

Comparative Evaluation of the Border Morphology Produced by Three Different Border Molding Materials: An In-vivo Study

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ABSTRACT

Introduction: Different materials and technique exist to record the functional and physiologic border of the denture. There is a need to determine which among the various materials available would accurately record the borders width and height as compared to tissue conditioner.

Aim: To compare and evaluate the morphology of the denture borders produced by three different commercially available border molding materials.

Materials and Methods: This in-vivo study was conducted at KAHER's KLE VK Institute of Dental Science, Belagavi, Karnataka, India, from November 2012 to June 2013. The study included 20 patients with previous dentures. The labial flange of 20 patients with the existing maxillary denture was trimmed 2 mm short of the sulcus and border molding was done with tissue conditioner. The patients were instructed to perform routine activity with the denture and asked to report after first day. Three custom trays were fabricated without spacer, 2 mm short of the labial border. Border molding was carried out with low fusing compound, putty

addition silicone and pattern resin. The trays were beaded at 2 mm from the depth of the vestibule and were poured with die stone. Casts were obtained and with the standardised method, the cast were sectioned into six sections. Border morphology of the sulcus was viewed under stereomicroscope and under image analyser. The statistical analysis carried out was using Statistical Package for the Social Sciences (SPSS) software version 19.0 Inc. Chicago, IL, USA. The level of significance was 95% confidence with p-value <0.05 was considered. Analysis of Variance (ANOVA) test and Bonferroni multiple posts-hoc test was used to analyse the data.

Results: The descriptive analysis showed that the mean area of tissue conditioner (111590.95 μm^2) was least, next being pattern resin (131253.30 μm^2) followed by Low fusing impression compound (154854.20 μm^2) and addition silicone (190968.55 μm^2) (p-value <0.001).

Conclusion: The result of the study showed that tissue conditioner was the best material that could be used for border molding followed by pattern resin and low fusing compound.

Keywords: Pattern resin, Resin, Sulcus, Tissue conditioner

INTRODUCTION

Complete denture Prosthodontics can be a technically demanding endeavor for any practitioner [1]. A successful complete denture fabrication begins with the assessment of the patient's mental, physical and psychological condition which helps us to determine a complete treatment that will deliver a functional complete denture which will satisfy the expectations of the patient at large [2]. The final impression is one of the critical steps in the fabrication of complete denture. The objective of complete dentures impression is to accurately record the entire denture bearing area to produce a stable and retentive prosthesis while maintaining patient comfort, aesthetics and preservation of remaining tissues.

One of the most demanding and time consuming steps of final impression is the border molding that establishes the impression borders to assure optimal extensions for the final prosthesis [1]. Proper peripheral extension and recording of tissue detail in the final impression are indispensable to success of a complete denture. It should simulate the finished and polished denture base [2]. Different materials that exist to record the functional and physiologic border of the denture include low fusing impression compound, waxes, elastomeric materials, acrylic resin and tissue conditioners [3].

To record the most functional and physiologic borders, a material with high flow rate for an extended period of time is needed. However, among the materials available, only tissue conditioners exhibit this property. But the use of tissue conditioner needs a denture base or an old denture, which is not always available or practically possible in every patient. Therefore, there exists a need to determine which of the available border molding material would be most close to

accurate recording of border width and height as compared to tissue conditioners [4].

The aim of the present study was to evaluate the morphology of the borders of the complete denture produced by three different commercially available border molding materials.

MATERIALS AND METHODS

The present in-vivo study was conducted at the Department of Prosthodontics, Crown and Bridge at KAHER's KLE VK Institute of Dental Science, Belagavi, Karnataka, India, from November 2012 to June 2013. The study was carried out over a period of six months. Informed consent was obtained from the patients.

Inclusion and Exclusion criteria: A total of 20 patients within the age group of 50-70 years with old dentures and with firm, well-formed maxillary edentulous ridge and with minimal labial undercut were included in the study. Patient with severe maxillary undercuts, flabby tissues in the maxillary anterior region, severe ridge resorption were excluded from the study.

Study Procedure

The labial flange of 20 patients with the existing maxillary denture was trimmed 2 mm short of the sulcus and border molding was done with tissue conditioner (Coe Comfort GC America) [Table/ Fig-1]. The patients were instructed to perform routine activity with the denture and asked to report after first day. Three custom trays were fabricated without spacer, 2 mm short of the labial border.

Primary impression of the maxillary anterior edentulous residual alveolar ridge was made with alginate (Zhermack Tropicalgin) in

perforated stock tray and was poured with dental plaster (Kalabhai Kaldent). Three custom trays were fabricated on retrieved cast with self-cure acrylic resin (DPI RR cold cure Lab pack) without spacer. The trays were trimmed 2 mm short from the depth of the labial sulcus. Border molding was carried out with three different materials namely low fusing impression compound (DPI PINNACLE tracing Sticks), Putty Addition silicone (Dentsply Aquasil) and Pattern resin (GC America). After the material hardened, the border molded tray was removed, washed, inspected and disinfected (using 2% glutaraldehyde (Cidex) [Table/Fig-2]).



[Table/Fig-1]: Functionally molded denture flange with tissue conditioner.

[Table/Fig-2]: Border molding done with three materials (Low fusing compound, pattern resin and putty addition silicone). (Images from left to right)

On the border molded tray points were marked, 2 mm below highest point of the border along the periphery with the help of metal scale and permanent ink and all those points were joined to form a line. They were beaded along the line to achieve 2 mm uniform border. Petroleum jelly was applied all over the inner surface of the tray except the border molded area and poured with die stone. The casts were retrieved from the tray and denture, trimmed and they were numbered and labeled according to the material used. A thermoplastic vacuum formed sheet was adapted on the cast (tissue conditioner). A string was adapted on the cast and was marked at equal intervals [Table/Fig-3].



[Table/Fig-3]: A string was adapted on the cast and marked at equal intervals.

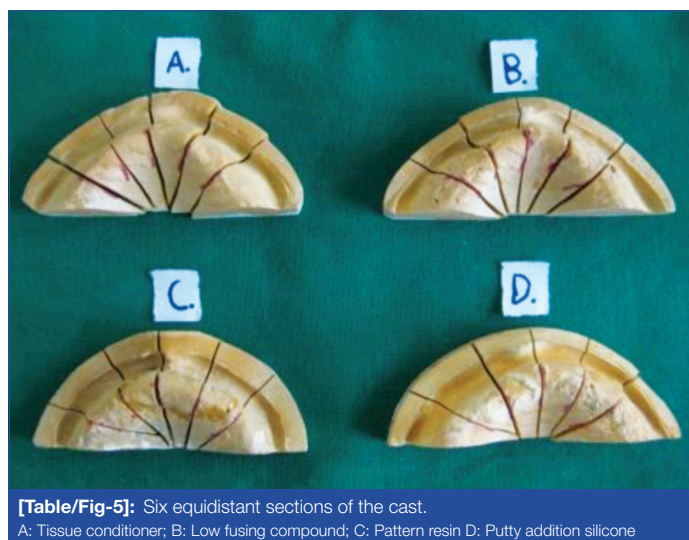
Vacuum formed template was placed on the top of it, markings were transferred, and holes were made. Markings were transferred on the cast from the holes with the help of a permanent marker. This template with holes at equal interval was used on other casts. After placing the template on the other cast, the marks were then transferred using the holes on the template [Table/Fig-4]. The lines were drawn on the cast by joining the two points.

The casts were then sectioned along these lines with the help of die cutting machine to obtain six equidistant sections which were numbered from 1-6 (1-extreme right section, 6-extreme left section) [Table/Fig-5].

Border morphology of the sulcus of each section was viewed and photomicrographs of these were taken with camera under a stereomicroscope with a magnification of 10x and zoom of x1 [Table/Fig-6-9]. The area (μm^2) was measured on an image analyser (LEICA). The average measurement of total area for all the six sections was taken as the final measurement for that material in those patients.



[Table/Fig-4]: Marks transferred on the cast.



[Table/Fig-5]: Six equidistant sections of the cast.

A: Tissue conditioner; B: Low fusing compound; C: Pattern resin D: Putty addition silicone

STATISTICAL ANALYSIS

Data collected was tabulated and subjected to statistical analysis. The statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) software version 19.0 Inc. Chicago, IL, United States of America. The level of significance was 95% confidence with p-value <0.05 was considered.

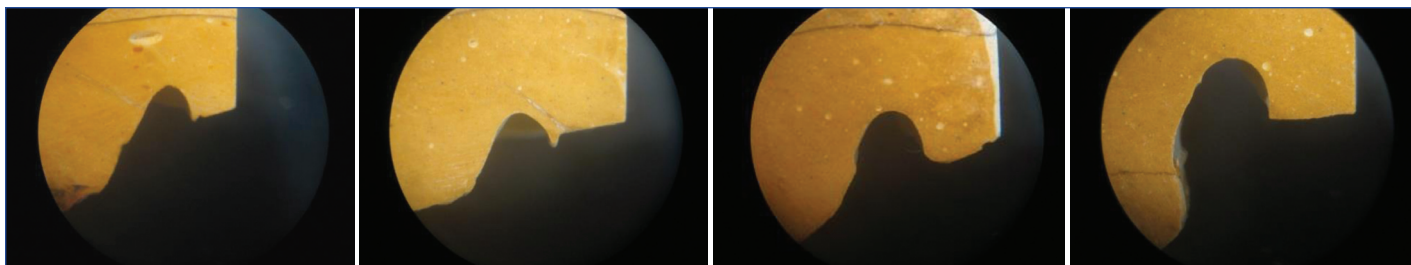
RESULTS

The descriptive analysis of all the four border molding materials used for this study showed that the mean of tissue conditioner ($111590.95 \mu\text{m}^2$) which was the control group was least, next being pattern resin ($131253.30 \mu\text{m}^2$) followed by low fusing impression compound ($154854.20 \mu\text{m}^2$) and maximum of putty consistency addition silicone ($190968.55 \mu\text{m}^2$). The result showed no demographic findings [Table/Fig-10]. One-way ANOVA was applied for comparison in between and within the groups [Table/Fig-11,12].

DISCUSSION

A complete denture must be closely adapted to the structures on which it rests, and it should intimately adapt to the cheeks, tongue and lips with which it is in constant contact therefore its fabrication till date remains one of the most technically challenging procedure in removable prosthodontics. Muscle trimming ends at a point where the border tissues rest firmly, but lightly, against the denture periphery when those border tissues are in extreme function [5]. The present study was undertaken to compare and evaluate the different materials used for border molding.

Many materials are used for the purpose of border molding but the commonly used materials are low fusing impression compound, autopolymerising acrylic resin, elastomeric materials and impression waxes [3]. Although, few other materials like PerioPack, light polymerised resin, waxes etc have also been used in the past for border molding, but literature suggests its very less clinical significance [3,6-8].



[Table/Fig-6]: Cross-section of the sulcus morphology using tissue conditioner. [Table/Fig-7]: Stereomicroscopic cross-section of sulcus morphology using pattern resin. [Table/Fig-8]: Stereomicroscopic cross-section of sulcus morphology using low fusing compound. [Table/Fig-9]: Stereomicroscopic cross-section of sulcus morphology using addition silicone. (Images from left to right)

Border molding materials	N	Mean (µm²)	Standard deviation (µm²)	Standard error (µm²)	95% Confidence interval for mean		Minimum (µm²)	Maximum (µm²)
					Lower bound	Upper bound		
Tissue conditioner	20	111590.95	13996.371	3129.684	105040.45	118141.45	93594	158178
Pattern resin	20	131253.30	11330.691	2533.620	125950.37	136556.23	112255	149987
Low fusing compound	20	154854.20	14493.196	3240.777	148071.18	161637.22	132339	185948
Addition silicone	20	190968.55	62980.479	14082.863	161492.78	220444.32	91315	310448
Total	80	147166.75	44358.729	4959.457	137295.20	157038.30	91315	310448

[Table/Fig-10]: Descriptive analysis surface area was measured in µm² for tissue conditioner, pattern resin, low fusing compound and addition silicone.

Variables	Sum of squares	df	Mean square	F-value	p-value
Between groups	6.993E ¹⁰	3	2.331E ¹⁰	20.716	<0.001
Within groups	8.552E ¹⁰	76	1.125E ⁹	-	-
Total	1.554E ¹¹	79	-	-	-

[Table/Fig-11]: Comparison of four materials by one-way ANOVA test.

practitioners, dental students and academicians as suggested by Solomon EGR [11]. It is very advantageous because of its ability to soften easily and quick hard at mouth temperatures. Hence, incremental technique can be followed for border molding and corrections and additions are easily accomplished as suggested by Bernard Levin CD [3].

Material	Material compared	Mean difference (I-J)	Standard error	p-value	95% Confidence interval	
					Lower bound	Upper bound
Tissue conditioner	Pattern resin	-19662.350	10607.635	0.406	-48399.18	9074.48
	Low fusing compound	-43263.250	10607.635	0.001	-72000.08	-14526.42
	Addition silicone	-79377.600	10607.635	<0.0001	-108114.43	-50640.77
Pattern resin	Tissue conditioner	19662.350	10607.635	0.406	-9074.48	48399.18
	Low fusing compound	-23600.900	10607.635	0.174	-52337.73	5135.93
	Addition silicone	-59715.250	10607.635	<0.0001	-88452.08	-30978.42
Low fusing compound	Tissue conditioner	43263.250	10607.635	0.001	14526.42	72000.08
	Pattern resin	23600.900	10607.635	0.174	-5135.93	52337.73
	Addition silicone	-36114.350	10607.635	0.006	-64851.18	-7377.52
Addition silicone	Tissue conditioner	79377.600	10607.635	<0.0001	50640.77	108114.43
	Pattern resin	59715.250	10607.635	<0.0001	30978.42	88452.08
	Low fusing compound	36114.350	10607.635	0.006	7377.52	64851.18

[Table/Fig-12]: Multiple comparisons Bonferroni post-hoc test.

In the present study, four materials i.e. tissue conditioner, pattern resin, addition silicone (Putty consistency) and low fusing impression compound were used. Border molding material should reproduce an accurate record of the shape of the supporting soft tissues while they are loaded under clinical conditions [9]. One of the materials fulfilling the above mentioned criteria is tissue conditioner hence it was used as the control group in the study. The flow of tissue conditioner is continuous under pressure and at a rate inversely proportional to time, making it stiffer but resilient [10]. So, the patient was asked to perform her/his regular activities and report after one day [9]. Since, the functional and parafunctional forces exerted upon the supporting tissues vary in magnitude and direction, the final shape registered by the functional impression material is a “composite” or “modal” form. Dynamic flow in the material is necessary in the early stages of the impression process to allow the material to adapt closely to the supporting tissues.

One of the most commonly used material for border molding i.e., low fusing impression compound was also included in the study which has been mostly widely used material of choice for many

Apart from low fusing impression compound, elastomeric impression material i.e., putty consistency addition silicone (putty) was also included in this study. The elastomeric impression material have advantages like high degree of accuracy, dimensional stability, ease of manipulation and decrease in chair-side time, hence was included in the study [12]. In the recent past, various resin materials have been introduced for the purpose of border molding. One among them is pattern resin but very few literatures suggests it as a border molding material due to its low polymerisation shrinkage, favourable flow, unlimited dimensional stability, short setting time and high strength, it was included in the study [4, 13].

In the present study, the border morphology of the sulcus was viewed under stereomicroscope and in image analyser depth was measured from the horizontal projection of the ledge of the ridge specimen to lowest point of labial sulcus. Woelfel JB et al., conducted a study where the contour variation was checked in one patient’s impressions made by seven dentists [14]. In their study, a Leitz tool maker’s microscope was used. This microscope was used to make vertical measurements on the casts or impressions [14]. By this method only contour variation can be checked. In the present study, LEICA image

analyser was used to determine the contour along with surface area of each of the material to give more appropriate results.

In the present study, the total surface area was measured using LEICA image analyser. The surface area was measured as a cumulative average of the six sections for that material in that specific patient. Surface area was measured in micrometer square. Obtained data was collected and tabulated which was then subjected to statistical analysis.

The descriptive analysis of all the four border molding materials used for this study showed that the mean of tissue conditioner which was the control group was least, next being pattern resin followed by low fusing impression compound and maximum of putty consistency addition silicone. There was a significant difference among the groups. Further comparison within the groups was done by Bonferroni multiple post-hoc tests and six different results were obtained which showed statistically significant difference between groups, whereas, the rest of the groups showed no statistical significant difference.

The basic difference between using different border molding material is in the different working viscosities. The results which the present study concluded could be due to the fact that pattern resin has optimum working properties and better flow characteristics which help in recording the borders accurately. One of the disadvantages of pattern resin for using it intraorally as border molding material is the exothermic reaction during polymerisation of the material. However, this heat release does not interfere in the border molding procedure as the functional movement was already done by the time the material starts setting [4].

The next appropriate material was low fusing impression compound. But, vigorous molding movements should be performed within a short working time due to the viscous nature and the thermal plasticity of the material [11]. Though, the procedure can be repeated if desired, it is doubtful whether the material will give a homogenous consistency. Addition silicone (putty) showed the maximum surface area. This could be due to the fact of its high filler content making it highly viscous. Literature suggests its use for a single step border molding procedure because of its homogeneity and consistency but it affects the aesthetics and retention in the permanent denture base as it produces extremely thick borders [11]. Previous studies have also shown that sectional border molding technique was found

to be more retentive in comparison with single step border molding [15,16]. However, both offered satisfactory retention clinically.

Limitation(s)

The patient compliance and repeated appointments were the limitations of the study, although the limitations did not alter the results of the study.

CONCLUSION(S)

Tissue conditioner, would be the most preferred material for recording the border morphology under functional moulding followed by pattern resin, low fusing impression compound and putty consistency addition silicone.

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