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Research Article

Clinical Study to Evaluate Tissue Compressibility at the Posterior Palatal Seal Area in Maxillary Complete Denture by Using Three Different Border Molding Materials under Constant Pressure

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Abstract

Objective: A clinical study to evaluate tissue compressibility at the posterior palatal seal area in maxillary complete denture by using three different border molding materials, under constant pressure.

Materials and Methods: Thirty completely edentulous subject of either sex, between 50 to 70 years of age, requiring class I soft palate were selected. The materials were used to record PPS area includes, Pattern Resin (LS 1:1 PKG GC America INC for patterning), Putty Addition Silicon (Dentsply Aquasil Soft Putty/Regular Set) and Low fusing compound (DPI Pinnacle tracing sticks). Three compressibility areas were selected to evaluate tissue compressibility at the PPS area. The compressibility was evaluated under image analyzer stereomicroscope.

Results: One way ANOVA statistics and post-hoc bonferroni correction shows that the statistical means are significantly differ ($p = 0.000$) when compared with group 1 (control group) however pattern resin mean (Group 2) was close to the group 1 (control group) and means of group 3 (low fusing compound) and Group 4 (putty addition silicon) was statically insignificant ($p = 2.163$)

Conclusion: Pattern resin records the tissue detail more precisely with minimum tissue compressibility and greater dissipation of compressive stress at posterior palatal seal area followed by low fusing compound. Putty recorded highest tissue compressibility and not suitable material to record the posterior palatal seal.

Keywords: Posterior Palatal Seal; Tissue Compressibility; Pattern Resin; Silicon Putty; Low Fusing Compound

Abbreviation

LS: Low Shrinkage.

Introduction

Posterior palatal seal is an important anatomical landmark, in complete denture retention [1]. The correct location and placement posterior palatal seal not only compliments buccal and labial border seal, but effectively resists rotational thrusts exerted on complete denture by utilizing the function of atmospheric pressure [2,3], Apart from retention the successful posterior palatal seal minimize the gag reflex. Compensates for polymerization shrinkage of acrylic resin thereby blocks air and food entry beneath the denture [4-7].

The soft tissue compressibility at posterior palatal seal area is a significant clinical consideration while making secondary impression. The tissues for a few millimeters on either side is begins from the posterior border of the hard palate (limited compressible area) and merge towards the soft palate (completely movable tissue), depends upon its anatomical configuration [4,5]. House MM. describe the soft tissue compressibility in his classification of soft palate and according to that Class 1 soft palate has maximum compressible area, whereas class 3 soft palate has minimum compressible area [8,9]. The controlled placement of soft tissue during secondary impression procedure is not only produce adequate seal but improve the health of the tissue at posterior palatal seal area [6].

There are certain methods such as conventional technique and fluid wax technique that record the posterior palatal seal. However, both these techniques were not clinically popular because there is a high chance of over scraping of master cast and subsequent over compression of soft tissue, irrespective of various methods of scraping of master cast describe in literature [7,8]. Fluid wax technique is physiologic technique, but it is time consuming, it requires extra unit for heating the wax and difficulty in handling the materials while manipulation [6-8]. Recently the technique that records the posterior palatal seal area by using CAD/CAM or digital complete denture bases and compared with conventional denture base. Author suggested that Retention acquired with CAD/CAM or digital complete denture bases was significantly higher than that offered by conventional complete denture bases. However, amount of tissue compressibility produces by CAD/CAM or digital complete denture bases was not mentioned with study [9].

In the routine clinical practice, posterior palatal seal is recorded mostly during secondary impression procedure. The technique involves border molding of labial and buccal border that continuous with posterior palatal seal [10]. Low fusing compound most commonly used material to record the labial, buccal border and posterior palatal seal. Since it is easily available and economical, but heat involves while manipulation of the tissue and it hardens quickly [11-13]. Meanwhile silicon elastomers was investigated as a border molding material. In elastomer family, addition Silicon, condensation silicon in putty consistency and polyether were studied as a one-step border molding materials alternative to low fusing compound [14-18]. Recently pattern resin was studied as a material to record border morphology, alternative to low fusing compound. Author suggested that pattern resin records the border morphology more precisely. It has effective flow and remain stable even in thin section with negligible polymerization shrinkage [19].

Irrespective of techniques and materials used to records the posterior palatal seal area. The most important observation about soft tissue compressibility that, it is totally depends upon the pressure exerted by border molding materials. This correlation is significant clinically as the soft tissue have very limited range of tissue compressibility, i.e. 1-3 mm and modulus of elasticity of posterior palatal seal is less compared to rest of palatal mucoperiostium [20]. Over compressibility of soft tissue not only compromised the health by blocking the local circulation, but it creates an unseating force at the posterior palatal seal area, that results in lack of stability and patient discomfort [20]. It is essential to evaluate the properties such as toughness, effective flow and viscosity of border molding materials that support the soft tissue and counteract stress dissipation from soft tissue to material toughness [20]. It is clear distinction that there is limited research that shows the relationship between soft tissue compressibility and material properties at posterior palatal seal. Similarly, the recent materials were studied only on labial and buccal border, not on the posterior palatal seal. Hence to find out the correlation between material properties and tissue compressibility, the controlled clinical study is needed. On the similar line, present study was designed to evaluate tissue compressibility at posterior palatal seal area in maxillary complete denture base by using three border molding materials under constant pressure.

Materials and Method

The study protocol was reviewed by the ethical committee of the institute and clearance for the same was obtained. Thirty completely edentulous subject of either sex, between 50 to 70 years of age, requiring class I soft palate (MM House classification of soft palate) was selected. Patients with class II and Class III soft palate, congenital soft and hard palate anomaly and post-surgical hard or soft palate trauma were excluded from the study. The procedure for the study was explained to the subject in their language and consent was taken from each subject.

Posterior palatal seal was recorded as a routine clinical method of labial and buccal border recording that continuous with posterior palatal seal and wash impression made with zinc oxide eugnol impression paste (ZNOE) (DPI impression paste, India). The study was designed in two steps. First step was recording final impression without posterior palatal seal (Control group) and second step was recording posterior palatal seal area using three border molding materials (test group). In the first step preliminary impression was recorded with medium fusing impression compound (Figure 1A) ("Y" Dent Impression Composition, India) with an aim to fabricate diagnostic cast and custom tray (Asian Special Instant Tray Material) for final impression. While making final impression only the labial and buccal border was recorded, with low fusing compound (DPI Pinnacle Tracing Sticks, India) and the wash impression was made with zinc-oxide and eugnol paste (ZNOE) (DPI impression paste, India) (Figure 1B). The wash impression was poured with type III gypsum material (Gyprock type III, India) and master cast was obtained. This group is treated as a control group (Group 1) to compare with test group of three border molding materials, to find out the tissue compressibility.

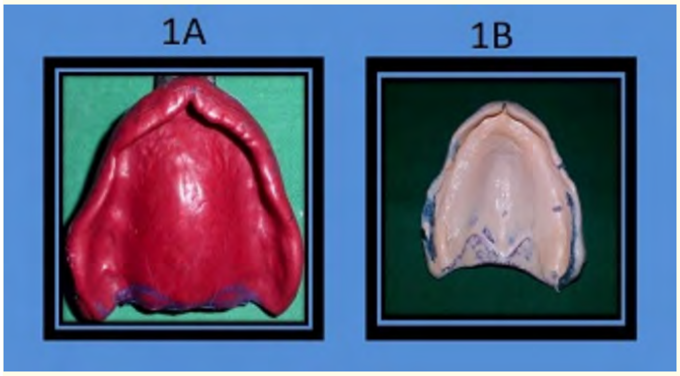

Figure 1: A) Preliminary impression.
B) Final impression without PPS (Control group).

In the second step, three border molding materials were used to records the PPS area, that divided as a Pattern resin (Group 2: LS 1:1 PKG GC America INC for patterning), low fusing impression compound (Group 2: DPI Pinnacle tracing sticks) Addition silicone putty (Group 3: DentsplyAquasil Soft Putty/Regular Set). Since, three test materials were used in the study, three more master cast was needed, hence the control group master cast was duplicated in the agar-agar duplicating machine {Hongying Model Number HY-45 Place of origin Tianjin, China (Mainland)} with duplicating flask. The duplicating flask was poured with type III gypsum material and three master cast was obtained for three test materials. There were three transparent custom tray was fabricated on each master cast for three test materials (Figure 2A,2B and 2C) (Acralyn -'H' Transparent Acrylic). While recording the PPS area, the bias of variability of finger pressure was minimized by using pressure sensor device with strain gauge (Haoyve DT 830 Digital millimeter assembled with strain gauge). The strain gauze is a small pressure sensor chip that was secured at the center of the palate by applying small amount of adhesive (Figure 3A and 3B). The strain gauge detects the finger pressure that subsequently transfers to the pressure sensor machine through the electronic device. The pressure sensor machine is a specially designed diaphragm pressure transducer was constructed for this project. The pressure sensor machine processed the pressure signal and displayed on the monitor. When the finger load was applied on the strain gauge, the gap becomes smaller and then the electrostatic capacitance changes. This change is calculated as pressure by using a miliammeter used for measuring amplitude. Three border molding materials were manipulated as per the manufacturer instructions and adapted at the PPS area between anterior and posterior vibrating lines (Figure 2A, 2B and 2C)}. Custom tray was placed inside the patient mouth and finger pressure was kept on the strain gauge, till the final set of the materials except for pattern resin. Since the pattern resin induces exothermic reaction during final stage of polymerization. To prevent heat transfer intraorally, the custom tray was removed, before the material reach to final stage of polymerization. Once posterior palatal seal recording was completed, the custom tray was lubricated and poured with type IV gypsum material (Gyprock type IV, India) and new cast was fabricated to evaluate the tissue compressibility.

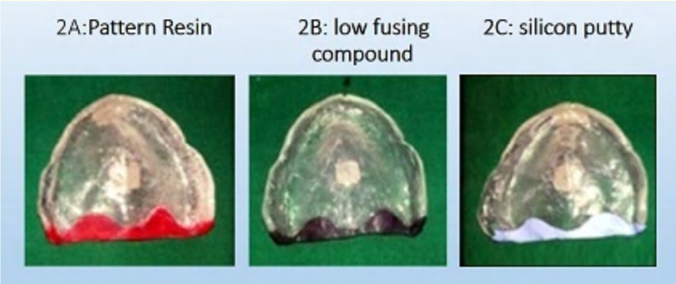

Figure 2: PPS recordings with three different border molding materials.
A) Pattern resin. B) Putty addition silicon. C) Low fusing compound

Tissue compressibility was evaluated under "Steriomicroscop". It is a Production of Wuzhou New Found Instrument Co. Ltd, China. Model: XTL 3400E, Magnification:7 X to 45 X. Image Analysis System Production: Chroma Systems Pvt Ltd, India. Model: MVIG 2005. The three areas were selected to measure the tissue compressibility, as per suggested finding of the study of varying palatal form21. The first two areas were the intersected mid-point between the hamular notch and posterior nasal spine horizontally and anterior

Figure 3: Pressure sensor device with strain guage.

-posterior vibrating line in sagittal plane on both right and left side of the PPS area and posterior nasal spine was selected as a third area of tissue compressibility [21] (Figure 4A).

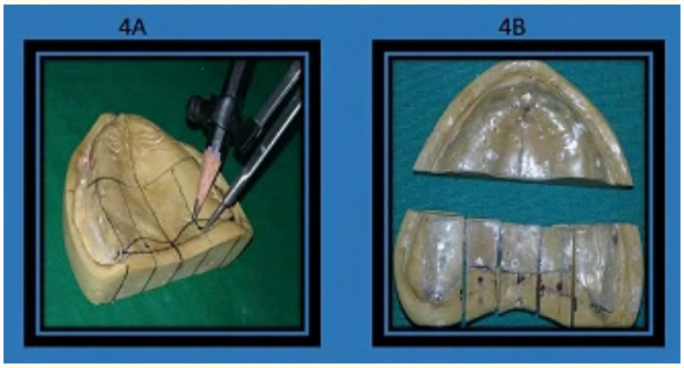

Figure 4: A) Compressibility area.
B) Sectioning of the master cast.

The thermoplastic sheet (Bio-star sheet) was adapted on the new cast (0.05 inch thick). This sheet was used as a standard reference to measure the depth produced by each impression material. To highlight the PPS area more precisely the cast was sectioned horizontally, just few mm anterior to the anterior vibrating line (Figure 4B). The cast at the PPS area was further sub sectioned, so that segment of preselected compressibility area can be separated from the rest of the cast and stabilized on the mounting glass of the microscope. The picture is captured from under the microscope and transferred to the computer connected to measure the depth of compressibility, a straight horizontal line was drawn from the reference thermoplastic sheet and a perpendicular vertical line was used to measure the depth (Figure 5A and 5B). The observations data of the compressibility value was collected and presented in tabulated and graphical manner for statistical analysis (Figure 6A,6B,6C and 6D).

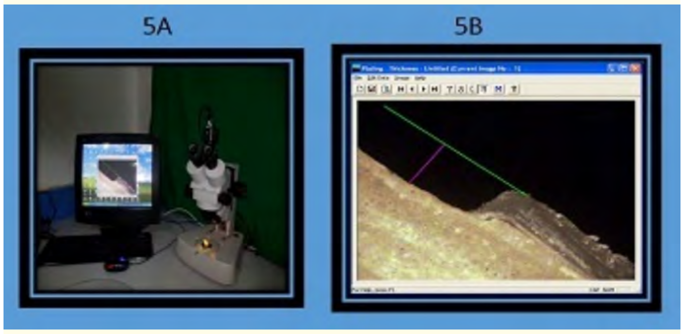

Figure 5: Compressibility depth measurement under stereomicroscope.

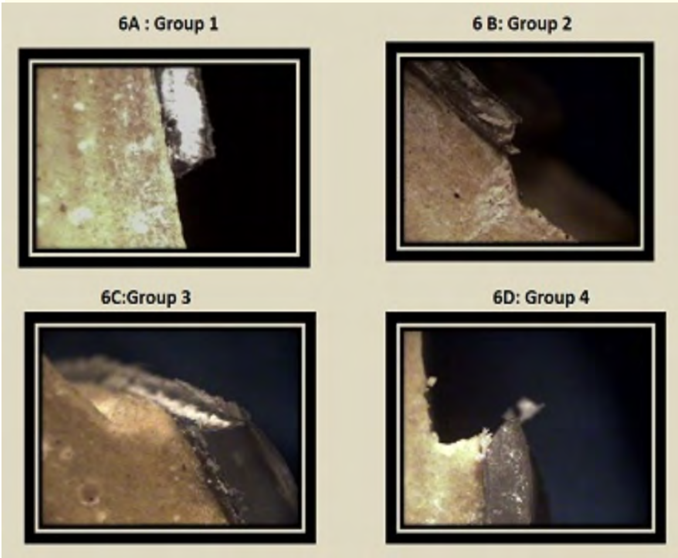

Figure 6

All the obtained data were entered into a personal computer on Microsoft excel sheet and analyzed using the software; Statistical Package for Social Science (SPSS; IBM, USA) version 20. Data comparison was carried out by applying ANOVA test. The statistically significant level was fixed at $P < 0.05$.

Results

The study was conducted to evaluate tissue compressibility at posterior palatal seal area under constant pressure. There were total 30 patients were examined, between the age group of 50 to 70 years. The study was divided into four groups as Group 1(control group), Group2 (pattern resin), Group3 (low fusing compound) and Group 4 (addition silicon putty). The three areas were selected at posterior palatal seal are to evaluate tissue compressibility, as per mentioned into the materials and methods. The mean of the three areas was taken as a final score of tissue compressibility.

Descriptive and One way ANOVA statistics of different groups are summarized in table 1. It has been observed that there was statistically significant difference between the soft tissue compressibility produced by the three materials when compared with the control group p = 0.000 (Table 1 and 2, Graph 1). However, means of pattern resin was close to the control group. Post -hoc multiple boferroni correction values are summarized in table 3. Mean difference was statistically significant (p = 0.000) when group 1 was compared to group 3 (1.111) and group 4 (1.14) than group 2 (0.58). Similarly, mean difference of group 2 when compared with group 3 (0.531) and group4 (0.56) was statically significant (p = 0.000). However mean difference between group 3 and group 4 (0.029) was statically insignificant (p = 2.163).

Group No.	N	Mean	Std. Deviation	Std. Error	95%confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	30	0.816	0.1082	0.019	0.77	0.85	0.66	0.99
2	30	1.103	0.0763	0.013	1.079	1.131	0.66	0.99
3	30	1.433	0.0988	0.018	1.397	1.496	1.26	1.63
4	30	1.962	0.1666	0.030	1.902	2.022	1.73	2.33
Total	120	1.329	0.491	0.044	1.241	1.417	0.66	2.33

Table 1: Descriptive statistics of Various Groups.

	Sum of squares	df	Mean square	F	Sig.
Between Groups	21.772	3	7.2575	527.377	.000
Within Groups	1.596	116	0.014		
Total	23.369	119			

Table 2: ANOVA test for comparison between and within groups.

Group 1 versus 2	0.58	0.0000e+00
Group 1 versus 3	1.111	0.0000e+00
Group 1 versus 4	1.14	0.0000e+00
Group 2 versus 3	0.531	0.0000e+00
Group 2 versus 4	0.56	0.0000e+00
Group 3 versus 4	0.029	2.1636228

Table 3: Multiple comparison of tissue compressibility values within groups using post-hoc Bonferroni test.

Discussion

The success of the complete denture retention depends upon the peripheral seal and posterior palatal seal. Posterior Palatal Seal is distal limit of complete denture and involved by limited amount of soft tissue [6-8]. Posterior palatal seal is unsupported by bone; hence the modulus of elasticity is less compared to rest of palatal muco periosteum [20]. Any longitudinal stress generated by border molding material there will equal amount of strain produces into the tissue. The resultant stress strain ratio between the tissue

Low fusing compound is commonly used material to record the peripheral seal and posterior palatal seal area in routine dental practice. Recently manufacturers of elastomers and pattern resin have suggested to use these materials to record the peripheral as well as posterior palatal seal area. However, these materials were studied and compared with low fusing compound at peripheral seal area (labial and buccal border), no study was conducted at posterior palatal seal area. Hence the study was planned to evaluate tissue compressibility at the posterior palatal seal area a by using pattern resin, low fusing compound and addition silicon putty, under constant pressure.

The study population was selected on the basis of convenience non probability sampling technique, as no previous study was found for estimation of the mean values of the measured variables [24]. The randomized block design was decided to be used while selecting the inclusion criteria for the study, in order to minimize the bias of unwanted variability [25]. Hence class I soft palate was only involved in the inclusion criteria as it has embraced maximum compressible area. The class II and Class III soft palate have limited compressibility area [7-9]. Three areas were selected to evaluate tissue compressibility at posterior palatal seal area, on the basis of maximum and minimum compressibility as proposed by palatal form study [21]. Measurement of the exact extent of soft tissue compressibility cannot be possible by intraoral means hence the final impression without posterior palatal seal was considered as a control group. This group only records the labial and buccal border and no Posterior palatal seal area was recorded by any border molding materials and wash impression was made with zinc oxide and eugnol paste (ZNOE).

It is observed from the result that there was comparison of difference between the groups was highly significant at p = 0,000. This shows that no single test material records tissue compressibility less than control group (group 1). However descriptive analysis of means between groups was observed, it was seen that the least mean difference was observed between the group 1 (pattern resin) and control group. This means that tissue compressibility produces by pattern resin was very nearer to control group. This particular investigation can be concluded on the basis that, pattern resin has effective flow, effective viscosity and adequate toughness even in thinner section. It is easy to manipulate as is available in powder -liquid form with rubber dispenser. The material was mixed as per the manufacturer instructions. and it was easy to adapt at the tray border. Since the material belongs to resin family, it produces excellent bond with custom resin tray. Pattern resin flows actively towards the tissue and records the tissue details in single application. However, heat was generated at the end of the polymerization reaction. The polymerization heat did not create any significant problem as the material have sufficient setting and working time. The tray was kept inside the mouth till the material reach to dough stage by that time tissue manipulation was already elapsed and rest of the polymerization was completed extra orally. Polymerization contraction can be expected by the end of polymerization that can be effect on stability of the material. However, pattern resin has negligible polymerization contraction when compared with other denture base resin [26]. Moreover, the manufacturer of pattern resin (LS 1:1 PKG GC America INC for patterning), have documented that the shrinkage is 0.36%, after 30min and 0.37%, after 24hrs [27]. Due to this valuable property, Pattern resin is recommended material for endodontic core build up and inlay wax pattern [28]. Border morphology study between the Pattern resin, silicon putty and low fusing compound shows that pattern resin have recorded better border morphology than low fusing compound and silicon putty [19]. pattern resin is economical material when compared the ratio of total cost and cost of per border moulding as the very less material required to complete the border moulding.

Means of low fusing compound and putty addition silicon were recorded higher than control group and pattern resin. However, the mean difference between low fusing compound and putty addition silicon was statistically insignificant (p = 2.163). This mean both materials produce higher tissue compressibility and means of putty addition silicon was marginally higher than low fusing compound.

Low fusing compound is thermoplastic material; hence the flow is depending upon tempering of the material into hot water bath. It rigid quickly from room temperature to mouth temperature [16,19]. The material doesn't have effective flow and viscosity that further complicated by less tissue manipulation time. Hence Clinician not only have to apply extra stress while tissue manipulation, but the patient is not cooperative as the whole clinical step is tiring and heat involve in tissue manipulation [19].

Putty addition silicon shows highest mean for tissue compressibility. The compressibility value of putty is almost closest to upper limit of suggested palatal compressibility values [20]. This observation may be due to that Putty is highly filled, and bulk material [29]. It has high viscosity and limited flow that particularly useful to make putty- light bodied wash impression material for fixed partial denture [30]. However similar properties were adversely affected while recording the tissue at posterior palatal seal area as it not only overstresses the tissue, but it produces thicker edge at the posterior palatal seal area. Several authors have recommended that Putty can be a useful alternative to low fusing compound as a border molding material. Putty records the border in single step, easy to manipulate, reduce chair time, good tear strength and accurate reproduction of undercut areas [14-16]. However, comparative border molding study by qanungo A. shows that putty records inferior retention value than low fusing compound [31,32]. Border morphology study by Patel JR, suggested that putty produces extremely thick border, and this is unacceptable for clinical use [19].

Finding of the results of the study suggested that, not a single test material shows better tissue compressibility than control group. However, pattern resin has recorded better posterior palatal seal with minimum tissue compressibility that is closet to control group. Pattern resin have effective flow, effective viscosity and toughness, that records the tissue details more precisely and better dissipation of lateral stress. Low fusing compound have recorded maximum value of compressibility than pattern resin and control group. It has limited flow, heat involves while tissue manipulation and less working time. Putty have recorded highest value of tissue compressibility and not advisable material to record posterior palatal seal as it has high viscosity and limited flow, that produces not only adverse tissue compressibility but thicker edge at posterior palatal seal area. Further study is needed to evaluate the stress -strain relationship between the specific material properties and soft tissue compressibility at posterior palatal seal area.

Conclusion

Within limitation of this study pattern resin shows lowest tissue compressibility followed by low fusing compound at the posterior palatal seal area. Putty addition silicon gives highest tissue compressibility value and may not be advisable as suitable material to record posterior palatal seal area.

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