Influence of high expansion dental stone and teeth on the adaptation of maxillary complete denture base

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ABSTRACT

Background: The aim of this study was to verify the influence of high expansion dental stone and teeth on the adaptation of maxillary complete dentures.

Materials and Methods: Maxillary complete dentures/bases were processed on type III dental stone and high expansion dental stone casts. The gap-space between the acrylic denture base and the cast in the posterior palatal seal area was measured by using dino-lite digital microscope. A comparison was made between G1 and G2, G3 and G4 to evaluate the influence of dental stone on the adaptation accuracy and another comparison between G1 and G3, G2 and G4 was made to evaluate the influence of teeth on the adaptation accuracy of maxillary complete denture.

Results: Statistical analysis of the data revealed that the fitness of maxillary complete denture base was significantly improved in some points with high expansion dental stone compared to dental stone type III and the presence of teeth reduced the gap-space in the posterior palatal seal area when dentures with teeth were compared with denture bases without teeth (p<0.05).

Conclusions: Using the high expansion dental stone and presence of teeth would influence the adaptation accuracy of denture base which in turn would improve the quality of the dentures.

Key words: High expansion dental stone, Gap-space, Adaptation accuracy. (J Bagh Coll Dentistry 2012; 24(Sp. Issue 2):31-35).

INTRODUCTION

Since the introduction of acrylic resin as a denture base material in 1937, its use has become almost universal (1). The dimensional changes that occur during the processing of these materials, however, still continue to concern the practitioner seeking an accurate denture base (2,3). Dimensional changes during processing have been reported as resulting from the resin itself as well as the accompanying manipulative procedures (1-5).

Upon polymerizing, these poly (methyl methacrylate) resins exhibit a 0.2% to 0.5% linear polymerization shrinkage. A similar degree of linear expansion should occur because of water sorption (6). Therefore, it would appear that these two opposing processes would balance each other and would result in an accurately fitting base. However, clinical experience and research findings indicate that this does not occur. Linear shrinkage is actually greater than linear expansion (7). The expansion of dentures after storage in water at room temperature for one week failed to compensate for the initial processing shrinkage (8). The dentures remained dimensionally stable even after storage in water for eight months (9).

A long-established method for denture processing for acrylic polymer is a closed-flask compressing molding with heat activation in a water bath for resin polymerization (10). However, polymerization shrinkage of the resin and distortion of the denture base due to thermal stress is virtually unavoidable during the processing of dentures. These adverse effects cause movement of the artificial teeth position and increase the gap between the denture base and underlying mucosa, resulting in an ill-fitting denture (11). It was suggested that an accurate fitting is a key factor in the physical mechanisms of complete denture retention (12).

The current study was carried out to assess the effect of the high expansion dental stone (dental stone type V) and teeth on the adaptation accuracy of the maxillary denture base at the posterior palatal seal area.

MATERIAL AND METHODS

Silicon duplication material (16), dental stone type III, high expansion dental stone (dental stone type V), dental plaster, heat cure acrylic resin powder and liquid, bioacryl plates (2mm thickness), articulator (Hanau), biostar machine, electronic scale, flask, clamp, hydraulic press, vibrator, water bath, cutting saw device and Dino-Lite digital microscope, were some of the material used in this study.

Sample grouping:

The study involved 40 samples (maxillary complete denture/base) grouped as following:

Group 1 (G1): denture base without teeth processed on type III dental stone cast.

Group 2 (G2): denture base with teeth processed on type III dental stone cast.

Group 3 (G3): denture base without teeth processed on high expansion dental stone cast.

Group 4 (G4): denture base with teeth processed on high expansion dental stone cast.
Group 2 (G2): denture base without teeth processed on type V dental stone cast.
Group 3 (G3): denture base with teeth processed on type III dental stone cast.
Group 4 (G4): denture base with teeth processed on type V dental stone cast.
Each group included 10 samples.

Maxillary cast mold preparation:
A maxillary edentulous cast of medium depth palate was sealed on the base of a container which was already placed on the vibrator. The silicone duplication material was mixed (1:1) and poured gradually in 45° angle into the container to avoid air bubble entrapment. After complete setting of the silicone, the mold was removed from the container. This mold was used to pour 40 casts; 20 casts poured with type III dental stone while the other 20 casts poured with type V dental stone.

Conventional denture mold preparation (denture base with teeth):
A cast with its record base which was made from a biostar sheet was used to construct the occlusion rim. Both width of the occluding surfaces and the contour of the arch form of the occlusion rim were established to facilitate the arrangement of the artificial teeth. The maxillary cast along with its occlusion rim was mounted on the articulator and a plate was used to assemble the lower occlusion rim. Once the cast was mounted on the articulator, the teeth were set on the occlusion rim which provided reliable guides for the placement of the teeth. After completing teeth arrangement, wax sprues were made and waxed on each side on the maxillary tuberosities. Then the cast was glued to the base of a container which was already on the vibrator; the biostar denture base was sealed to the cast by waxing. Silicone duplication material was mixed (1:1) and poured gradually in 45° angle into the container which was already placed on the vibrator. After complete set, the set mold was removed from the container, the cast and the wax sprues were removed as well and a cutter was used to remove the excess of the duplication material.

Duplication of maxillary complete waxed denture (with teeth):
Wax sheet was cut into pieces and heated by using burner; meanwhile, artificial teeth were inserted into their holes in the mold and the cast was adapted onto the mold. The wax was poured from one hole until the wax was spilled out from the other hole. After waiting for an hour, the cast was removed from the mold. The sprues were removed and carved. Group 3 and 4 were duplicated by using this mold.

Record base preparation:
The record base was prepared by using a biostar machine. This was done to all samples in both, group 1 and 2, to ensure even thickness for the samples.

Flask preparation and wax elimination:
The cast with the record base was flasked in the lower part of a traditional brass flask with (50/50) plaster/stone mixture (13). A separating medium was applied to the investment and allowed to dry, and then the upper part of the flask was assembled and filled with the same plaster/stone mixture ratio. After 1 hour, the flask was placed in boiling water for 10 minutes for wax elimination. The flask parts were separated, the record bases were removed, and a layer of separating medium of fixed volume about 1 ml was applied on the surface of the investment material and cast.

Packing and curing the acrylic:
Poly (methyl methacrylate) dough was used for packing with a monomer/polymer ratio of (1:3) by volume according to the manufacturer instruction. Each two flasks were placed in a clamp after a final pressing in the hydraulic press under the load of 100 Bar for 5 minutes. The flasks were immersed in water at room temperature, heated up to 100 ºC, left in the boiling water for 30 minutes according to the manufacturer instructions.

De-flasking and Sectioning:
The flasks were removed from the water bath and allowed to bench cool for 3 hours before the casts were de-flasked with their corresponding dentures on and sectioned. While de-flasking, great deal of attention was made to avoid separating the denture from its corresponding cast because once the denture is removed from the gypsum cast on which it has been cured, the denture, when it is replaced on it, will not fit it. The denture/base casts were transversely sectioned 2 mm posterior to the fovia palatinae (14). After determining the cutting line, each denture/base-cast set was positioned in the sawing device. The cutting was made on a fixer table under constant water cooling. Then five points were marked on the section (midline point “M.P”, right 5mm from the midline point “R5mm”, right 10mm from the midline point “R10mm”, right crest ridge “R.C.R”, right marginal ridge “R.M.R”) in order to measure the gap-space at these points. The midline of each maxillary cast was determined by drawing a line from labial frenum & incisive papilla along the mid-palatine raphe to the posterior border of the cast.
Measurements were made on the right side of the midline.

**Measurements:**
Measurements were made immediately after sectioning of the casts by using a digital microscope (Dino-Lite digital microscope) with magnification power of 200x. The software of the microscope allows the investigator to take the measurements while observing the magnified objects. Three measurements were taken for each point & their mean was estimated.

**RESULTS**
T-test and P-value were used to evaluate the influence of high expansion dental stone and teeth on the adaptation accuracy of denture base.

**Influence of dental stone on the adaptation of maxillary denture bases:**
Table (1) shows that there is a significant statistical difference between G1 and G2 at M.P as (P < 0.05) while there are no significant differences in the other four points. Table (2) shows that there are significant statistical differences between G3 and G4 at M.P, R5mm, R.C.R as (P < 0.05) while there are no significant differences in the other points.

**Influence of teeth on the adaptation of maxillary complete denture base:**
Table (3) shows that there is a significant statistical difference between G1 and G3 at the R10mm as (P < 0.05) while there are no significant differences in the other four points.
Table (4) shows that there is a significant statistical difference between G2 and G4 at the R5mm as (P < 0.05) while there are no significant differences in the other points.

Figure (3) shows the Mean distribution of the measured gap-space between G 1 and G 3 samples. It is obvious that there is a significant difference between the means at R10mm. Figure (4) shows the Mean distribution of the measured gap-space between G 2 and G 4 samples. It is obvious that there is a significant difference between the means at R5mm.

**DISCUSSION**

**Influence of dental stone on the adaptation accuracy of maxillary complete denture:**
Dentures processed on high expansion high strength dental stone casts (group 2 and group 4) produced more adaptive dentures than those processed on type III dental stone casts (group 1 and group 3). Type III dental stone which was used in this study has setting expansion of only (0.07%). In contrast, the high expansion dental stone which was used in this study has a setting expansion of (0.18-0.20%). This study demonstrated that the high setting expansion of dental stone can help compensate for shrinkage that occurs as a result of thermal contraction of the acrylic resin material. The addition of different chemicals affects the setting expansion of gypsum products and also may change other properties. As the addition of sodium Chloride (NaCl) in a small concentration increases the setting expansion of the mass yet shortens the setting time (15).

**Influence of teeth on the adaptation accuracy of maxillary complete denture:**
Dentures processed with teeth (group 3 and group 4) produced more adaptive dentures than those processed without teeth (group 1 and group 2). This is probably due to the thickness of the denture base; the denture base in group 3 and group 4 was thicker than that in group 1 and group 2 at the buccal flange and the ridge because of the extra acrylic needed to attach the teeth to the denture. The thicker the denture base, the more the polymerization shrinkage but the higher the adaptation in the palatal seal area because the strain will be higher in that area since de-casting of the dentures from their casts was not required in this study so there was no release for the stress. According to this, the thicker denture supposes to have higher internal stress. However, the adaptation was not improved in both the right crest of the ridge (R.C.R) and right marginal ridge (R.M.R); figures (3) and (3) show that the gap is increased but this increase was statistically non-significant. This may be related to the anatomical form of that area (topographic form); acrylic in the marginal ridge is not as confined as the palatal area so the internal stress will be somewhat released there which will somehow increase the gap between the acrylic denture base and the cast.

The position of the denture in the flask may affect the adaptation since the direction and the amount of force applied on the acrylic may vary. This could be explained as the acrylic in the palatal area is subjected to higher forces than the crest & the marginal ridge areas due to the higher the investment column (pillar) upon the palatal area compared to the crest and the marginal ridge areas. This means that more force is subjected on the palatal area in comparison to the other areas.

The discrepancies recorded on the cast that take place during denture base fabrication are not uniform and depend on its location inside the flask, this agrees with the results of this study (16).

Also in this study, rapid curing polymerization cycle was used. This means that acrylic was cured.
up to 100°C for 30 min. which probably increased the amount of residual monomer contents in the final denture bases. Several studies showed that the polymerization temperature and time considerably affected the residual monomer content of the denture base polymers (17).

REFERENCES
Figure 1: Mean distribution of the measured gap-space between G1 & G2

Figure 2: Mean distribution of the measured gap-space between G3 & G4

Figure 3: Mean distribution of the measured gap-space between G1 & G3

Figure 4: Mean distribution of the measured gap-space between G2 & G4