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Evaluating The Interrelationship of Primary Impression Material and Mode of Tray Fabrication on The Efficacy of Posterior Palatal Seal: A Pilot Study

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Abstract:

Aim: To evaluate the efficacy of PPS with respect to muco-compressive primary impression materials.

Methodology: Four primary impressions were taken, two using hydrocolloid and two using putty elastomer. From each group, one denture base was fabricated without recording the posterior palatal seal (PPS). Retention test was performed using hook-type digital hanging weighing scale with an accuracy of 5 grams measurement sensors was used to apply vertical force. The scale's handle was engaged with the loop on the denture base handle, and the force was measured in grams.

Results: the Bonferroni test revealed statistically significant differences between the putty elastomer with PPS vs. Alginate with PPS ($p < 0.05$) and alginate with PPS vs. Alginate without PPS ($p < 0.05$). The denture base made from an elastomeric primary impression, without recording the posterior palatal seal (PPS) during the final impression, exhibited superior retention values compared to the other groups.

Conclusion: Utilizing a muco-compressive primary impression material could eliminate the additional step of recording the posterior palatal seal (PPS) during the final impression without compromising denture retention.

Keywords: Complete denture, Posterior palatal seal, Primary impression material, Retention.

Introduction

Complete denture retention profoundly influences functional stability and patient satisfaction. Achieving optimal retention involves a comprehensive consideration of mechanical, biological, and physical factors during prosthesis design and fabrication. The positive contact between the denture base and mucosal surface plays a pivotal role in determining the success of dentures. Several factors contribute to improved retention, encompassing posterior palatal seal design,

impression technique, palatal tissue surface design (with or without relief), denture base surface enhancement through airborne particle abrasion, and the judicious use of technique, palatal tissue surface design (with or without relief), denture base surface enhancement through airborne particle abrasion, and the judicious use of adhesives[1,2]. Among these considerations, establishing the distal length of the basal seat and crafting the posterior palatal seal stand out as crucial steps in constructing a maxillary denture. The tradition of incorporating a posterior palatal seal into maxillary complete denture prostheses has been followed for so long that its origin remains obscure in dental history. As Skinner [3]aptly noted, "The most effective addition to increase retention is the post-dam." The primary role of the posterior palatal seal (PPS) in the complete maxillary prosthesis is to maintain contact with the anterior portion of the soft palate, which undergoes shallow displacement during functional movements of the stomatognathic system.

A well-formed border seal is indispensable for resisting horizontal forces and minimizing lateral torquing of the maxillary denture, both of which contribute significantly to denture retention[4]. Beyond its role in enhancing retention, developing the posterior palatal seal on the denture offers several advantages[5]:

- It ensures close contact of the denture base with the mucous membrane, effectively preventing food particles from infiltrating beneath the denture.
- It establishes a firm connection between the denture base and the tissue, reducing or eliminating the sensation of gagging.
- It creates subtly recessed distal borders that are less noticeable to the tongue.
- It provides a sturdy border to counteract potential denture warpage.

It is essential to recognize that the posterior extension of the basal seat has received less attention in the literature concerning denture retention than the morphology of the posterior palatal seal. This is noteworthy because extending the denture border beyond the posterior vibrating line may lead to a loss of retention and stability[6,7]. Existing literature has tended to overemphasize the shape and depth of the PPS, primarily based on the soft palate's morphology, without adequate justification. Consequently, the author underscores the importance of focusing more attention on the posterior extension of the PPS, rather than fixating solely on its shape and depth.

Choosing the appropriate primary impression materials for recording denture-bearing tissues can also contribute to functional fit, and denture retention, if it is associated with a close adaptive custom tray fabricated using sprinkle-on technique[9,10]. If muco-compressive impression material is employed for primary impressions, the need of additional pressure at the PPS region during the final impression-making becomes unnecessary.

Recently, there is a growing trend towards the fabrication of injection-moulded dentures and CAD/CAM dentures. Consequently, the need for compensation to address polymerization shrinkage has diminished[7]. Thus, the practice of applying excessive pressure and placing undue emphasis on the depth of the PPS becomes obsolete in the current context. This study attempts to explore the interrelationship of primary impression material and mode of tray fabrication on the efficacy of the posterior palatal seal.

Objective

This clinical study aims to examine the potential impact of primary impression material type and tray fabrication method on the retention and efficacy of the posterior

palatal seal in maxillary dentures. The null hypothesis is that no difference in efficacy of posterior palatal seal between dentures fabricated using muco-static and muco-compressive primary impression materials.

Methodology

Patient Selection: A sixty-year-old edentulous patient with optimal general health and relatively ideal intra-oral anatomical landmarks (class 1 soft palate and smooth rounded ridges without any undercuts) was selected for the study.

Impression Technique: Selective pressure impression technique was employed using Boucher's spacer design.

Special tray fabrication: Sprinkle-on technique using auto-polymerizing acrylic resin

Procedure

- A total of four primary impressions were taken, where the first two were obtained using alginate hydrocolloid impression material, and the remaining two were acquired using putty consistency condensation silicone impression material. Posterior vibrating line is outlined in patient's mouth using an indelible pencil and transferred to the impressions
- Casts were poured using type 2 dental plaster. Boucher's spacer design(fig.1) was employed for all four casts using 2mm thick base plate wax (type 1).
- Special trays were fabricated by sprinkle-on technique(fig.2) using auto-polymerizing acrylic resin, extending up to the demarcated posterior vibrating line. The fit and extension of the trays were checked intraorally before proceeding with secondary impression procedures.
- Border moulding was performed using low-fusing greenstick impression compound. Two trays, one made out of alginate impression and the other out of silicon impressions, were peripherally traced without recording the posterior palatal seal area(fig.3), while the other two trays were used for peripheral sealing with conventional posterior palatal seal recording using the Valsalva manoeuvrer.
- Final impressions were taken using light body consistency condensation silicone impression material. The impressions were poured, and master casts were prepared using type 3 dental stone (fig.4 and 5).
- Permanent denture bases were prepared by conventional compression molding technique using heat cure acrylic resin. The finished denture bases were checked intraorally for fit and extension
- To test retention, the permanent denture bases were modified by attaching a 2 cm handle to the anterior midline region of each base using auto-polymerizing acrylic resin. U-loops formed from orthodontic wires were attached to the superior surface of the handle using self-cure acrylic resin (fig.6).
- Testing Apparatus: A hook-type digital hanging weighing scale with an accuracy of 5 grams measurement sensors was used to apply vertical force. The scale's handle was engaged with the loop on the denture base handle, and the force was measured in grams.
- Retention tests were performed in a single appointment. All denture bases were stored in water until being tested. The patient's head was firmly held on the head-rest with the occlusal plane parallel to the floor.
- Each denture base underwent three retention tests. Progressively increasing upward force was applied to the loop attached to the handle of the denture base until complete dislodgement from the palate occurred. The force values, displayed on the digital weighing scale in grams, were recorded.

Figure 1: Boucher's spacer design

Figure 2: Special tray fabricated using sprinkle-on technique

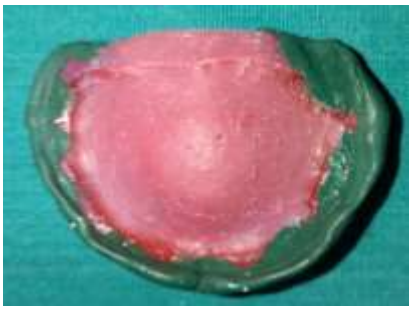

Figure 3: Border molding without PPS

Figure 4: Master cast with PPS recording

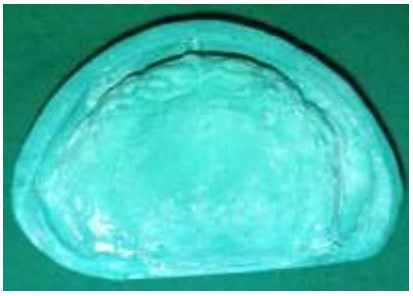

Figure 5: master cast without PPS recording

Figure 6: Modified denture by attaching U-loop to the extended handle

Figure 7: Denture bases formed by four methods

Figure 8: Testing Apparatus

Figure 9: Retention testing

Statistical Analysis

The data were analysed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL), and the level of significance was set at $p < 0.05$. Descriptive statistics were performed to assess the mean and standard

deviation of the respective groups. The normality of the data was assessed using the Shapiro-Wilk test. Inferential statistics were used to find out the differences between the groups, employing the ONE-WAY ANOVA TEST, followed by the BONFERRONI POST-HOC TEST for pairwise group Comparison.

Results

The average retention values for all four groups of denture bases are illustrated in the figure. Regarding the mean force, the between-group analysis by the ONE-WAY ANOVA TEST reported an overall statistically significant result (P < 0.05). The Bonferroni test revealed statistically significant differences between the PUTTY ELASTOMER WITH PPS vs. ALGINATE WITH PPS (P < 0.05) and ALGINATE WITH PPS vs. ALGINATE WITHOUT PPS (P < 0.05). These results indicate that there are significant differences in mean force between these specific pairs of groups in terms of denture base retention.

Table 1: Comparison of Force

		Mean	SD
Putty Elastomer Without PPS (A)		1.76	0.12
Putty Elastomer With PPS (B)		1.07	0.01
Alginate With PPS (C)		0.60	0.08
Alginate Without PPS (D)		0.35	0.04
P Value (One Way Anova)		0.0001*	
Boneferroni Post-Hoc Test	A vs B	0.11	
	A vs C	0.93	
	A vs D	0.93	
	B vs C	0.0001*	
	B vs D	0.21	
	C vs D	0.0001*	

*P<0.05 is statistically significant (Shapiro Wilkinson test, p<0.05)

Graph 1: Showing mean retention values given by the four denture bases

Discussion

This study aimed to assess the impact of primary impression material type and tray fabrication method on the retention and efficacy of the posterior palatal seal in maxillary dentures. The null hypothesis was partially rejected, as there was a statistically significant difference (p<0.05) between the retention values obtained from denture bases fabricated with putty-consistency elastomer and alginate hydrocolloid as primary impression materials. This indicates that the rigidity of the primary impression material influences denture base retention. Alginate is known for its ease of use but may not provide the same level of detail and accuracy as silicone. Additionally, being a muco-compressive impression material, the pressure exerted by the elastomer on tissue is greater when compared to a muco-static hydrocolloid material. This pressure within physiological limit is adequate to record the PPS. Interestingly, this study did not find a significant difference in retention between denture bases fabricated with or without a posterior palatal seal (PPS) when a muco-compressive primary impression material is used. This finding aligns with authors perception of unnecessity of applying additional pressure over the PPS area while making final impression. According to Charles H. Moses[8], if the post dam is not too severe and the tissues are not distorted too much, it is very likely

that there will be a physiologic adaptation. That means judicious sealing without causing pathologic conditions is a justifiable procedure. However, indiscriminate "beading" of a denture cannot be justified. We must analyse the tissues and not pull them out of position for a distance beyond the limits of their capacity for physiologic adjustment. It suggests that other aspects, such as the adaptation of the denture base, may play a more substantial role in retention. Tray fabrication methods can influence the fit and adaptation of the trays, which, in turn, can affect retention. This study utilized the 'sprinkle-on' method for fabricating custom trays across all four groups, enhancing the accuracy of muco-compressive primary impressions by effectively replicating the Posterior Palatal Seal (PPS) without requiring additional compression during the final impression.

Furthermore, the study highlights that the concept of compensating for polymerization shrinkage has become obsolete with the advent of CAD/CAM and injection-moulded dentures. In this study, despite of using a heat-cure acrylic with compression moulding for denture fabrication, the retention of denture bases achieved with or without a posterior palatal seal was comparable. This underscores the idea that applying excessive pressure to the posterior palatal seal area during the secondary impression may not be necessary, especially in the current context of digital dentures.

However, it's important to consider that this study was conducted on a single patient, and further research with a larger sample size may be needed to confirm these findings.

Clinical Implications

The study's findings have practical implications for prosthodontists and dentists involved in complete denture therapy. It highlights the importance of nature of primary impression material and method of tray fabrication to ensure accurate recordings of denture-bearing tissues. Additionally, this study suggests concentrating on the posterior extension and overall adaptation of the denture base rather than needlessly fixating on the shape and size of the posterior palatal seal.

Limitations

It's important to acknowledge the limitations of this study, including the small sample size of one patient. The study's results may not be fully generalizable to a broader population. Moreover, the study focused solely on immediate retention, and long-term retention and patient satisfaction were not evaluated.

Conclusion

This study contributes to the understanding of factors influencing the efficacy of posterior palatal seal and thereby overall retention of maxillary complete dentures. It highlights the importance of primary impression material on palatal seal placement while challenging the traditional emphasis on placing additional pressure over it. Posterior extent of the PPS is far more important than meticulous geographic location and estimation of vibrating lines. Further research with a larger and more diverse sample size is necessary to confirm these findings and explore the long-term implications for denture success and patient satisfaction.

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