

# An In-Vivo Study To Compare The Effect Of Different Border Molding Techniques On Retention Of Heat Cure Complete Denture Bases Fabricated Using Various Border Molding Materials

<sup>1</sup>Dr. Ijaz Ahmad Bhat, <sup>2</sup>Dr. Archana Nagpal, <sup>3</sup>Dr. Furkan Ahmad Khan, <sup>4</sup>Dr. Archana Jalheria, <sup>5</sup>Dr. Atul Arunrao Sanap, <sup>6</sup>Dr. Nikita Mehta

<sup>1</sup>Senior Lecturer, Department of Prosthodontics, Surendera Dental College & Research Institute, Sri Ganganagar, Rajasthan, India

<sup>2</sup>Professor & Head, Department of Prosthodontics, Himachal Dental College, Sunder Nagar, Himachal Pradesh, India

<sup>3</sup>Senior Lecturer, Department of Prosthodontics, Sri Aurobindo College of Dentistry, Indore, Madhya Pradesh, India

<sup>4</sup>MDS, Consultant Prosthodontist, Smile Dental Care, Ahmedabad, Gujarat, India

<sup>5</sup>Senior Lecturer, Aditya Dental College, Beed, Maharashtra, India

<sup>6</sup>MDS, Consultant Prosthodontist, Mehta Clinic, Solapur, Maharashtra, India

**Corresponding Author:** Dr. Ijaz Ahmad Bhat (E-mail Id: [drijazbhat11@gmail.com](mailto:drijazbhat11@gmail.com))

## Abstract

**Aim:** The aim of this study was to compare the retention of heat cure complete denture bases made by using three different border moulding materials.

**Method:** The present study was conducted to compare the retentive quality of maxillary heat cure denture bases fabricated using three different border molding materials and two border moulding techniques. The study was carried out on 20 edentulous patients with well formed, rounded edentulous maxillary arch with adequate width and height. On each patient, border moldings were done, with Sectional border molding technique using green stick compound and Single step border molding technique using heavy body addition silicone and polyether. According to the border molding materials and techniques used, the sample were categorized into three different groups Low fusing impression compound (Group A), heavy body addition silicone (Group B) and polyether (Group C). In all three groups, secondary impressions were made using light body addition silicone followed by fabrication of maxillary heat cure denture bases. The retention of each denture base was checked using a digital force gauge.

Statistical analysis used: Analysis of variance (ANOVA) with least significant difference (LSD) test was employed.

**Results:** A P value of less than 0.05 was considered statistically significant. Highest retention was obtained with (Group C) Single step border molding technique using polyether material. (mean  $42.6 \pm 4.01$ ), intermediate retention value was obtained with (Group B) Single step border molding technique using heavy body addition silicone material (mean  $39.3 \pm 5.19$ ) and least retention was obtained for (Group A) sectional border molding technique using low fusing impression compound (mean  $34.5 \pm 6.00$ ).

**Conclusions:** Based on the study it is concluded that the polyether (single step) shows better retention.

**Key Words:** Border molding, Sectional, Single step, heat cure denture bases, Retention

## Introduction

The complete denture prosthodontics is one of the important parts of dental education and practice. The quality of complete denture depends on various factors, impression techniques along with different kinds of impression materials used for the accurate reproduction of oral foundation, being one of them .1 The main objectives of an impression making are to provide support, retention, stability, preservation of residual structures and esthetics for the denture. Retention of complete dentures depends on several factors, e.g., the biological, physical and mechanical, these factors can be achieved by means of an accurate border molding followed by an accurate final impression.1 The original material used for border molding was low fusing impression compound, since it was introduced by Green brothers in 1907. 2The technique for border molding using low fusing impression compound requires separate application of the material to different sections of the tray borders which can be quite messy. However, it is important that the profession continuously strives to develop new procedures aimed at improved accuracy, convenience, and patient acceptance. More recently, the use of polyether, vinyl polysiloxane (VPS) impression material, or condensation-silicone (c-silicone) for custom-tray border correction has been described. The properties of elastomeric impression materials like high degree of accuracy, dimensional stability, ease of manipulation and adequate working and setting time make them viable alternative to low fusing impression compound.3 More important than selection of material is the dentist's complete understanding of the concepts and principles in impression making. The manner in which the

impression was made may be more important than the material.<sup>4</sup> Studies have attempted to evaluate and compare the efficacies of various materials and techniques. However, the literature is still equivocal about the efficacy of various materials and techniques used for this purpose.

### **Material And Methods:**

Twenty edentulous patients with age group ranging from 50 – 60 years seeking prosthodontic rehabilitation were randomly selected as test subjects from the Department Of Prosthodontics Crown and Bridge, Himachal Dental College, Sundernagar. The benefits and drawbacks of the study were explained to the patients and upon signing an informed consent. The patients were recruited for the study after following through inclusion and exclusion criteria.

### **Inclusion criteria:**

Well-formed residual alveolar ridges, no severe undercuts or bony exostosis, firm mucosa with no signs of inflammation, ulceration or hyperplasia, average quantity and consistency of saliva and normal temporomandibular joint function.

### **Exclusion criteria:**

Extremely high palatal vaults, bony spicules, oral infection, neuromuscular disorder, thin mucoperiosteum and presence of systemic diseases e.g. diabetes mellitus.

### **Primary impression:**

Primary impression of the maxillary arch was made using impression compound material in a suitable sized stock tray and poured in dental plaster to obtain primary cast.

### **Special tray fabrication:**

Three identical custom trays were fabricated using autopolymerising acrylic resin for each patient, using spacer (J. J. Sharry's design) for selective pressure technique. Each tray was tried in the mouth and peripheries reduced so that they are 2 to 3 mm short of the tissue reflection. It was made sure that the distal end contained both the hamular notches and extended by 2 mm beyond the vibrating line.

### **Border molding**

Table I: Represents the grouping of the samples.

### **Group: A**

Technique 1: Sectional Border Moulding Technique

With Low Fusing Impression Compound:

Using one of the custom trays, border molding was completed with the conventional method with low fusing impression compound (Fig: 1).



**Figure 1: Low Fusing Impression Compound**

The low fusing impression compound was slowly heated over the flame in a rotating manner and the molten

compound was loaded along the periphery of the custom tray in an incremental fashion in order to perform border molding to record depth of the sulcus. Buccal and labial molding was carried out by moving the lips and cheeks upward, forward, and downward. Hamular notches were recorded by asking the patient to protrude and move the mandible from side to side. Finally, posterior palatal seal was functionally recorded by performing the Valsalva maneuver. After applying the softened compound from one hamular notch to other. The adequacies of the border extension were checked by the dull surface of the impression material (Fig no.2).



**Figure 2**

After the wax spacer was removed, holes were made in the tray over the median palatal raphe, anterolateral and posterolateral regions of the hard palate for relief as well as to aid in the retention of the impression material. Tray adhesive was applied to the inner surface of the tray. That was followed by making a definitive impression using light viscosity addition silicone. After the material hardened, the tray was removed, washed, inspected and disinfected and stored.

### **Group: B**

Technique 2: Single-Step Border Molding

With Addition Silicon: The second custom tray was used for border molding using an injectable heavy viscosity PVS (Fig no.3).



**Figure 3: Heavy viscosity PVS, Polyether, Light body & tray adhesive**

The tray borders were painted with a tray adhesive 3mm inside and outside the borders. The heavy viscosity addition silicone was injected onto the tray borders and across the posterior palatal seal area, labial and buccal borders and posterior palatal seal were molded in a manner similar to as explained for Group A, and hence border molding was completed by single step method (Fig no.4).



**Figure 4**

Holes were made and wax spacer was removed. A tray adhesive was also applied to the inner surface of the tray. After the adhesive dried up, the tray was loaded with light viscosity addition silicone (Fig.no.5)



**Figure 5: light body addition silicone**

to complete the definitive impression. The obtained impression was inspected for any defects and then disinfected and stored.

**Group: C**

Technique 2: Single-Step Border Molding

With Polyether: Third tray was used for border molding using polyether impression material (Fig no.6)



**Figure 6**

The tray borders were painted with a tray adhesive. The monophasic polyether was injected onto the tray borders and across the posterior palatal seal area (Penta mix machine 3M ESPE, 3M Deutschland GmbH Germany) (Fig no.7).



**Figure 7: Penta mix machine 3M ESPE, 3M Deutschland GmbH Germany**

Labial and buccal borders and posterior palatal seal were molded in a manner similar to as explained for Group A, and hence border molding was completed by single step method .

Holes were made following removal of the wax spacer. A tray adhesive was also applied to the inner surface of the tray. After the adhesive dried up, the tray was loaded with light viscosity addition silicone to complete the definitive impression (Fig no.9).



**Figure 9: Definitive impressions with beading & boxing**

The obtained impression was inspected for any defects and then disinfected and stored. So, for one patient three border moldings were obtained using three different materials and two techniques. Same procedure was repeated on all the selected patients. All the three impressions were marked as Group A, B and C each group having 20 impressions. The impressions were boxed (Fig no.9), and the casts were poured (Fig no.10).



**Figure 10: Cast with markings**

Denture bases were waxed on each cast and coded . Prefabricated stainless steel hooks were attached to anterior palatal region of the waxed up bases approximately corresponding to a line joining the distal surfaces of cuspids (Fig no.11)



**Figure 11: Prefabricated stainless steel hooks placement**

As suggested by Ritz F,<sup>29</sup> Qanungo Et Al,<sup>6</sup> Gupta Et Al.<sup>16</sup> The casts with waxed-up bases were flaked, placed in the same flask compress, and processed in a curing unit. Using compression molding technique and by long curing cycle (ideal for denture curing). The finished bases were inserted, checked in the mouth with pressure-indicating paste, and adjusted as necessary (Fig no.12 & 13).



**Figure 12 finished denture bases**



**Figure 13 Denture base checked in mouth**

#### **Measuring the retention of denture bases**

The finished denture bases were tried in patients mouth and evaluated for retention using a digital force meter (Fig no.14).



**Figure 14: Digital force meter**

Patient head position was standardized with the help of a cephalostat so that maxilla was parallel to the floor.<sup>6</sup> Force meter is a spring-loaded device that engage onto the hook of the heat polymerized trial denture base and force was applied by pulling it vertical downwards (Fig no.15).



**Figure 15: Retention measured with force meter**

Three readings were taken for each border molding technique and an average was calculated. In this study the force required to dislodge the maxillary denture bases was measured in Newton's. The retentive values were collected and was tabulated and statistically analysed to evaluate the difference in retention of the denture bases obtained from the three different border molding materials and techniques.

**Results**

This study compared three different border molding materials using two different border molding techniques with retention as a comparative parameter (table 1).

Group	Technique	Materials
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<b>Group-A</b>	<b>Sectional border moulding technique</b>	<b>Low fusing impression compound</b>
<b>Group-B</b>	<b>Single step border molding</b>	<b>Heavy body addition silicone</b>
<b>Group-C</b>	<b>Single step border molding</b>	<b>Polyether</b>

**Table 1: Represents the grouping of the samples**

The basic data was collected from twenty patients.

The following descriptive statistical analysis were used in the analysis of the present study.

A one-way ANOVA (Table 2)

**Table 2: ANOVA results shows the comparison of means of retention values obtained with three different materials**

Source of Variation	SS	df	MS	F	P-value	F crit
<b>Between Groups</b>	669.1958	2	334.5979	12.70052	0.00003	3.158843
<b>Within Groups</b>	1501.677	57	26.34522			
<b>Total</b>	2170.873	59				

ANOVA: Analysis of variance

Table 2 revealed a highly statistically significant differences in the mean values of retention obtained with three treatments. ANOVA signifies whether difference of values between groups is significant or not. For the significance within groups post-hoc Tukey test was used.

**Table 3 shows the Homogeneous subsets of groups created with post hoc tukey test based on group means**

Groups	N	Subset for alpha = 0.05	
		1	2
<b>Group A</b>	20	34.50	
<b>Group B</b>	20		39.3
<b>Group C</b>	20		42.6
<b>Sig.</b>		1.00	0.116

It revealed that retention obtained with (Group C) single step border molding technique using polyether and (Group B) single step border molding technique using Heavy body addition silicone was significantly higher as compared to (Group A) sectional border molding technique using low fusing impression compound. Level of significance: "P" is level of significance:  $P > 0.05$  - not significant  $P < 0.05$  significant.

There was a highly significant difference between (Group A) sectional border molding technique using low fusing impression compound and (Group C) single step border molding technique using polyether. ( $P=0.00$ ), between (Group A) and (Group B), ( $P=0.01$ ) and between (Group A) and (Group B) but the difference was not statistically significant. ( $P=0.12$ ) (Table 4)

**Table 4 shows the Inter group Comparison based on retentive value among three different materials**

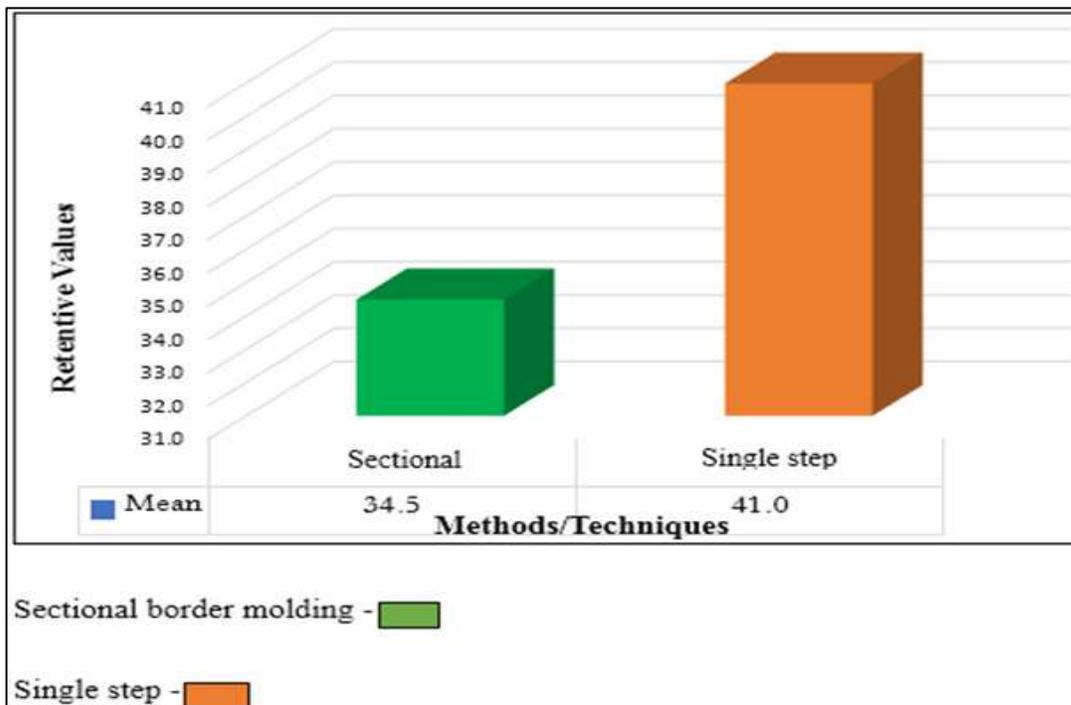
Inter Comparison	group	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group A	Group B	-4.85	1.62	0.01*	-8.76	-0.94
	Group C	-8.13	1.62	0.00*	-12.04	-4.22
Group B	Group A	4.85	1.62	0.01*	0.94	8.76
	Group C	-3.28	1.62	0.12	-7.19	0.63
Group C	Group A	8.13	1.62	0.00*	4.22	12.04
	Group B	3.28	1.62	0.12	-0.63	7.19

The mean difference is significant at the 0.05 level.\*Statistically significant difference.

**Table 5 shows the Comparison of retention obtained with two methods/techniques**

Methods	N	Mean	SD	T	p
Sectional	20	34.5	6.00	-4.499	0.000
Single Step	40	41.0	4.87		

SD standard deviation



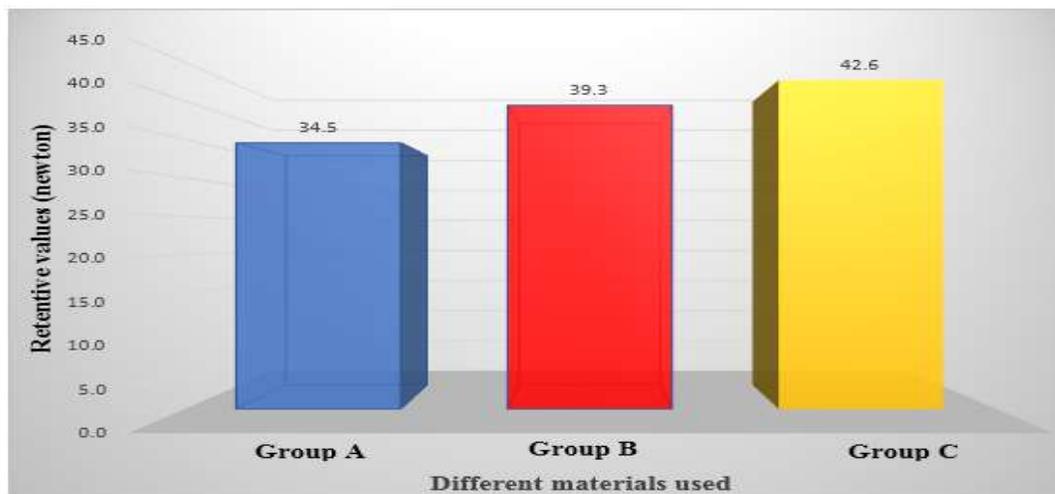
**Graph 1 shows the Comparison of retention obtained with two methods/techniques**

It shows the single step border molding more retentive (41N) as compared to sectional (34.5N).

**Table 6 descriptive statistics of retention values obtained with three treatment materials**

Groups	N	Mean	SD	Median	Minimum	Maximum
Group A	20	34.5	6.00	34.1	23.6	45.2
Group B	20	39.3	5.19	40.3	29.4	47.4
Group C	20	42.6	4.01	43.4	33.5	47.9

SD: standard deviation



Group – A: ■ Border molding technique using low fusing impression compound

Group – B: ■ Border molding technique using Heavy body addition silicone

Group - C: ■ Border molding technique using Polyether

**Graph 2 descriptive statistics of retention values obtained with three treatment materials**

Graph 2 shows group mean values of retention obtained with three different border molding materials. Border molding using low fusing impression compound shows (34.5N), Heavy body addition silicone (39.3N) and Polyether (42.6N) as respective retentive mean values.

**Discussion**

The current reality is that a majority of patients are unsuitable for dental implants or opt for other treatment options due to cost or fear of surgery. Thus the option of conventional prosthodontics still remains a provision for many edentulous patients.<sup>7</sup> *SH Soratur*,<sup>8</sup> concluded that for better retention of complete denture, the denture must cover the largest area possible. The most commonly used material for border molding was low fusing impression compound.<sup>9</sup> However, the technique for border molding using low fusing impression compound is usually divided into steps where sections of the tray borders are molded in separate applications, making it more time consuming, tedious and uncomfortable for the patient. Further, it has a short manipulation time, and does not provide sufficient time for the vestibular tissues to act and mold the periphery of the special tray.<sup>4</sup> *Woelfel et al*,<sup>10</sup> have determined that it may require

an average of seventeen insertions. Hence, a need existed to develop a new materials aimed at improving convenience, accuracy, and patient acceptance.<sup>16</sup> Impression waxes,<sup>11-13</sup> self-cure acrylic resins,<sup>2,14</sup> tissue conditioner,<sup>15</sup> are the materials which are being used for border molding procedure but now a days green stick,<sup>1,3,6,16</sup> polyether,<sup>2,17,18</sup> and polyvinyl siloxanes<sup>19,13,20</sup> are mainly used materials. *Petrie et al,*<sup>21</sup> have concluded that distinct trends are being observed regarding increasing use of polyvinyl siloxane and polyether for border molding procedures and impressions of edentulous patients. They exhibit the properties of dimensional stability, a high degree of accuracy, ease of manipulation, and adequate working and setting time. Heavy body addition silicone and polyether are the new addition to this group. However their effect on retention of denture bases obtained using different techniques is not well known. Hydrophilic addition silicone produced casts with more soft tissue details than zinc oxide paste *Pratten and novetsky1991.*<sup>22</sup> Even though zinc oxide Eugenol paste records accurate surface details *Zarb et al,* 1981.<sup>23</sup> the difference could be explained by one or more of the following: shear thinning effects, amount and size of filler particles, extent of initial crosslinking and compatibility of gypsum and impression material *Pratten and novetsky1991.*<sup>22</sup> So, in this study, this problem was overcome by using light viscosity addition silicone in all the three groups to maintain standardization *Abdel Hakim et al,*<sup>24</sup> *Yarapatineni et al,*<sup>25</sup> & *Qanungo et al,*<sup>6</sup> have also used light bodied polyvinyl siloxane as secondary impression material to maintain standardization. *Ritz F N,*<sup>29</sup> *Gupta et al,*<sup>16</sup> *Qanungo et al.*<sup>6</sup> The casts with waxed up bases were flaked, placed in the same flask compress, and processed in a curing unit. Using compression molding technique and by long curing cycle (ideal for denture curing). The finished bases were inserted, checked in the mouth with pressure indicating paste, adjusted and confirmed fit as necessary. Each denture base was stored in water immediately after fabrication and remained soaked until the test was performed to avoid the dimensional changes due to shrinkage. Retentive values obtained for all the three materials in all the twenty patients was compiled and subjected to statistical analysis. Single step border molding shows better retentive values than sectional border molding technique. As was shown by the similar studies conducted by *Rohit Sharma et al,*<sup>26</sup> *Renu Gupta et al,*<sup>16</sup> *RobinaTasleem al,*<sup>27</sup> *Silvia Pridana et al,*<sup>28</sup> *Kheur M et al,* *Rizk,*<sup>29,30</sup> Some authors show sectional border molding better than single step border molding *Vishal Singh,*<sup>30</sup> *Qanungo et al*<sup>6</sup> *Yarapatineni et al.,*<sup>25</sup> *Anna Jone et al,*<sup>31</sup> The reason attributed to GROUP C (with single step technique using polyether) is that the single step insertion of the entire peripheral seal is achieved simultaneously with the same thickness as the entire smooth surface, which results from continuous activation of soft tissue which changes when the material is in a viscoelastic state. This minimizes simultaneous errors due to errors on one side of the border molding area that occur in sectional techniques on the use of green stick compound materials. Presence of the highest retention over the other two materials can be due to the fact that polyether gives optimum working time and exhibits good flow characteristics which help in recording the borders accurately. Polyether developed least bubbles, cracks and is more hydrophilic than silicones and polysulphide. Polyether impression materials meet all of the requirements required for single step border molding. It can be shaped with a moist finger in or outside the mouth, and can be trimmed with a scalpel or a bur. Polyether material has a viscosity that is great enough to stay in the vestibule but soft enough to be molded by the functional movement of the border tissues. The simultaneous muscle movement resulted in an appropriate peripheral seal. In addition to this, the elasticity of the material helped in accurate adaptation of the border tissues. The results were in coherence with the studies conducted by *Smith DE et al,*<sup>2</sup> *Tan HK et al,*<sup>17</sup> *Arora AK, et al,*<sup>3</sup> *Khajuria R R et al,*<sup>32</sup> *Dou E E et al,*<sup>4</sup> *Renu Gupta et al,*<sup>16</sup> *Rohit Sharma et al.*<sup>26</sup>

**GROUP B** (single step border molding using heavy body addition silicone) came out to be the next appropriate material for border molding. The reason can be due to the fact that heavy body addition silicone has a uniform consistency, good and controllable initial flow, near to ideal viscosity, and excellent working time which allows the operator to simultaneously mold all the borders with extreme finess. The results were in coherence with the studies conducted by *Chafee et al,*<sup>20</sup> *Yilmaz et al,*<sup>33</sup> & *Kheur et al.*<sup>34</sup> However the results are not in agreement with the study conducted by *Qanungo et al,*<sup>6</sup> who concluded that low fusing impression compound gave better retention as compared to heavy body. This could be attributed to difference in operator skill and experience with the material. The least retentive among all the four materials came out to be GROUP A (with sectional border molding technique using low fusing impression compound). This material although conventionally used since 1990's faces a lot of limitations. This material has thermoplastic properties which have a low conductivity which is around 490C (120 OF) to 60 OC (140 OF) and hardens at a temperature of 37 OC. It has a very short manipulation time and hardens quickly in patients mouth even before the functional movement of vestibular sulcus are completed. Since the material is applied in increments, propagation of mistake in one section affects the border contours in another section *Rohit Sharma et al,*<sup>26</sup> *Renu Gupta et al,*<sup>16</sup> *RobinaTasleem al,*<sup>27</sup> *Silvia Pridana et al,*<sup>28</sup> *Kheur M et al,*<sup>34</sup> *Rizk,*<sup>29</sup>. However, studies conducted by *Abdel hakim et al,*<sup>24</sup> *Drago et al,*<sup>36</sup> & *Yarapati*<sup>10</sup> *il*<sup>25</sup> showed no difference between addition silicone and low fusing

impression compound. This could be because of technical errors, processing errors like those involved in packing, curing or volumetric shrinkage of acrylic resin, which resulted in improper fit of the permanent denture base with underlying soft tissue, disrupting the perfect adaptation of the denture base to the underlying soft tissues.

### Conclusions

Under the limitations of the present study following conclusion can be made:

1. All the three different border molding materials show the significant retention in maxillary heat cure denture bases.
2. Out of the two techniques used in the study, single step border molding technique provided better retention to the maxillary denture base.
3. Among all the three materials used in the study, polyether provided best retention to the maxillary denture base.
4. Polyvinyl siloxane provided better retention as compared to low fusing impression compound.
5. Low fusing compound using sectional border molding technique provided least retention to the maxillary denture base.

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