Effect of border molding materials and techniques on peripheral tissue morphology and retention of denture bases in edentulous patients at RSGM USU

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Abstract
The objective of border molding procedure is to get peripheral seal to achieve a retentive denture. An exact border molding record is influenced by the material and technique. Green stick compound is usually the material of choice nowdays, it has thermoplastic mechanical properties that makes some problems. Polyvinylsiloxane have a long working time which come as material option that resolved the green stick compound limitations. This material is available in several viscosity, which influence their mechanical properties. This study aimed to evaluate the effect of border molding materials and techniques in recording morphologic detail of pheriferal tissue and denture base retention. Four custom trays were made from each subject then border molding procedure was done with either heavy body or putty polyvinylsiloxane material with fuctional or manual technique. Retention value was measured after recording final impression with analog push and pull gauge. Working models were then scanned with digital scanner CAD/CAM and measured with 3D builder software. The statistical significance of retention value and morphologic detail of pheriferal tissue was tested with univarian dan unpaired T test. Mean value at morphologic detail of pheriferal tissue with heavy body polyvinylsiloxane is smaller than with putty polyvinylsiloxane. Higher mean value of retention at putty with functional technique is (48,00 $\pm$ 6.65) N. there is no significance value on both materials and techniques. Based on this research putty polyvinylsiloxane with functional technique can be recommended for border molding procedure.

Keywords: Border molding, Polyvinylsiloxane, Peripheral seal.

Introduction
The purpose of the final impression procedure in making full dentures is to get the maximum expansion of the supporting area of full denture. The border molding process is carried out before final impression.[1-4] The purpose of the border molding in the manufacture of full dentures is to obtain peripheral seals, namely tight contact between the full denture base and the mucosa around the periphery of the full denture boundary to prevent the entry of air between the base and the mucosa.[1-3,5]

The border molding material that is currently still frequently used is the green stick modeling compound. This material has thermoplastic properties which have a low conductivity which is around 49^{o} C (120^{o} F) to 60^{o} C (140^{o} F) and hardens at a temperature of 37^{0} C. This property causes the border molding process to require twenty-four insertions, namely eight in the maxilla and sixteen in the mandible causing long working time and discomfort in patients.[5-7]

Due to the many shortcomings it has, some researchers recommend a variety of border molding materials including polyvinylsiloxane, polyether, acrylic resin and tissue conditioner. Chaffee *et al*., suggested using polyvinylsiloxane material by adding adhesive on impression tray (quoted from Qureishi I et al. 2010). The polyvinylsiloxane material consists of silicon polymers containing vinyl and hydrogen which polymerize in addition to platinum salt catalysts such as chloropatinic acid. The advantage of Polyvinylsiloxane material is that it has very elastic properties so that it does not experience significant distortion when printing in undercut areas, high dimensional stability and allowing charging up to seven days after impression. The working time of polyvinylsiloxane which reaches seven minutes causes the border molding process to be carried out in 1 insertion with functional muscle activation and the muscle activation movement carried out by the patient itself. This can eliminate the drawback of conventional materials, which is repeated insertions.[1,5-7]

Polyvinylsiloxane has several viscosities, it is due to the difference in the amount of filler it has. The polyvinylsiloxane viscosity influences the properties of dimensional materials, stability, tear strength, detailed reproduction and elasticity.[1,8] In the process of border molding putty viscosity is the most commonly used while the medium body and heavy body are also mentioned by researchers. The ability of the detailed reproduction of polyvinylsiloxane makes it possible to obtain the detailed morphology of the edentulus patient.[1,8-10]

Aim
The purpose of this research is to determine the influence of type of material and border molding techniques in recording the details of peripheral tissue morphology and on retention of denture bases in edentulus patients at USU RSGM

Materials and Methods
Type of this research is clinical trial research design. This research was conducted by the USU RSGM Polyclinic and the Simon Dental Laboratory. The sample selection is done using the purposive sampling method. Samples are chosen based on inclusion criteria, which are: edentulus, Patients do not have systemic diseases that can affect the

shape and resilience of supporting denture tissue, well rounded alveolar shape, no undercut, inflammation or mucosa hyperplasia or flabby and no problems in the jaw joint, which can limit the opening of the mouth. The total number of subjects in this study was 10 subjects, each of which made 4 pieces of impression tray, so that 40 samples were obtained.

The equipment used for measuring retention is Push and Pull analog scale (Krisbow) and for measuring peripheral morphology using 3D builder software. The research begins with the subject first approving the statement contained in the research goal sheet. An intra-oral estimate of the height of the alveolar margin is done by determining the position of greater fovea palatine and marked with pencil copy then measured to the creast of the alveolar ridge using digital caliper (Krisbow). To ensure the alveolus margin is well rounded, which has a height of > 6mm, then a panoramic x-ray is taken and the measurement is done using the Liang XH method (2014).[11,12]

Preliminary impression of the maxilla was recorded with alginate material. The tray used is the manufacturer's tray. On the working model 4 custom tray were made. A sheet of wax as a spacer on the surface of the anatomical model which will be made a custom tray in accordance with the outline and then stopper location was at the canine and first molar region on both sides.

The swapolymerization acrylic resin application for the manufacture of physiological print spoons with loops on the center of the print spoon. The center position of the print spoon is determined by guiding the labial frenulum (point A) and the pterygomaxillary fissure (points B and C). Then mid lines B and C are determined (point D). Then the distance from point A to D is determined, and the midpoint (point E) is determined. Point E as a push and pull scale attachment point at the time of retention measurement. (Fig. 1 & 2)

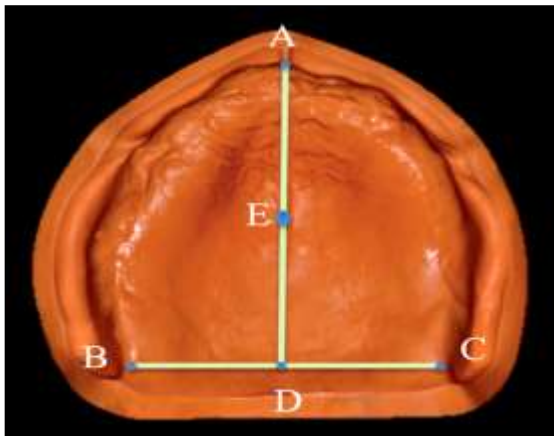

Fig. 1: Determine the loop position on the impression tray

Fig. 2: Loop position on the impression tray

Border molding procedure was done with two techniques functional and manual. The procedure is: 1. Impression material material adhesive tray is applied to all peripheral parts of impressiontray 2. The heavy body polyvinylsiloxane material is mixed with the automixing method using a dispensing gun (groups A and B), 3. The polyvinylsiloxane putty is mixed manual with base and catalys as much as 1: 1 (groups C and D), 4. Application of border molding material to the entire peripheral tray. 5. Patients are instructed to perform functional movements, which are: Smile, Grin, Call the letter O three times, than Move the jaw to the left and right, Open and close mouth, and perform a valsalva manuever. The manual method done with the operator helps perform muscle activation movements, which: Emphasis on hamular notch, withdrawing the buccal muscles out and down three times, withdrawal of the labial muscle outward three times than Then the dentist Instruct the patient to do a valsalva maneuver (Fig. 3)

The physiological printing procedure is carried out by using a mucocompression technique with a polyvinylsiloxane medium. In the physiological printout, retention measurements are carried out. Patient is seated upright with the occlusal plane parallel to the floor surface than Installing a modified push and pull gauge handle to reach the pull direction 45^0 on the loop with the palate on the print spoon (Fig. 4)

Push and pull gauge was held with the palm of the hand and the vertical downward pull was done as a force for removing the denture (Fig. 5) and then the retention value (N) was noted needed and was carried out three times to avoid bias results. This procedure was performed on the all other three sample groups. After boxing filling final impression was recorded with type IV gypsum to obtain working cast.

Then working cast was scanned with a CAD / CAM digital scanner. Determining the width of the vestibule sulcus in the physiological model is the horizontal distance between the inner points adjacent to the vestibule sulcus margin with the outer point of the vestibule adjacent to the buccal part, anteriorly he is mid and right buccal and labial frenulum (points 1 and 2) and posterior to the tuberosity area, measurements use (points 3 and 4) (Fig. 6) measurements using 3D builder software. Measurements were made on 40 sample models from groups A, B, C and D.

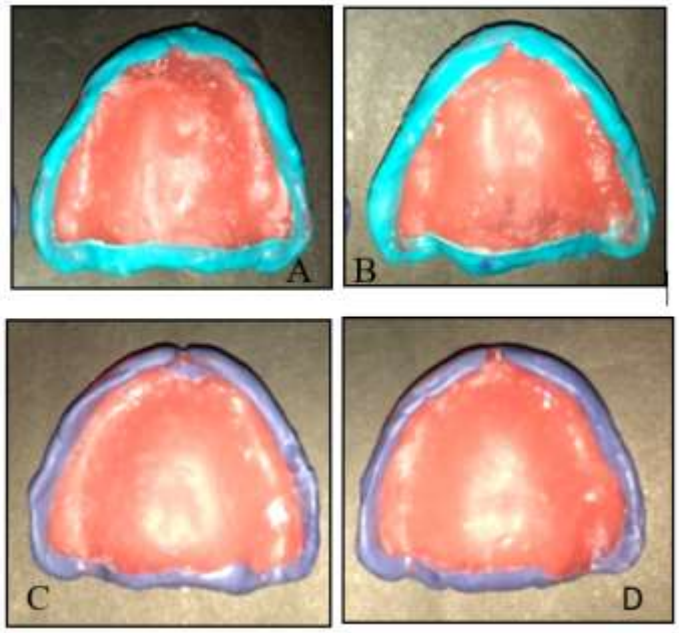

Fig. 3: Border molding results; (A) Heavy materials with functional techniques; (B) Heavy materials with manual techniques; (C) Putty materials with functional techniques; (D) Putty materials with manual techniques

Result

Data normality test was carried out using the Kolmogorov-Smirnov test and obtained a value of p => 0.05, which means that the research data was normally distributed. From the results of the study it was found that in the anterior the largest value was found in group C which was 5.53 mm and the smallest value was in group D which was 2.61 mm. In the posterior area the largest value was found in group C which was 5.67 mm and the smallest value was in group B which was 3.21 mm. (Table 1). The highest retention measurements were found in the sample groups C and D that is equal to 54 N while the smallest value is obtained in the sample in groups A, D and B which is equal to 33 N. (Table 2)

Fig. 4: Hook modification of push and pull gauge

Fig. 5: Retention measurement

Fig. 6: Morphological detail measurement with CAD / CAM image

Table 1: Size of detail of peripheral morphology of denture base using heavy body border molding and putty polyvinilsiloxane materials with functional and manual techniques in edentulus patients at USU RSGM

Number of Subject	Detail Morphology (mm)							
	PVS Heavy Body				PVS Putty			
	Fuctionall (A)		Manual (B)		functional (C)		Manual (D)	
	Anterior	Posterior	Anterior	Posterior	Anterior	posterior	Anterior	Posterior
X ± SD	3.62 ± 0.52	4.29 ± 0.59	3.48 ± 0.59	4.31 ± 0.69	4.03 ± 0.81	4.71 ± 0.64	4.00 ± 0.80	4.51 ± 0.80

Table 2: Retention value of denture base using heavy body border molding and putty polyvinilsiloxane materials with functional and manual techniques in edentulus patients at USU RSGM

Number of subject	Retention (N)			
	PVS Heavy Body		PVS Putty	
	Functional (A)	Manual (B)	Functional (C)	Manual (D)
X ± SD	44.20 ± 6.89	42.20 ± 5.28	48.00 ± 6.65	44.90 ± 6.57

Table 3. Effect of polyvinilsiloxane heavy body border molding materials with functional and manual techniques on morphological details of full denture base peripheral networks in edentulus patients at USU RSGM

No	Group	N	X + SD (mm)		p	
			Anterior	Posterior	Anterior	Posterior
1	Heavy - functional (A)	10	3,62 ± 0,52	4,29 ± 0,59		
2	Heavy - manual (B)	10	3,48 ± 0,59	4,31 ± 0,61	0,58	0,53

Table 4. Effect of border molding putty polyvinyl siloxane material with functional and manual techniques on the details of morphology of peripheral tissue full denture edentulus base USU RSGM

No	Group	N	X ± SD		p	
			Anterior	Posterior	Anterior	Posterior
1	Putty – functional (C)	10	4,03 ± 0,81	4,71 ± 0,64		
2	Putty –manual (D)	10	4,00 ± 0,80	4,51 ± 0,80	0,93	0,53

Table 5. Effect of polyvinilsiloxane heavy body border molding material with functional and manual techniques on retention of denture bases in edentulus patients at USU RSGM

No	Group	N	X ± SD	p
1	Heavy body - Functional (A)	10	44.20 ± 6.89	
2	Heavy body - manual (B)	10	42,20 ± 5,28	0,47

Table 6. Effect of polyvinilsiloxane border molding putty material with functional and manual techniques on retention of denture bases in edentulus patients at USU RSGM

No	Group	N	X ± SD	p
1	Putty – functional (C)	10	48,00 ± 6.65	0,30
2	Putty – manual (D)	10	44.90 ± 6,57	

To determine the effect of heavy and putty polyvinilsiloxane material with functional and manual techniques on the detailed morphology of the denture peripheral tissue in USU RSGM edentulus patients, the sample data was analyzed by unpaired T test. The results showed significance value at anterior p = 0.58 and at posterior p = 0.53 (p> 0.05). Value at putty material at anterioris p = 0.93 and at posterior p = 0.53 (p> 0.05). From these results it is known that there is no effect of heavy body border molding material and putty polyvinylsiloxane with functional and manual techniques against details of the morphology of the full denture base peripheral network (Tables 3 & 4)

From the test results it was found that the significant value was p> 0.05, this means that there is no effect of the heavy body polyvinilsiloxane molding border material with functional and manual techniques on the retention of denture bases in edentulus patients at USU RSGM (Tables 5 & 6)

Discussion

In this study border molding manual technique found the size of the vestibule sulcus chamber was smaller than the functional technique. This might be caused by activating the cheek and lip muscles with an outward and inward pulling motion that does not match the muscle movement when functioning. Tension in the muscles that causes a different size of the vestibule sulcus when the muscle returns to resting position.[12]

Larger size of the verstibular sulcus was found in the posterior region due to the anatomical structure of the coronoid process, buccinators muscle and the alveolar margin. In the upper jaw the process of absorption of the alveolar ridge in the posterior region begins in the buccal part which causes the vestibule sulcus wider and shallower. The variation in the shape of the widening coronoid process also results in a larger posterior vestibule sulcus size. In addition, in the anterior region there is a muscle fiber perpendicular to the posterior region, whereas there are muscle fibers from the horizontal direction. This is consistent with research conducted by Chen (2012) who measured vestibular sulcus using a periodontal probe stating that the mean value of the anterior vestibule in 100 people in China in the anterior region was 3.3 mm smaller than 7.9 mm in the posterior region.[1,13]

The largest size of the vestibule sulcus is found in the putty (group C) because has a high viscosity of 800 fitting thatcan withstand muscle pressure around the vestibule sulcus so that it can fill the entire vestibule sulcus space wall. In material with smaller viscosity it can be displaced by muscle muscles around the vestibule and when border insertion molding the maxilla and the possibility of material degeneration is caused gravity. This is in accordance with Patel's (2010) study, which states that the size of the vestibule space in polyvinylsiloxane putty material is significantly larger at 22.77 sqmm compared to other materials such as tissue conditioner of 11.53 sqmm, acrylic resin of 14.12 mm and green compound stick of 20.50 sqmm.[3,13-15]

Retention value has a spread of varying sizes for each sample due to the inclusion criteria in this study, all patients do not have systemic diseases that can affect the shape and resilience of denture supporting tissues, well rounded alveolar ridges has no undercut, torus and mucosal inflammation that is hyperplasia or flabby. This is aimed at uniformity the sample minimizes the effect of these retention factors on the results of retention measurements. But not all retention factors can be controlled in this study, namely viscosity and salivary volume and jaw size, which can affect adhesion factors and cohesion and surface tension. There is on the surface of the intaglio denture base. This is also in accordance with the previous retention measurement study conducted by Aoyagi et al. In the subjects of 9 men and 5 women on some salivary viscosities who got the lowest score of 0.92 N and the highest value of 17.78 N. Gupta R obtained the results of retention measurements from the mandible get an average value of 39.9 gr and 55.9 gr. Hemmati research on the basis of being given sandblasting with retention results of 30.89 N before sandblasting and 37.66 + 9.76 N after sandblasting.[16-18]

The polyvinylsiloxane putty border molding material with functional technique has the best retention results because the muscles that contract according to their physiological conditions get uniform thickness so that they get maximum seal peripherals. This is in accordance with research by Rizk 2008 stating that the putty with functional technique has a greater retention strength of 3401.4 + 1382.3gms compared to 1640.7 + 1250 gms using polyvinylsiloxane body medium and 1311.2 + 1261 gms using green stick compound. Al Judy (2015) found the highest retention value of the putty with light body impression material and functional technique of 3406.55 + 6.78 gm. This is also supported by the Jone et al statement which obtained results on the border molding using putty polyvinylsilosane with functional techniques having a greater average retention compared to the low fusing compound material.[4,19,20]

The absence of influence in this study may be caused by the two polyvinylsiloxane materials used having the same material properties, like detail reproduction and dimensional stability, and having a long working time. 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.[5,13] The border molding process with a single step manual technique is a choice in geriatrics due to geriatric patients having decreased organ function including the central nervous system which causes limited muscle muscle movement and atrophy of the muscles of masticatory muscles.[19,21] Because of the above, it is necessary for the operator to activate the muscle in the process of border molding. The results of measurements of retention on heavy and putty polyvinylsiloxane are clinically acceptable. Low viscosity polyvinylsiloxane material preparations such as heavy bodies are available in the form of pastes in tubes with automix manipulation with automatic stirring using dispensing gun. This automix has advantages compared to the manual method because of the right comparison of materials, minimizing air intake, smaller contamination and shorter stirring time. Whereas in high viscosity materials, putty polyvinylsiloxane is available in two containers consisting of base and catalyst. Manual stirring process Because of this the polyvinylsiloxane putty material is very sensitive to operator skills while the heavy body polyvinysiloxane material has an ease because it uses a dispensing gun that shortens the material manipulation process and has better efficiency.[1,7,15]

There are discrepancies in the results of this study with previous studies such as in the research conducted, Yarepateni and Rizk which state a significant difference in the strength of retention in border molding materials using putty, polyvinylsiloxane medium body, and low fusing

compound. This might be caused by a tool that is used for retention measurements, analog equipment Whereas in the previous study using digital force gauge, whipmix earpiece facebow modification and custom made tools.[19,22-25] In this study there was a modification of the shape of the hook measuring device retention with a loop on the physiological print spoon palate. This aims to get a 90^{o} pull direction to avoid any bias due to the direction of force that is not perpendicular to the denture base because the angle of the vector can affect the measurement results. Larger angulation angles require greater force. In previous studies there were 10^{o} angulations in the direction of attraction that might influence the measurement results.

Conclusion

The functional technique of putty polyvinylsiloxane is a choice of border molding material because it has the best retention measurement result. Heavy body polyvinylsiloxane as border molding material can shorten the time due to the manipulation process using the automix method using dispensing gun. Manual border molding technique is an option when the patient's condition does not allow for functional border molding techniques, such as a decrease in motor function due to systemic neurological disease and geriatric patients.

Conflict of Interest: None.

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