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ORIGINAL ARTICLE

A Comparative Analysis of the Effect of Various Denture Adhesives Available in Market on the Retentive Ability of the Maxillary Denture: An In Vivo Study

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Abstract "Every human being has a divine right to enjoy the health to its fullest." Oral and Dental health is not an exception to this dictum. The speciality of Prosthodontics has emerged as a science to provide replacement of missing dentition for its form and functions along with associated structures. Any successful complete denture treatment combines exemplary technique, effective patient rapport, patient education, and familiarity with all possible management options in order to provide maximum satisfaction to patient. There are some forcing situations where providing desirable (optimal) retention may be a problem. In such types of patients use of denture adhesives is recommended for enhancing the quality of retention. The use of denture adhesive provides comfort and additional confidence not only by increasing the adhesive and cohesive but also eliminating voids between the denture base and the basal seat. This study is undertaken to evaluate the enhancement of retentive quality of complete denture with the use of denture adhesives available in Indian markets for the use by denture wearers.

Keywords Retention · Denture adhesive · Compact force gauge transducer · Spindle-handle mechanism

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Introduction

"Every human being has a divine right to enjoy the health to its fullest." Oral and Dental health is not an exception to this dictum. The loss of teeth by disease or accident has plagued mankind throughout ages which demands replacement by artificial substitute [1]. Complete denture [2] is a removable prosthesis that replaces the form and functions of missing teeth along with associated structures without causing much of damage to remaining structures of masticatory apparatus.

Fabrication of complete denture has to satisfy certain fundamental principles about stress distribution and optimum tissue preservation. Sears [3] clearly stated that these principles are the important factors that justify what we do and the way we do it.

The successful complete denture must provide desired degree of retention and stability to prosthesis. Retention is a resistance offered by denture to vertical dislodging forces acting away from foundation. The glossary of Prosthodontic terms [2] defines denture retention as "The resistance of a denture to dislodgement."

Hardy and Kapur [4] stated that retention of complete denture may be influenced by a number of factors as Physical, Physiologic, Psychologic, Mechanical and Surgical. The physical factors are Adhesion, Cohesion, Interfacial surface tension and Atmospheric pressure. In following forcing situations [5] providing desirable degree of retention may be a problem.

1. Severely atrophied edentulous ridges of severe grade;
2. Severely abused/hypertrophied tissue covering the ridges;
3. Patients having lack of neuromuscular control (e.g. stroke and Parkinsonism);

4. Cases with Xerostomia;
5. Maxillofacial defects which provides inadequate tissue support.
6. Patients with lack of neuromuscular control.

In these situations, use of denture adhesives is recommended for enhancing the quality of retention. "Denture adhesive" [6] is a commercially available, non toxic, soluble material of sticky nature that can be applied over tissue surface of the denture in order to enhance the quality of denture retention and thereby improving quality of denture stability too. These are available as powder, cream or liquid.

This study was conducted to evaluate increase in retentive quality of complete dentures with various types of denture adhesives.

Materials and Methods

For measuring of retention, five patients were selected for the study that were fulfilling the above criteria and were having minimal retention. It was planned to fabricate five denture bases for each patient making the total of 25 denture bases.

Routine materials and standard techniques were used for the fabrication of denture bases used in this study. Preliminary and final impressions were made for the selected subjects used in this study. The denture bases were fabricated, using master cast made by boxing-in technique (Fig. 1) in heat cure acrylic resin using slow curing cycle. The bases were then finished and polished using accepted methods.

The centre of bases was then marked by using a crossing point which has been obtained by two lines diagonally marked between Canine-Tubeorisity points. A stainless steel loop was then fixed at this centre point using self cured resin. This loop was used to engage a stainless steel hook attached with Nylon fishing line of the apparatus to record the values of retention (Fig. 2).

Fig. 1 Master cast

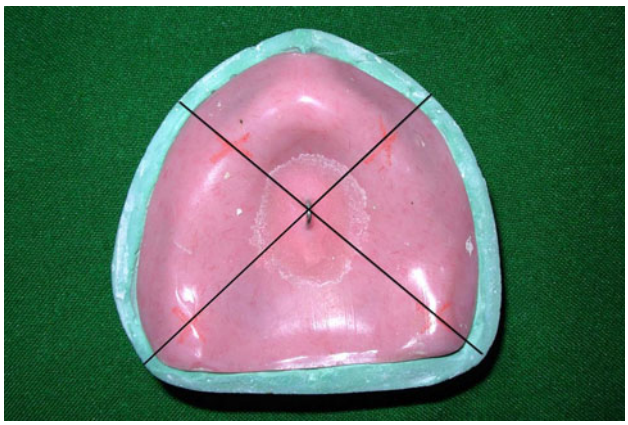


Fig. 2 Centering of cast

Fig. 3 Denture adhesives

Following four denture adhesives were used in the study (Fig. 3):

P1: Fixon powder (ICPA, Mumbai)
P2: Fixon supergrip powder (ICPA, Mumbai)
P3: Fittident powder (Dr. Reddy's Lab. Ltd., Hyderabad)
P4: Fittident paste (Dr. Reddy's Lab. Ltd., Hyderabad)

Retention Measuring Apparatus

Specially designed apparatus, based upon the principle stated by Skinner was fabricated and used to measure the values of denture retention for each base with and without the denture adhesives (Fig. 4).

In 1953, Skinner and Chung [7] used an apparatus based upon the principle of "Force application at right angle to the denture base to evaluate denture retention". The direction of force in caudal direction was applied by engaging hook by nylon fishing line suspended perpendicularly. The hook was fixed at centre of the palatal vault

Fig. 4 Specially designed apparatus with description

of the denture base. At the other end of the nylon fishing line force application in the form of dynamometer was used to simulate dislodging force which was considered as a value of denture retention.

In the year 1976 Bulbule and Joshi [8] used the apparatus with some modifications in Skinner's apparatus to measure the values of retention. Thombare et al. [9] in 1978 also used this apparatus and measured the values using weighing pan with weights and sand for obtaining the values of denture retention.

In this study, following modifications were made in the design of the apparatus using the basic principle stated by Skinner and Chung [7]. To activate accurate dislodging force 'Spindle-handle mechanism' was incorporated. This force was then applied to dislodge the denture base using nylon fish line. The 'Compact force gauge transducer', an electronic device, was used to measure the values of retention probably for the first time in dentistry. The apparatus was having provision to adjust the height in vertical direction and horizontal direction for adjusting the chin rest. The entire assembly was mounted on a tripod stand (Fig. 5).

By rotating the handle in clockwise direction, the required force was created and applied slowly on the denture base till the maxillary denture base was dislodged. The values recorded in the force transducer was the force required to dislodge the denture and hence were considered as the 'Value of retention.'

This compact force gauge transducer used in this study has been certified by "Force and torque measurement application engineering, Mecmesin Ltd, U.K. to confirm operational accuracy of ±0.5% for any measurement within its working range."

Recording the Values of Retention

The selected patient was positioned in a chair. The patient's head was positioned at a desired level using cephalostat. The patient was then advised to rinse the mouth with luke-warm water, for cleaning the deposits and mucoid secretions. The wet denture base was then firmly seated over the foundation and was kept in position for 2 min. The apparatus was then adjusted vertically at required height and horizontally for locating the hook of nylon fishing line perpendicular to the loop fixed at the center of the palatal portion of denture base. The chin

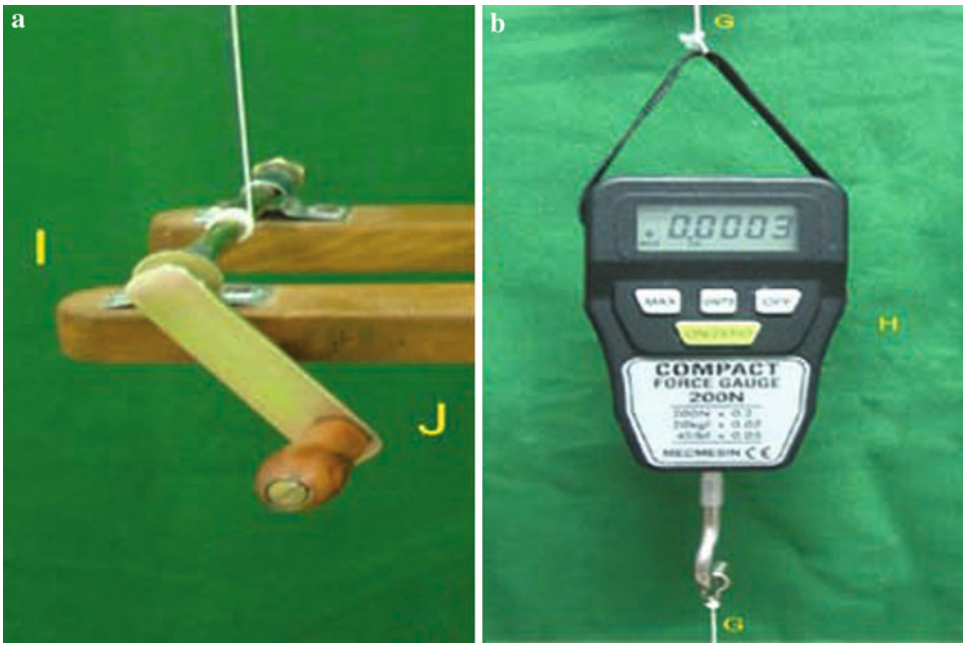
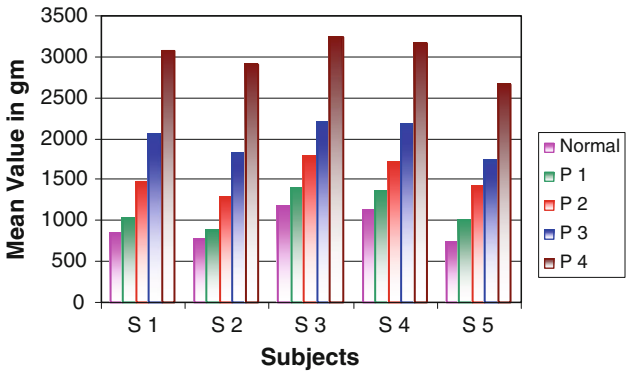


Fig. 5 **a** Spindle handle mechanism for application of constant force, **b** compact force gauge tranducer

Table 1 Comparative evaluation (mean) of different varieties of denture adhesives used (average values in g)

Subjects	Normal	P1	P2	P3	P4
S1	836	1030	1468	2044	3072
S2	754	874	1276	1832	2906
S3	1172	1398	1780	2198	3244
S4	1116	1352	1710	2184	3158
S5	732	1002	1408	1726	2670
Average	992	1131.2	1528.4	1996.8	3010
Values of retention raised by (g)		139.2	–	–	–
			536.4	–	–
				1004.4	–
					2018



Graph I: Bar diagram showing relationship between the mean of the values of retention without and with application of various denture adhesives for all the five subject

support was adjusted in vertical and horizontal direction. The wire loop attached at the center of denture base was then engaged by wire hook of nylon fishing line. A dislodging force was then created and applied at right angle to denture base by rotating the handle in a clockwise direction. Each time, half a turn was given till such a time patient experienced stretching force. The intensity of force was then increased slowly by giving quarter turn to handle and then slow rotation was given to handle till the denture base got dislodged from the foundation. The reading recorded in compact force gauge transducer were the values of retention. Similar procedure was followed to obtain values of retention for all five denture bases of each patient. Only one denture base was tested at each appointment. Readings for all five subjects were obtained without and with the use of selected groups of denture adhesives. Mean values of retention were recorded and exhibited in Table 1.

Results

The mean of the values of retention in regard to five denture bases for each patient without and with the use of denture adhesives for each subject were obtained by observing same protocol and following same procedure.

Statistical Analysis

The result of the study was statistically evaluated by using

(1) One way ANOVA and
(2) Post hoc tests: multiple comparisons by using Tukey test for subjects

'Descriptive statistical analysis' (i.e. mean, standard deviation and standard error) was carried out for all four groups of denture adhesives used in this study for all the five patients (Table 2).

The lowest value of mean for normal had the minimum value of retention and the maximum value of mean for P4 had the maximum value of retention.

Discussion

Successful Prosthodontic treatment for all edentulous patients necessitates prior treatment of oral tissues to have its optimal state of health. The patient's education in relation to the prosthesis and the state of oral and general health requires counselling of the patient for his fullest cooperation thereafter so that patient accepts his part of responsibility in making the treatment meaningful and successful.

Critical evaluation of review of literature clearly indicated the importance of properly designed and well fabricated complete denture to satisfy the demands of esthetics and phonetics, and also restoring the function of mastication to the maximum. These goals can be achieved by understanding the need of the patient, through clinical examination, meticulous planning with preparation of patient and executing perfect craftsmanship well supported by scientific knowledge.

In complete denture patients, physical factors attribute for adequate retention of the prosthesis. To provide desired optimal retention, it is necessary to have maximally stable denture. Boucher CO [10] has also emphasized on the factors suggested by Brill N (1967) that must be incorporated while making of impression viz: (i) Maximum area of coverage, (ii) Intimacy of contacts of denture base with the tissue and iii) Eliminating the effect of fulcrum by way of providing relief at the centre of palate.

In an extremely compromised situation e.g. Geriatric patient with severely resorbed alveolar ridge covered by abused tissues pose a serious threat of inadequate retention, and thus demands the use of an alternative mechanism to encounter such adverse situations. Search in literature has revealed the use of mechanical devices viz. Wires, Springs,

Table 2 Table showing descriptive statistical analysis i.e. mean, standard deviation and standard error for four groups of denture adhesives used in this study for all the five patients

Subject	Group	*n*	Mean	Std. deviation	Std. error	95% Confidence interval for mean		Min.	Max.
						Lower bound	Upper bound		
S1	Normal	5	836.00	48.78	21.81	775.42	896.57	790.00	910.00
	P1	5	1030.00	58.30	26.07	957.59	1102.40	970.00	1100.00
	P2	5	1468.00	119.03	53.23	1320.19	1615.80	1320.00	1600.00
	P3	5	2044.00	104.30	46.64	1914.48	2173.51	1930.00	2190.00
	P4	5	3072.00	90.66	40.54	2959.42	3184.57	2990.00	3210.00
S2	Normal	5	754.00	103.10	46.10	625.98	882.01	640.00	920.00
	P1	5	874.00	85.02	38.02	768.42	979.57	780.00	970.00
	P2	5	1276.00	87.92	39.31	1166.83	1385.16	1180.00	1380.00
	P3	5	1832.00	58.05	25.96	1759.91	1904.08	1770.00	1900.00
	P4	5	2906.00	85.02	38.02	2800.42	3011.57	2770.00	2990.00
S3	Normal	5	1172.00	38.34	17.14	1124.39	1219.60	1130.00	1220.00
	P1	5	1398.00	53.57	23.95	1331.48	1464.51	1320.00	1470.00
	P2	5	1780.00	80.31	35.91	1680.27	1879.72	1680.00	1860.00
	P3	5	2198.00	103.53	46.30	2069.44	2326.55	2030.00	2290.00
	P4	5	3244.00	128.56	57.49	3084.36	3403.63	3030.00	3340.00
S4	Normal	5	1116.00	54.12	24.20	1048.78	1183.21	1020.00	1150.00
	P1	5	1352.00	75.29	33.67	1258.50	1445.49	1240.00	1420.00
	P2	5	1710.00	84.55	37.81	1605.00	1814.99	1580.00	1780.00
	P3	5	2184.00	132.21	59.12	2019.83	2348.16	2030.00	2370.00
	P4	5	3158.00	92.84	41.52	3042.71	3273.28	3060.00	3280.00
S5	Normal	5	732.00	68.33	30.56	647.14	816.85	640.00	810.00
	P1	5	1002.00	72.59	32.46	911.86	1092.13	910.00	1110.00
	P2	5	1408.00	95.76	42.82	1289.09	1526.90	1290.00	1500.00
	P3	5	1726.00	120.12	53.72	1576.84	1875.15	1560.00	1890.00
	P4	5	2670.00	123.89	55.40	2516.16	2823.83	2540.00	2860.00

Suction discs, Suction chambers, use of Magnets and Undercuts for providing required retention to prosthesis. Above devices increases the retention but complicates the situation by causing further damage to the tissues of the foundation. Therefore, denture adhesives being commercially available, non-toxic, soluble material of sticky nature and having ability to hold a denture in position has emerged as an acceptable solution to meet the challenges of retention in such patients [12, 13, 16, 18, 20].

The patients selected for this study were having nearly poor foundations with acceptable neuromuscular control.

The procedure related to impression making, cast preparation and duplication and fabrication of denture bases were standardized for all patients to avoid influence of variations on the values of retention. Cephalostat was used for standardization of patient's position. Ala-tragus line was made parallel to rod of cephalostat [7]. 'FH' plane was provided parallelism with the horizon for all patients used in this study (Fig. 6).

The Retention measuring apparatus designed and fabricated for this study has a 'unique variation' as compared with the apparatus used in earlier studies [7–9]. The force required to dislodge a denture base was measured by using 'Compact force gauge transducer' with 'Spindle-handle technique' which has provided accurate values even in fractions (grams). The limitation of this apparatus was that as the force could only be applied in the caudal direction, it could not be used for checking the retention of mandibular dentures.

Similar to the earlier studies [7–9], the point of detachment of denture base from the foundation was taken into account as the value of retention recorded on compact force gauge transducer.

The values of retention recorded in this study are in agreement with the observations of earlier studies [11–20]. Thus the modified apparatus for measuring retention has proved its validity and usefulness in this study.

The statistical analysis of the values of retention recorded in this study, showed variations in the mean differences in 'S' group, means in all the five subjects were found significant relationship. Also there was a significant variation in the values of retention with different denture

Fig. 6 Measuring of retentive force using the specially designed apparatus & cephalostat. **a** Frontal view. **b** Profile view

adhesives used for all the five subjects. Denture adhesives have proved to have a beneficial effect on all subjects from the point of retention.

Minor variations in the values of retention in same subjects were noticed which can be attributed to the negligible procedural inadequacy and some unavoidable variations may be due to lack of desired neuromuscular coordination by those patients at the time of recording the values. These variations were insignificant.

Three types of powder forms of adhesives were tested in this study namely Fixon (P1), Fixon Supergrip (P2) and Fitident powder (P3). Analysis of the results so received indicated that there was a variation in the values of retention with the use of these powder adhesives but it confirmed the fact that "Denture adhesives definitely enhance the quality of Denture retention".

"The paste form (P4) of denture adhesive enjoys superiority over the powder form" as reflected by the higher values of retention by almost double as observed in this study. It is in confirmation with earlier research [18].

In a developing country like ours, owing to socio-economic conditions of the patients, use of Implant dentures is beyond the reach of many, and thus conventional denture prosthesis is still a treatment of choice of majority. The use of denture adhesives in providing adequate retention in those patients facing problem of denture retention will be a viable solution. However the patients must be warned about the 'use and misuse', and 'do's and don'ts' related with the applications of denture adhesives to enjoy best possible results without threatening the health of oral tissues. The patient should be informed about the importance of frequent "Recall appointments" [21], and reason for the evaluation of the condition of denture and foundation, for assuring best quality services by complete denture to mankind.

Conclusion & Summary

The loss of teeth poses a problem of Esthetics, Phonetics and reduces the Masticatory efficiency. Patients are often desirous of getting these functions restored by way of the dentures.

In the Geriatric, Compromised and Handicapped patients, providing desired quality of denture retention is always a problem. In such patients, use of denture adhesives to enhance the quality of denture retention has proved to be a viable solution befitting to the socio-economic status of the patient.

In this study, four denture adhesives, easily available and being commonly used by patients were evaluated for their effect on enhancing the quality of denture retention.

The value of retention obtained with adhesives is more than double as compared to dentures used without adhesives. The paste form have established its superiority over powder form of denture adhesives and provided retention about double in the values in comparison with powder form of adhesives.

The modified retention measuring apparatus with 'Compact force gauge transducer' used in this study proved to be a reliable device in obtaining accurate values. 'Handle-spindle mechanism' used in the study is more

convenient and more accurate method of producing nearly accurate dislodging force to record the value of retention.

Further exploring the utility of denture adhesives for its effect on denture retention and overall health status of oral tissues is desired.

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