

Comparison and Evaluation of Effectiveness of Different Border Molding and Final Impression Materials on the Retention of Heat Cure Maxillary Denture Bases (An *In vivo* Study)

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Abstract

Background: This study aims to compare and evaluate the effectiveness of different border molding and final impression materials on the retention of heat cure maxillary denture bases. **Materials and Methods:** Fifteen completely edentulous subjects including male and female were used in the study with in the age range of 40–65 years of age. A total number of 45 samples were collected and divided into three groups (A, B, and C), consisting of 15 samples each. Border molding with three different materials was performed with low fusing impression compound, polyvinyl siloxane, and combination of above two. Effectiveness of above three border molding materials was evaluated by score criteria. Heat cure trial denture bases were fabricated after the wash impression with zinc oxide eugenol in Group A and light body in Groups B and C, respectively, were taken. Master casts were poured on which heat cure trial denture base and retention was measured with the help of force meter spring dynamometer after placing a loop in the maxillary record bases was fabricated. **Result:** Statistical analysis was conducted using Kruskal–Wallis test, ANOVA and Tukey's *post hoc* analysis. There was a statistically significant difference between the three groups ($P < 0.05$) and Group B showed the highest effectiveness and retentive values. **Conclusion:** Comparing the three different materials, polyvinyl siloxane (Putty) showed the highest efficiency in terms of score criteria. Heat cure trial denture bases produced by Group B showed the highest mean retentive values followed by Group C and Group A.

Keywords: Border molding, Putty, Retention, force meter.

INTRODUCTION

Complete denture prosthesis is one of the important dental services rendered to edentulous patients worldwide. Since teeth loss leads to impairment and disability, restoration of teeth leads to improvement in the quality of life of an individual. The acceptable function of a complete denture to a great extent depends on impression techniques, which includes the maximum coverage of denture supporting areas and management of peripheral movable soft tissues along with different materials and techniques for accurate reproduction of the oral foundation.^[1]

One of the goals of a prosthodontist in the construction of complete denture is retention.^[1] According to Glossary of Prosthodontic Terms 9, retention is defined as “that quality inherent in the dental prosthesis acting to resist the forces of dislodgment along the path of placement.”^[2] A non-retentive denture leads to loss of speech and mastication which, in turn, affects a patient's psychology.^[1] An ideal complete denture should be retentive, stable, provide adequate support, and be

esthetically pleasing.^[3] In complete denture prosthodontics, the impression plays a key role in the success of a complete denture. The final impression procedure for a complete denture entails capturing the vestibule through border molding procedures and then making an impression of the edentulous arch.^[4]

Ideally, the material used for border molding, when it is in a plastic state should contact the entire vestibular sulcus area at one insertion. A material which will allow simultaneous molding of all borders has two general advantages, first, the number of insertions of the trays for border molding

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could be reduced, and second, development of all borders simultaneously avoids propagation of errors caused by mistakes in one section affecting the border contours in another section.^[5] Incremental border molding using low fusing compound does not meet this prerequisite. According to Woelfel *et al.*, seven dentists required an average of 17 insertions to secure a final maxillary impression on the same patient while using low fusing impression compound.^[6]

These limitations led to the use of elastomers for complete denture impressions with a high degree of accuracy, dimensional stability, ease of manipulation, and adequate working and setting times. The use of polysulfide, polyether, or vinyl polysiloxane putty impression materials for custom tray border molding has been described and their use has proven much promising results required for ideal border molding.^[5] Metallic oxide (zinc oxide eugenol) was the most commonly used material for wash impression (final impression). However, some limitations like irritation to the oral tissues due to eugenol and brittle nature causing breakage on removal, especially from the undercut areas, led to the introduction of polyvinyl siloxane as a suitable impression material for use as a final or wash impression material, as it records the undercut areas accurately without distortion.

The purpose of this study is to evaluate the effectiveness of different border molding materials based on score criteria method and to evaluate and compare retention of heat cure maxillary trial denture bases made by different border molding and wash impression materials, that is, low fusing compound and zinc oxide eugenol as wash impression, putty polyvinyl siloxane, and light body as wash impression and combination of two materials (low fusing impression compound labial flanges and putty polyvinyl siloxane buccal flanges and posterior palatal seal area) and light body as a final impression material.

MATERIAL AND METHODS

This study was conducted in the Department of Prosthodontics and Crown and Bridge, Career Post Graduate Institute of Dental Sciences and Hospital, Ghaila, Lucknow. The study involved 15 completely edentulous subjects including male and female. All the subjects were included within the range of 40–65 years of age. Patients were included, if they had high well-rounded maxillary alveolar ridges with no ulceration or severe undercuts; non-diabetic and non-hypertensive patients; no bony exostosis, firm mucosa all over the denture-bearing area with no signs of inflammation, ulceration, or hyperplasia; average, quality, and consistency of saliva; and normal temporomandibular joint function.

For each subject, border molding was done thrice with three different materials (low fusing impression compound/greenstick, polyvinyl siloxane (putty), and combination of the two materials) followed by final/wash impression with two different materials (zinc oxide eugenol paste and light body). For each subject, border molding using the three

different materials was carried out at a gap of 48 h between two successive materials. A total number of 45 samples were collected and were divided into three groups – Group A, Group B, and Group C with equal number of samples (15 samples each).

- Group A: Border molding with low fusing impression compound (greenstick) and final impression with zinc oxide eugenol
- Group B: Border molding with polyvinyl siloxane (putty) and wash impression with light body
- Group C: Border molding with combination, that is, with greenstick (labial flanges) and putty polyvinyl siloxane impression material buccal flanges and posterior palatal seal area (PPS) and wash impression by light body.

Methodology

Making primary impressions

Primary impressions of maxillary edentulous ridges were made with impression compound using edentulous non-perforated stock tray and the casts were poured in dental plaster (type II). After retrieval of the primary cast, three custom trays (1, 2, and 3) were fabricated with auto-polymerizing acrylic resin for Groups A, B, and C, respectively.

Border molding with low fusing impression compound (greenstick) and wash impression with zinc oxide eugenol (Group A)

The sectional/incremental method was used for border molding with low fusing compound (greenstick) using first custom tray. The finished border molding was checked and final impression was made using zinc oxide eugenol paste.

Border molding with heavy-bodied addition silicone (putty) impression material and wash impression with light body (Group B)

The single-stage/simultaneous border molding was done with heavy-bodied addition silicone (putty) using second custom tray of the same subject. The finished border molding was checked and final impression was made using light body polyvinyl siloxane.

Border molding with greenstick (labial flanges) and putty polyvinyl siloxane material (buccal flanges and posterior palatal seal area) and wash impression by light body (Group C)

The third custom tray was border molded sectionally, the labial flanges were molded using the greenstick compound while the buccal flanges and posterior palatal seal were border molded using putty polyvinyl siloxane impression material. The finished border molding was checked and final impression was made using light body silicone.

Fabrication of master cast

All final impressions taken by above three methods were beaded and boxed and poured in type III dental stone to fabricate master casts.

Fabrication of heat cure denture bases

Maxillary heat cure trial denture bases were fabricated and a 19 gauge wire loop was attached in the center of the palatal vault [Figure 1].

Measurements

Evaluation of the efficiency of the materials based on the score criteria after the completion of border molding

The score criteria method was used for measuring the efficiency of different materials after completion of border molding. In this method, two experienced prosthodontics evaluated the border molding based on the aforementioned criteria. Each criterion was scored on a scale of 1–5, with score 1 as bad while score 5 was considered excellent. The average of the score recorded by the two examiners for each criterion was considered. Criteria for evaluation included tissue contact, bond to the tray, and overall peripheral seal.

Measurement of retention with the help of force meter spring dynamometer on maxillary heat cure trial denture bases

Newton meter (force meter spring dynamometer) was used to measure retention values of the heat cure trial denture bases. The patient was made to stand upright with the head position standardized with the help of a cephalostat such that the maxilla was parallel to the floor and force was directed perpendicularly to evaluate the retention. Force meter spring dynamometer is a spring-loaded device that was engaged onto the loop of the polymerized denture base and force was applied by pulling it downward while being held in the palm of the operator. The retention of the denture base was determined by the force value that is displayed on the force meter at the moment the denture base gets dislodged. Three readings were taken for each heat cure trial denture base and an average was calculated. The data were tabulated and statistically analyzed to evaluate the difference in retention of the denture bases [Figure 2].

RESULTS

The primary objectives of the study were to evaluate the effectiveness of different border molding materials (low fusing impression compound, polyvinyl siloxane, and combination of the two) based on score criteria and to evaluate and compare the retention of maxillary heat cure trial denture bases made by different materials for determining which technique gives maximum retention, by force meter spring dynamometer.

Comparison of tissue contact, bond to tray, and overall peripheral seal after completion of border molding by Kruskal–Wallis test for three different materials on the basis of score criteria method [Graph 1]

Statistically, there was a highly significant $P < 0.001$ difference among the three groups. The putty group showed maximum overall peripheral seal followed by combination group and finally the greenstick group as seen from the mean values.

Homogeneous subsets following Tukey *post hoc* analysis showing the three materials used for border molding and wash impression and their order with relation to force meter readings for retention of maxillary denture base [Table 1]

Table 1 shows the three different materials used for border molding in three different subsets 1, 2, and 3 indicating their statistically significant difference from one another. The table shows that putty has the best retention among the three followed by combination material and finally low fusing compound (greenstick) when used for border molding.

DISCUSSION

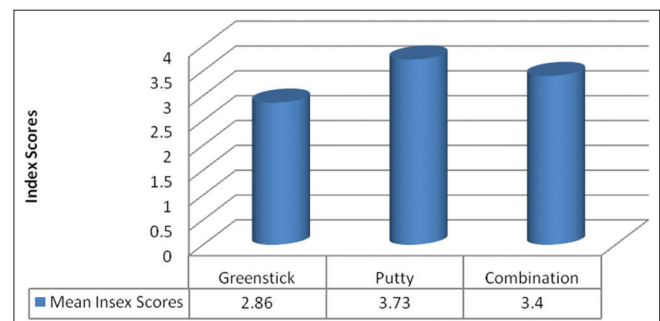
In the score criteria method, each criterion was scored on a scale of 1–5, with score 1 as bad while score 5 was considered excellent. The average of the score recorded by



Figure 1: Heat cure maxillary trial denture bases with wire loop



Figure 2: Measurement of retention with the help of force meter spring dynamometer



Graph 1: Mean index scores

Table 1: Homogeneous subsets following Tukey *post hoc* analysis showing the three materials used for border molding and wash impression and their order with relation to force meter readings for retention of maxillary denture base

Material for border molding and wash impression	n	Subset for alpha=0.05		
		1	2	3
Group A	15	5.8667		
Group C	15		7.6000	
Group B	15			8.8667

Means for groups in homogenous subsets are displayed. Uses harmonic mean sample size=15

the two examiners for each criterion was considered. Criteria for evaluation included tissue contact, bond to the tray, and overall peripheral seal. Based on the criteria of tissue contact, effectiveness of the three materials after completion of border molding was evaluated by Kruskal–Wallis test. No statistically significant difference in the tissue contact among the three groups was found with the mean values of 2.60 (low fusing compound), 2.80 (putty), and 2.53 (combination). Similarly, based on the criteria of bond to tray with the mean values of 2.4 (low fusing compound), 3.6 (putty), and 3.13 (combination) and overall peripheral seal with the mean values of 2.86 (low fusing compound), 3.73 (putty), and 3.40 (combination), effectiveness of the three materials after completion of border molding was evaluated by Kruskal–Wallis test. Statistically, there was a highly significant $P < 0.001$ difference in the bond to tray and overall peripheral seal among the three groups. The putty group showed maximum bond to tray and overall peripheral seal followed by combination group and finally the greenstick group.

After the score criteria evaluation, it was concluded that low fusing impression compound (greenstick) had the lowest efficiency as it is highly viscous when softened and it retains flow for a short time once displaced. In case of delay in seating the tray, the compound cools and flow ceases resulting in inaccurate molding. Its use to a large extent is dependent on the operator. Heavy-bodied elastomeric material – polyvinyl siloxane (Putty) had the best efficiency among the three as it has ease of manipulation, good initial flow, sets rigid, and has good working time required for simultaneous border molding. Kheur *et al.*^[6] conducted an *in vivo* study on comparative evaluation of three different techniques for single-step border molding and found that the heavy body elastomeric material – polyvinyl siloxane material proved to be most efficient among low fusing, modified zinc oxide eugenol impression paste for the purpose of border molding which is in accordance with the present study. In contrast to the current study, Qanungo *et al.*^[5] found that the sectional technique (greenstick with light body wash impression) was more retentive than the single-step border molding technique (polyether with light body was impression). This discrepancy may be attributed to the nature of the impression material used, age, and studied population.

In the current *in vivo* study, retention of heat cure denture bases was also evaluated/measured with the help of force meter after taking the wash impression. The mean retentive value of the Group 1 (greenstick/zinc oxide eugenol) was found to be 5.86, for Group 2 (putty/light body), it was 8.86, and for Group 3 (combination), it was 7.60. Therefore, in the present study, Group 2 showed the maximum retentive mean value. In accordance with the present study, Pachar *et al.*^[7] conducted a study and found mean retentive value of greenstick compound as 4.59 kgf. Gupta *et al.*^[8] did a study to compare the retention of complete dentures made using two different border molding materials and border molding techniques, that is, greenstick with incremental technique and heavy-bodied PVS with simultaneous technique. Mean retentive value of greenstick compound in their study was found as 1.497 kgf and for putty and light body, polyvinyl siloxane was 1.946 kgf. Hence, the putty and light body showed the higher mean value. However, in the current study, a significantly higher retentive value of 5.86 kgf was found. The differences in the results may be due to the difference in the methodologies, as they used denture bases made up of autopolymerizing resin.

According to the study conducted by Al-Judy *et al.*,^[1] on comparison of the effect of sectional border molding using different molding and final impression materials on the retention of maxillary complete denture bases, it was found that retention with denture bases obtained from full putty silicone border molding combined with the light body silicone was higher, then followed by denture bases which were fabricated from anterior greenstick tracing and posterior putty silicone border molding with light body silicone and metallic oxide final impression material. This is in congruence with the present study.

Furthermore, Rizk *et al.*^[9] also compared the retention of complete dentures made using different border molding materials where greenstick compound, medium, and putty rubber base were used. Their results also show that there was a statistically significant difference in retention among the three materials wherein putty and light body rubber base showed the highest mean value of retention followed by medium body and light body rubber base, while greenstick compound showed the lowest mean value. These findings are similar to the findings in the present study.

According to Jassim *et al.*,^[10] addition vinyl silicone material together with light body impression material and the single-step technique resulted in superior retention in the acrylic denture base over the denture base formed with the use of greenstick and zinc oxide eugenol as the final impression material using sectional technique, which is in accordance with the current study.

In contrast to the present study, Yarapatineni *et al.*^[11] conducted an *in vivo* study of border molding using two different techniques in maxillary edentulous arches and found that the effect of retention of dentures is not overwhelmingly influenced by techniques followed and the materials used. Jone *et al.*^[3] reviewed and compared the clinical outcomes of border

molding using greenstick compound, putty-type addition silicone, and mouth temperature wax followed by light body wash impression. It was concluded that border molding using greenstick compound and putty-type silicone exhibited similar clinical retention, which is in disparity to the current study.

Hence, in tandem to the above studies, polyvinyl siloxane material (putty) together with light body wash impression material resulted in superior retention in the heat cure acrylic denture base followed by combination (anterior greenstick and posterior putty-based polyvinyl siloxane material together with light body wash impression) and least for low fusing impression compound (greenstick) using zinc oxide eugenol as wash impression.

CONCLUSION

Within the limitations of this study, it was concluded that polyvinyl siloxane material (putty) had the best efficiency (in terms of bond to tray, tissue contact, and overall peripheral seal), among the three materials used in the study for tracing/ border molding. Polyvinyl siloxane (putty) can be manipulated easily, has good initial flow, sets rigid, and has good working time for simultaneous border molding. Heat cure maxillary trial denture bases produced by tracing with full putty silicone and final impression with light body silicone impression material (Group B) showed the highest mean values of retention, followed by combination of greenstick (anteriorly/labial flange) and putty (posteriorly/buccal flange and posterior palatal seal area) and wash impression with light body (Group C) when measured with the help of force meter spring dynamometer.

Heat cure maxillary trial denture bases produced by tracing with greenstick and using zinc oxide eugenol as final

impression material (Group A) showed the lowest mean values of retention forces. On clinical examination, all the heat cure trial denture bases showed an acceptable retention.

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