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AN IN-VIVO COMPARATIVE STUDY OF RETENTION OF HEAT CURED AND THERMOPLASTIC ACRYLIC RESINS IN MAXILLARY COMPLETE DENTURE BASES MADE WITH DIFFERENT POSTERIOR PALATAL SEALING TECHNIQUES

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ABSTRACT

Introduction: Complete denture retention is significant to achieve patient comfort while wearing complete denture. Denture retention plays an important role for the patient in feeling secure at the very beginning of denture wearing where neural and muscular controls are not developed yet. Moreover, it is hard to attain stability for the complete denture without establishing adequate retention. **Aim:** To evaluate the retention of heat cured and thermoplastic acrylic resins in maxillary complete denture bases made with different posterior palatal sealing techniques. **Material and methods:** Ten completely edentulous patients were selected for the study. Their age ranged from forty to fifty-eight. Four casts were made including a cast with Iowa wax posterior palatal seal, a cast with conventional posterior palatal seal, a cast with beading posterior palatal seal, and a cast with arbitrary posterior palatal seal. Then, the casts were duplicated for fabrication of injection molding acrylic denture bases. **Results:** The functional posterior palatal seal showed the highest retention. The deference in retention between the heat cure and the thermoplastic acrylic denture bases was not significant. **Conclusion:** The functional posterior palatal seal gave the upper complete denture the highest retention. The retention of the heat cure and injection molding denture bases was nearly the same.

INTRODUCTION

Lack of retention has always been the chief complaint for the majority of complete denture patients. Comprehending the factors of retention by the dentist's side is crucial for the delivery of a satisfactory prosthesis. Since the conventional complete denture is a simple treatment modality, it will continue to be the most convenient for many edentulous patients[(1)].

Posterior palatal seal is defined as "that portion of the intaglio surface of a maxillary removable complete denture, located at its posterior border, which places pressure, within physiologic limits, on the posterior palatal seal area of the soft palate; this seal ensures intimate contact of the denture base to the soft palate and improves retention of the denture" [(2)].

The posterior palatal seal is an influential factor in denture retention. It is a part of the peripheral seal. It acts as a valve of closure beneath the denture base. There are many techniques for recording the posterior palatal seal. These techniques can be mostly categorized into functional, conventional, and arbitrary techniques. The posterior palatal seal can be also added to an old denture if it lacks enough palatal sealing [(3)].

In order to improve the retention of complete denture, denture base has to be closely adapted to the underlying tissues. Owing to the inherent polymerization shrinkage of the acrylic resin, its adaptation to the underlying tissues will be affected to some extent which in turn may compromise the denture retention. So the technique of acrylic resin

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polymerization and the acrylic resin material itself have been developed in order to produce more fitting acrylic denture bases [4].

Thermoplastic injection molding resins have physical and mechanical properties that are comparable to the conventional heat cure acrylic resins, such as higher flexible strength which allows the denture bases fabricated by thermoplastic resins from engaging undercuts to gain mechanical retention [5].

MATERIAL AND METHODS

The study was conducted in the outpatient clinic of Prosthodontics Department, Faculty of Dental Medicine, Al Azhar University. Ten Edentulous patients with healed, smooth, well-formed and rounded ridges were selected. Oral mucosa was resilient and firmly attached to the underlying bone.

To locate the posterior palatal seal for taking the final impression, the patient was seated in relaxed position. A T-burnisher or mouth mirror was used to trace the pterygomaxillary notches which were felt as the instrument dropped after it passed the maxillary tuberosity by 2-3 ml posterior to it. Two line marks were made by the indelible pencil at the hamular notches three to four millimeters approximating the mucogingival junction on the anterolateral side of the notch. As the patient said "ah" in short and normal bursts a mark was drawn in the middle of soft palate to locate the posterior vibrating line. A connecting line was drawn between the marks at the hamular notches with the middle mark of the posterior vibrating line.

Zinc oxide eugenol (SS White, SS White Group, England) final impression was made for the mandibular arch and twice for the upper arch on two separate special trays for each patient. One of the two final impressions was corrected at its posterior border by using Iowa wax for the functional posterior palatal seal technique. The two final impressions, the one corrected with the Iowa wax and the non-corrected one, were boxed and poured with dental stone to obtain two master casts. Liquid silicone (Nobilsil Silicone, Nobilium, United States) base and catalyst were mixed and prepared in a flow consistency and poured over the master casts. Finally, the master cast was retrieved from the duplicating flask after setting of the silicone.

After the master cast was removed from the duplicating flask, silicone duplicate of the Iowa wax impression was poured with a hard-dental stone (Hard, Dental Stone, China). The other flask, which contained the master cast without the Iowa wax, was poured two times by dental stone to obtain two duplicate master casts. The three master casts (the original and the duplicate) were scrapped to obtain posterior palatal seal by three different techniques for construction of conventional heat curing acrylic resin bases. The scraped casts were then duplicated in flasks and poured with hard dental stone for processing of the denture bases by the thermoplastic injection molding acrylic resin.

For the functional technique, after making the final impressions, the anterior and posterior vibrating lines were located and drawn in the patient's mouth by indelible pencil. The posterior vibrating line was located and drawn as discussed before. The patient was requested to say "ah" in short vigorous bursts to locate the anterior vibrating line and it was drawn by an indelible pencil in a curved fashion similar to a "Cupid's bow" appearance or a butter fly wings (figure 1). Then, the impressions were inserted into the patient's mouth to transfer the vibrating lines to the impression surface. Iowa wax (Impression wax, D-R MINER, United States) was heated in the wax pot (Digital Wax pot, Wax Pot, China) and then it was painted by brush onto the final impression within the outline of the transferred vibrating lines.

The amount of wax added on the impression surface was coinciding with the compressibility palpated at the posterior palatal seal area (figure 2).

For the conventional technique, the anterior and posterior vibrating lines were accentuated with an indelible pencil on the original master cast. Within the outline of the anterior and posterior vibrating lines, the cast was scraped to a depth according to the amount to which the palatal tissues in that area was compressed as identified by pressing the ball portion of the T-burnisher or tip of the mirror. For the beading technique, the posterior vibrating line was transferred from the original cast to the duplicated cast by means of putty silicone ribbon (Zetaplus, Zhermack, Italy). The bead was made across the palate about 2 mm anterior to the posterior vibrating line extending through the pterygomaxillary notches [6]. The width of the posterior palatal seal was limited to the V-shape groove of the bead with width about 1.0 to 1.5 mm at its base and 1.0 to 1.5mm deep. Lastly, for the arbitrary technique anterior and posterior vibrating lines were approximately marked on the master cast. The arbitrary posterior palatal seal was scrapped with a predetermined width and depth, where the narrowest areas were in the mid palatal region and hamular notches. The areas in between mid-palatal region and pterygomaxillary notches were wider and deeper. All the scraped casts were then duplicated in flasks by using silicone duplicating material and poured with hard dental stone.

During the construction of denture base using the heat curing technique, the master cast was waxed up by a sheet of wax and a stainless steel wire ring was fixed into the wax plate before the posterior border by 0.5 cm at the midline [7]. Acrylic resin dough was made by mixing the powder polymer and liquid monomer (Vertex, Vertex Dental, Netherlands) to form dough which was packed into the gypsum mold. The flask was put in a spring clamp and the clamp was closed tightly under pressure. Denture base was cured in curing unit (Heat cure, OMEC, Italy) and the curing temperature was programmed on long cycle 100°C for 8 hours to assure maximum polymerization of the monomer.

While for the fabrication of denture base using the injection molding technique. A wax sprue former was connected to the wax plate to make a sprue channel in the investment where acrylic resin injection took place. The flask was opened and flushed with clean boiling water to remove all the residue of wax. A cartridge was loaded with 30 gm. (Polyan IC, Bredent, Germany) thermoplastic acrylic resin and placed into the cartridge carrier which was placed in electric cartridge furnace (Thermopress 400, Bredent, Germany) used for softening of denture base material to be plasticized for 15 to 20 minutes at 265°C. Pressure of the injection molding machine was adjusted at 9.5 bars for 60 seconds to allow complete flow of the material into the mold, and then the pressure was relieved. The flask was allowed to bench cool for at least 15 to 20 minutes and then it was opened to retrieve the denture base. After the denture base was retrieved, it was finished and polished and the sprue former was cut with special type of disks.

The retention of four different techniques of posterior palatal seal; functional, conventional, beading, and the arbitrary techniques were measured. Denture bases fabricated for each palatal seal technique by two materials; the conventional heat cure acrylic resin and the thermoplastic injection molded acrylic resin were tested for retention. The patient was asked to keep his head against the head rest with his or her upper jaw parallel to the floor along the whole procedure. Upper denture base was seated with a firm pressure for about ten seconds into the patient's mouth after the patient rinsed with water to keep away excess saliva. A measuring digital device with a hook (Force Gauge, WeiHeng, China) was joined to the ring of the denture base to apply vertical force.

The force was applied by hand on a fixed rate till the denture base was unseated from the patient's mouth. The amount of force was recorded in grams at which unseating of the denture base occurs. The retention was measured three times for each denture base and the average measure was recorded.

Fig. (1) Butterfly or the Cupid's bow appearance of the posterior palatal seal.

Fig. (2) Final impression with Iowa wax (lateral view)

RESULTS

Table (1) and figure (3) show the mean retention measured for each posterior palatal seal technique made in denture bases fabricated by two different acrylic resins that were the thermoplastic injection molding acrylic, and the conventional heat cure resin. For the functional posterior palatal seal technique, the heat cure acrylic resin showed the highest mean retention of 27.08 ± 12.44 followed by the denture bases fabricated by the thermoplastic injection molding acrylic resin with mean retention of 26.95±12.37. The conventional posterior palatal seal technique ranked the second with mean retention of 20.45 ± 11.58 for the denture bases fabricated by the injection molding technique, and with mean retention of 20.1 ± 11.51 for denture bases fabricated by the heat cure method. Then the beading posterior palatal seal technique ranked the third with mean retention of 19.38 ± 11.16 for the denture bases fabricated by the injection molding technique, and with mean retention of 19.36 ± 10.78 for denture bases fabricated by the heat cure method. Finally, the arbitrary posterior palatal seal technique ranked the last with mean retention of 17.05 ± 10.22 for the denture bases fabricated by the injection molding technique, and with mean retention of 17.04 ± 9.82 for denture bases fabricated by the heat cure method.

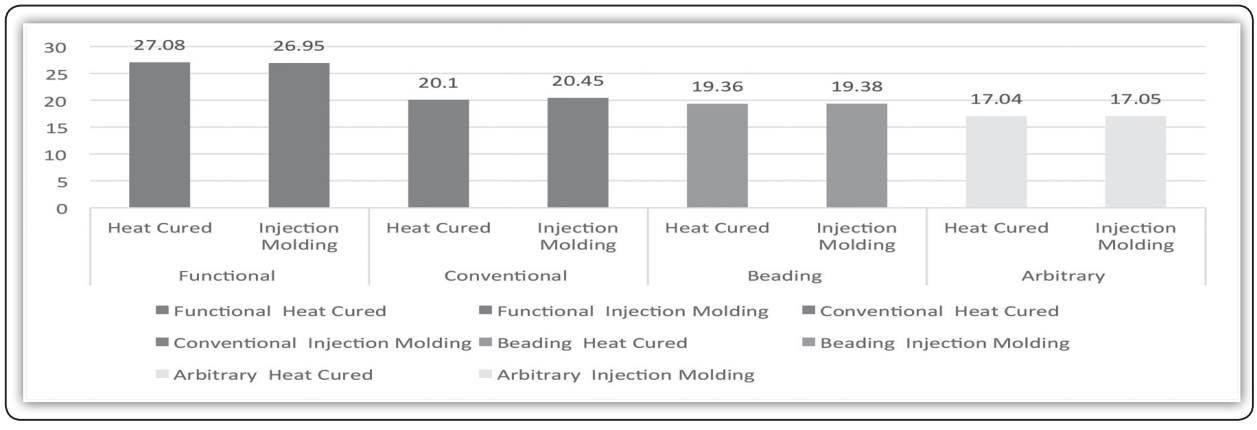

Fig. (3) The mean retention of denture bases with different posterior palatal seal techniques fabricate by two materials.

Table (2) shows the results of two-way analysis of variance (ANOVA) made on the retention measures of the four posterior palatal seal techniques. The difference in retention acquired by the variable posterior palatal seal techniques was statistically significant *p= 0.041 (≤0.05)*. However, changing the material of denture fabrication from heat cure resin to injection molding resin had a non-significant effect on the retention values p=0.981 (≥ 0.05). The interaction between the posterior palatal seal technique and the material of denture base fabrication had a non-significant effect on retention values p=1.000 (≥ 0.05).

TABLE (1) The mean retention of denture bases for the different posterior palatal seal techniques and base materials.

PPS Technique	Processing Technique	Mean	S.D
Functional	Heat Cured	27.08	12.44
	Injection Molding	26.95	12.37
Conventional	Heat Cured	20.1	11.51
	Injection Molding	20.45	11.58
Beading	Heat Cured	19.36	10.78
	Injection Molding	19.38	11.16
Arbitrary	Heat Cured	17.04	9.82
	Injection Molding	17.05	10.22

PPS: posterior palatal seal technique. *S.D: standard deviation*

TABLE (2) Two-way ANOVA comparing the amount of retention of denture bases.

Source of Variation	SS	df	MS	F	F crit	P-value
Processing Technique	0.075	1	0.075	0.001	3.974	0.981$^{n.s}$
PPS Techniques	1099.726	3	366.575	2.887	2.732	0.041*
Interaction	0.607	3	0.202	0.002	2.732	1.000$^{n.s}$

SS: sum of squares df: degree of freedom MS: mean square F crit: F critical
**: statistically significant p≤ 0.05 n.s: non-significant*

DISCUSSION

The results of the current study deduced that the technique of posterior palatal seal had a crucial effect on retention of upper complete denture. The highest retention was gained from the functional technique. The conventional technique was similar in retention to the beading technique. The arbitrary technique gave the least retention to the denture bases. Chandu et al [6] found that the retention of the functional posterior palatal seal was higher than the conventional posterior palatal seal by 28%. These results were consistent with this study where the functional posterior palatal seal was higher than the conventional posterior palatal seal by 26% for the heat cure technique and by 24% for the injection molding technique.

The results of the conventional and beading techniques were close to each other which agreed the clinical study made by Avant [8]. He scraped the master cast duplicates and constructed denture bases on them to compare retention for the both techniques. In the current study the conventional posterior palatal seal was slightly higher than the beading posterior palatal seal by 4% for heat cure technique and by 6% for injection molding technique. The measuring results of the conventional and the beading posterior palatal seal were similar because they depended on the same posterior vibrating line during locating posterior palatal seal.

The functional posterior palatal seal was higher than the arbitrary posterior palatal seal by 37.1% for the heat cure technique and by 36.7% for the injection molding technique, which agreed with Jkefowicz [9] who found that the retention of the functional posterior palatal was higher than the arbitrary posterior palatal seal by 41.5%.

There was no significant difference between the retention of denture bases fabricated by the conventional heat cure and the injection molding acrylic resins. Although the continuous pressure of the injection molding technique till the complete setting of the acrylic resin was thought to decrease polymerization shrinkage and enhance the dimensional accuracy of denture bases fabricated by the injection molding results. These results were in agreement with that of Artopoulos et al [10], Keenan et al [11], and Ramadan et al [12]. Artopoulos et al [10] digitized the intaglio surface of denture bases fabricated on a model by the heat cure technique and injection molding. They used surface matching software and found that the dimensional accuracy of the both methods were similar so the retention was expected to have no great difference.

Keenan et al [11] concluded that there is no difference in dimensional accuracy of the two techniques after they examined the vertical dimensional change of the fabricated complete dentures on the articulator. Ramadan et al [12] used a microscope to measure the gap distance between the master casts and the fabricated denture bases. They found that the measures were the same for the heat cure and injection molding techniques. Lamb et al [13] agreed with the results of the study where a palatal discrepancy persisted after processing of dentures. The influence of processing method did not improve by the injection molding. Dimensional accuracy of the injection molding acrylic resins did not have a significant clinical effect.

The Results of the study made by Nogueira et al[14] revealed that there were no appreciable differences between injection molding and heat cure techniques. The incisal pin opening was measured with a micrometer immediately after deflasking. Parvizi et al [15] in his study took the reference points for the linear measurements consisted of three attachments. He measured the distance between the three attachments before and after the processing. Results showed that the difference was not significant between the injection-molded specimens and the conventionally processed specimens.

CONCLUSION

Under the limitations of this study, it was concluded that the functional posterior palatal seal gave the upper complete denture the highest retention and it was statistically significant. The arbitrary posterior palatal seal gave the upper denture the least retention. The conventional and beading posterior palatal seal techniques were higher in retention than the arbitrary posterior palatal seal. It is recommended to use the functional posterior palatal seal technique. If this is not feasible either the conventional or the beading posterior palatal seal can be used. The arbitrary posterior palatal seal should not be attempted. Finally, the difference in retention between the injection molding and the conventionally cured acrylic resin denture bases was not significant.

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