in the literature since not many studies have been done on the use of these strips.(FIG9)

FIG 9-THICKNESS OF ADHESIVE STRIP

Conclusion

It was concluded that application of denture adhesives increased bite force due to increase in the stability of the complete denture. It was concluded that denture adhesive strips generated more force than the denture adhesive paste and that the paste generated more force than the denture adhesive powder.

Conflict of Interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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Nil

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