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Effect of curing cycles on vertical dimension of complete Dentures: An *in vivo* study

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Abstract
The Purpose of the study is to determine the effect of long curing cycle and short curing cycle on changes in vertical dimension of occlusion of complete. The study was conducted in 20 completely edendulous patients, 10 complete dentures were fabricated with short curing cycle and 10 dentures with long curing cycle. All of the initial clinical steps involved in fabrication of dentures, with the exception of the curing cycle, were the same for both the groups. Vertical dimension of occlusion was measured with digital vernier caliper from specific points of reference on upper and lower member of articulator at 3 stages, stage 1 before polymerization, stage 2 after remounting the processed complete dentures and stage 3 after remounting of finished and polished complete dentures. In order to determine the change in vertical dimension, the measurement recorded prior to processing the dentures was subtracted from the measurement recorded just after processing as well as the one recorded after finishing & polishing. The readings were statistically analyzed and compared. Both the groups demonstrated a highly significant increase in VDO after processing of dentures. On comparison between both the groups, non significant results were obtained in the mean difference in VDO just after processing and after finishing & polishing of dentures. The clinical relevance of these changes does not confirm the superiority of any one curing cycle in terms of dimensional changes in VDO after processing.

Keywords: Complete dentures, vernier caliper, vertical dimension of occlusion, curing cycles

1. Introduction
Dimensional stability is an essential physical property for denture base materials to make sure that they are able to maintain their shape during service. Polymethyl methacrylate is most regularly used denture base material since decades. Though it has good mechanical, physical and esthetic properties, it does not manifest all the requirement of an ideal denture base material. Many studies have revealed that polymethyl methacrylate undergoes deformation which can be attributed to thermal expansion, contraction during cooling and shrinkage during polymerization. These features produce internal stresses creating unavoidable dimensional changes and denture base deformation and a definite movement of teeth during processing of dentures which may result in an increase in vertical dimension of occlusion. This increase in vertical dimension of occlusion would disturb the occlusal scheme. An altered occlusal scheme and vertical dimension can be of potential clinical significance and may cause patient discomfort during mastication, swallowing and speech, trauma to denture bearing tissue, bone resorption, soreness and pain in temporomandibular joint. To recover the actual vertical dimension of occlusion a time consuming occlusal adjustment is needed that can also lead to destruction of anatomy of artificial teeth. Changes in the denture base, planned occlusal scheme and increased vertical dimension of occlusion should be minimum to avoid discomfort of patient and wastage of time. Several researches have been conducted to identify improved materials and processing technique to minimize changes in occlusion in order to avoid patient discomfort and reduction of chair-side time.

But in spite of improvement in acrylic properties the problem of undesirable dimensional changes remains unresolved. In 1983 Dukes *et al.* [2] compared the effects of different investing mediums on changes in vertical dimensions of occlusion in complete dentures, the study revealed that the combination of artificial stone with silicone rubber more accurately reproduced the vertical dimension of occlusion than any other investing medium used in investigation. Strohover (1989) [7] stated that dentures processed with injection molded method produced significantly less changes in vertical dimension as compared to conventional pack and press method. In 1991 Nelson *et al.* [4] conducted a investigation to compare the increase in vertical dimension of occlusion of complete dentures after processing with conventional and microwave technique and observed that less selective grinding of teeth was required to remove processing changes in conventional cure method. In literature various studies are available regarding effect of investing and processing methods on dimensional changes in complete dentures. However the effect of different curing cycles on vertical dimension of occlusion remained relatively unexplored. A study has been planned to evaluate the effect of long curing and short curing cycle on the changes in vertical dimension of occlusion.

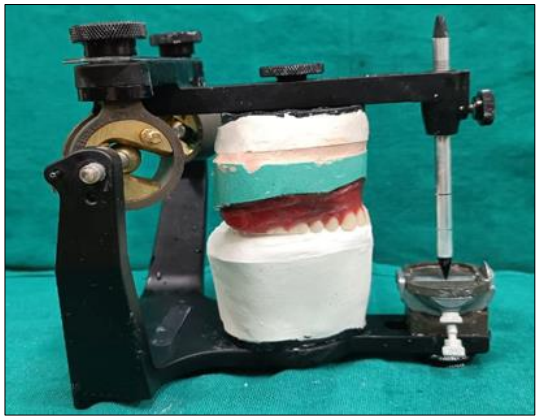
Materials and Methods

Maxillary and mandibular primary impressions were made with impression compound in non perforated metal stock trays of appropriate shape and size. The impressions were poured with type II gypsum (model plaster) to make the primary cast. On the primary cast auto polymerised acrylic resin custom trays were fabricated with 1mm thick wax spacer. The trays were checked in patient's mouth for peripheral extension and adjusted to be 2mm short of the reflections. Border moulding was done using low fusing impression compound and secondary impressions were made with zinc-oxide eugenol impression paste. The impressions were poured in type III gypsum (dental stone) to prepare the master casts. Trial denture bases of autopolymerizing acrylic resin and occlusal rims of modelling wax were fabricated on the master casts. The maxillary and mandibular occlusal rims were adjusted in the patient's mouth and maxillomandibular relations were recorded. Facebow transfer was performed, and the maxillary cast was oriented onto Hanau's semi-adjustable articulator using the split cast method to remount the casts accurately on the articulator after denture processing. Before articulation the casts were lubricated with petroleum jelly for easy removal during dearticulation. After recording the centric jaw relation, the occlusal rims were sealed followed by mounting of the mandibular cast along with sealed rims onto the lower member of the articulator against the maxillary cast. Anatomical acrylic resin teeth sets were selected according to shade, shape and size of the patient's requirements and teeth arrangement was done according to basic guidelines. On the try-in stage, the trial dentures were checked for acceptable aesthetics, occlusion and phonetics. Protrusive records were taken in order to adjust the condylar guidance, and the occlusion was balanced. It was checked in the patient's mouth again. Following try-in, both the maxillary and mandibular trial dentures were sealed to their respective casts. Reference points were marked on upper and lower member of the articulator and stage 1 VDO measurements were recorded before dearticulation with digital vernier caliper (Photograph 1).

Photograph 1: Stage 1 Measurements Recording with Digital Vernier Caliper

Occlusal jig (Photograph 2)

An occlusal jig was fabricated to remount the processed dentures along with casts in the same spatial position as it was before processing. A plastic glass was used to prepare the jig. The base of plastic glass was removed to ensure that it fixed onto the mounting plate. The mandibular cast along with mounting plate was removed from the lower member of the articulator and another mounting plate was fixed over the lower member of the articulator and the plastic glass was fitted over it. The maxillary trial denture`s teeth were lubricated with petroleum jelly. The plastic glass was filled with model plaster and upper member of articulator along with maxillary trial denture was placed within the plaster mix in such a way that it covered the lubricated portion of incisal and occlusal surfaces of the maxillary teeth. After the setting of plaster, the plastic glass was removed. The maxillary trial denture along with maxillary cast was carefully removed from set occlusal jig.



Photograph 2: Occlusal Jig

Flasking procedure

Before investing the cast and trial denture, a thin layer of

vaseline was applied to the base of the casts for easy removal during deflasking. The stone casts and trial denture were invested in a conventional manner. After the setting of investment medium, the flasks were immersed in boiling water for 5 minutes to soften the wax. The flasks halves were separated and wax was completely removed by flushing with boiling water. The packing was carried out in the conventional method. Heat cure acrylic resin was mixed in a polymer: monomer ratio of 3:1 by volume and packed in dough stage. A trial closure was performed with a cellophane sheet until no excess resin flash was seen between two half of flasks. The flasks were transferred to the traditional flask carrier [clamps] after packing. Before placing the packed flasks in the acrylizer, they were bench cured for 30 minutes.

Curing of complete dentures

Ten sets of complete dentures of Group A were processed with short curing cycle for 2 hours at 74°C with 1 hour terminal boiling and ten sets of complete dentures of Group B were processed with long curing cycle for 9 hours at 74°C.

After curing, the dentures were allowed to bench cool and were carefully deflasked to avoid denture breakage or dislodgement of the dentures from the casts.

Remounting (Photograph 3)

After curing process was complete, the casts along with dentures were carefully removed from the flasks. After cleaning the cast along with dentures from residual investment debris, maxillary cast was oriented on the articulator to the original mountings, with the help of split made on the base of the cast and occlusal jig being used as guides. Then occlusal jig was removed from the base of the articulator and mounting plate with attached mandibular cast along with denture was mounted on the articulator.

Photograph 3: Remounted Maxillary Cast Along with Denture with The Help of Occlusal Jig

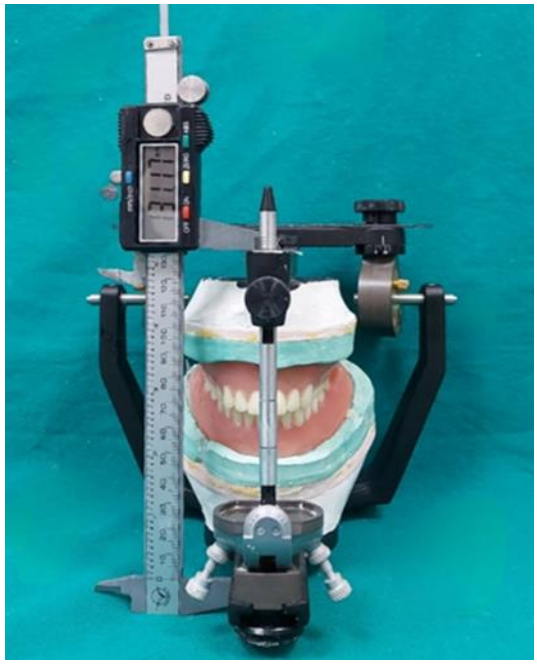
Measurement of vertical dimension of occlusion

Stage 2 recording- The distance between the reference points marked on upper and lower members of the articulator was measured after remounting of processed dentures on the articulator (Photograph 4).

Photograph 4: Stage 2 Measurements Recording.

After recording the stage 2 measurements the dentures were carefully removed from the cast and finishing and polishing was done.

Stage 3 recording- The finished dentures were again placed on the mounted maxillary and mandibular casts and the measurements were recorded (Photograph 5).



Photograph 5: Stage 3 Measurements Recording.

Readings of all the 3 stages were put to statistical analysis and the differences were evaluated.

Results: On comparison of difference in VDO of Group A Short curing cycle and Group B Long curing cycle the mean difference was 0.234mm between stage 1 and stage 2 with standard deviation of 0.330, t value 1.269 and p value 0.221, which was statistically non significant. The mean difference in VDO was 0.362mm between stage 1 and stage 3 with standard deviation of 0.189, t value 1.994 and p value 0.062, which was statistically non significant. The mean difference in VDO was 0.127mm between stage 2 and stage 3 with standard deviation of 0.127, t value 0.72 and p value 0.476, which was also statistically non significant.

Table 1: Comparison of difference in vertical dimension of occlusion between Short Curing Cycle and Long Curing Cycle (independent sample t-test)

	Groups	N	Mean change	Std. Deviation	Std. Error Mean	Mean Difference	95% Confidence Interval of the Difference		T	p value	Significance
							Lower	Upper			
Stage 1 & 2	Group A	10	1.092	0.544	0.172	0.234±0.330	-0.154	0.622	1.269	0.221	NS
	Group B	10	0.858	0.213	0.067						
Stage 1 & 3	Group A	10	1.318	0.489	0.155	0.362±0.189	0.019	0.743	1.994	0.062	NS
	Group B	10	0.957	0.300	0.095						
Stage 2 & 3	Group A	10	0.226	0.434	0.137	0.127±0.091	-0.241	0.495	0.727	0.476	NS
	Group B	10	0.099	0.344	0.109						

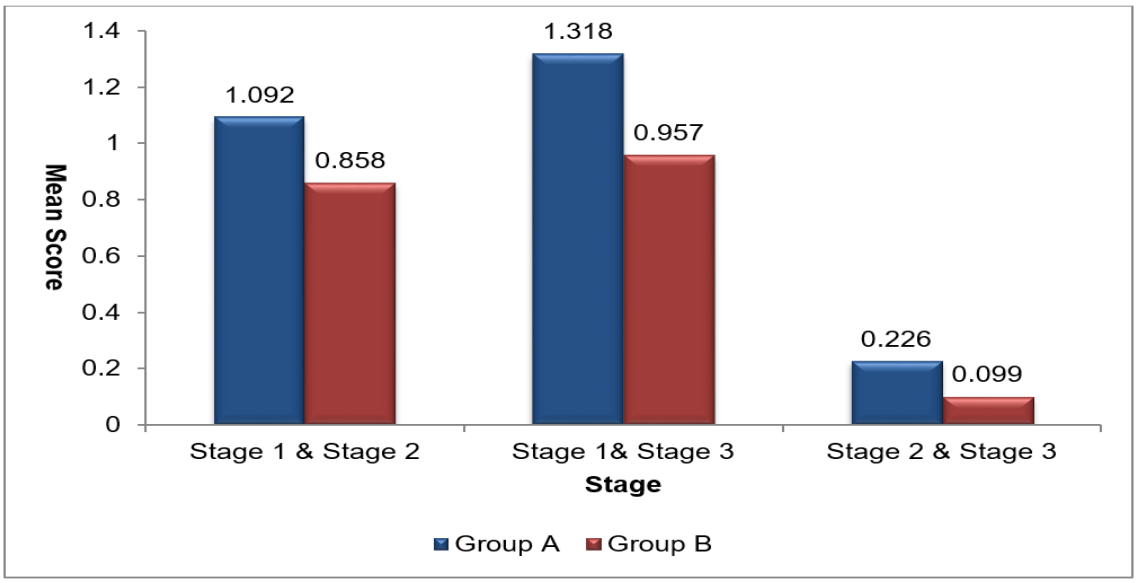


Fig 1: Comparison of difference in vertical dimension of occlusion between Short Curing Cycle and Long Curing Cycle (independent sample t-test)

Discussion

Any change in the relationship between teeth, and the teeth and master cast as a result of the investing procedure, careless packing of acrylic resins in the mold cavity or improper flask closure and warpage of the denture base due to the release of inherent strains when the denture is separated from the cast are the main causes of occlusal discrepancies in processed dentures. These occlusal discrepancies may alter the established vertical dimension of occlusion. The change may range from negligible to a significant increase in VDO, which may be well tolerated by some patients due to resiliency of oral mucosa while some patients may experience difficulty in speaking, eating and swallowing, mucosal pain and clicking sound made by the dentures. A study was conducted to compare the effect of long curing cycle and short curing cycle on the changes in vertical dimension of occlusion of complete dentures fabricated by conventional method. Twenty completely edentulous patient were provided with heat cure acrylic complete dentures. The dentures were divided into 2 Groups: Group A 10 complete dentures were processed with short curing cycle and Group B 10 complete dentures were processed with long curing cycle. Vertical dimension of occlusion was measured at 3 stages with a digital vernier caliper, stage 1 waxed up trial denture before processing the complete dentures, stage 2 after remounting of processed complete dentures and stage 3 after remounting of finished and polished dentures. The results of the present study revealed a significant increase in vertical dimension after processing of complete dentures of both the groups. In Group A complete dentures cured with short curing cycle, the mean increase in vertical dimension from stage 1 to stage 2 was 1.092 mm and from stage 1 to stage 3 was 1.318 mm. Whereas the difference of 0.226mm in vertical dimension from stage 2 to stage 3 was observed. The paired t-test result of Group A complete dentures between stage 1 to stage 2, the standard deviation of 0.543 with t value 6.35 and p value 0.001 was observed which was highly significant and from stage 1 to stage 3 the standard deviation of 0.489 with t value 8.526 and p value 0.001 was observed which was also highly significant. From stage 2 to stage 3 the standard deviation of 0.434 with t value 1.646 and p value 0.134 was observed which was non significant. For Group B complete dentures cured with long curing cycle, the mean increase in vertical dimension of dentures from stage 1 to stage 2 was 0.858mm and from stage 1 to stage 3 was 0.957mm. Whereas the difference of 0.099mm in vertical dimension from stage 2 to stage 3 was observed. Interestingly similar results were observed for Group B complete dentures in the paired t-test result. From stage 1 to stage 2, the standard deviation of 0.213 with t value 12.743 and p value 0.001 was observed which was highly significant and from stage 1 to stage 3 standard deviation of 0.301 with t value 10.062 and p value 0.001 was observed which was also highly significant. While from stage 2 to stage 3 the standard deviation of 0.344 with t value 0.907 and p value 0.388 was observed which was non significant. The results of present study are consistent with Steck (1950) [9] who observed an increase in vertical dimension of processed baseplates after long curing cycle. Results of his study indicated that vertical dimension of denture was influenced by various factors such as shrinkage of methyl methacrylate during polymerization, shape of teeth, shape of denture, flash and excessive pressure during packing and the

type of investment. D.B. Mahler (1951) [10] was also of the opinion that several factors contribute to change in vertical dimension or tooth position through out the procedure of denture construction. According to him, force applied to flasks during the packing procedure is one of the major contributing factors. Woelfel (1960) [11] conducted an elaborate study using different denture base materials and processing techniques emphasized that any force that distorted the investment or caused the movement of teeth into it, increased the vertical height of dentures. Such forces might be produced by packing, injecting, polymerizing and heating methods. Freeman Hardy (1978) [12] compared fluid resin and compression molding technique and observed that the incisal pin opening was significantly higher in dentures processed with compression molding technique as compared with dentures processed with fluid resin technique. He concluded that rigid investment used with fluid resin technique appears to be more accurate. Wagner A Negreiros (2009) [13] *et al*. were of the opinion that the displacement of teeth could modify the vertical dimension of dentures. They suggested that the delay of 6 hours before acrylic resin polymerization is an important factor in controlling the magnitude of the tooth movement.

Other than a number of variables including the investment process, packing method, and polymerization techniques, some variables are outside the technician's control. These elements are connected to the inherent qualities of the denture base material. The abrupt shift in temperature over a short period of time during a short curing cycle could result in inadequate polymerization of heat-cured acrylic resin, and the stress and strain that follows can increase the VDO in processed dentures. In a long curing cycle, a slow increase in temperature over a long period of time permits greater monomer to polymer conversion and nearly complete heat cure acrylic resin polymerization, resulting in less increase in VDO in processed dentures. The heat generated during finishing and polishing may also induce some stresses and strains in processed dentures which may cause some dimensional changes in VDO.

On comparison in mean difference in VDO between Group A short curing cycle and Group B long curing cycle, a statistically non significant difference was observed. The mean difference in VDO from stage 1 to stage 2 was 0.234mm and from stage 1 to stage 3 was 0.362mm. While the mean difference of 0.127mm in VDO from stage 2 to stage 3 was observed. The independent sample t-test result of comparison of difference in VDO between Group A short curing cycle and Group B long curing cycle, standard deviation of 0.330 with t value 1.269 and p value 0.221 between stage 1 and stage 2 was observed, which was non significant. The standard deviation of 0.189 with t value 1.994 and p value 0.062 between stage 1 and stage 3 was observed, which was non significant The standard deviation of 0.091 with t value 0.727 and p value 0.476 between stage 2 and stage 3 was observed, which was also non significant. The fact that the polymerization process never achieves 100% completion through any curing cycle may be considered as the potential explanation for this non significant difference in VDO between the two groups. Even though a long curing process supposedly results in a greater conversion of monomer to polymer, some residual monomer still remains. As a result, after processing the dentures, there is relatively little difference in the increase in VDO between the two groups. The physical characteristics of acrylic denture base resins cannot be changed by the processing method, and the processing method is not the only factor that can affect how the dimensions change. Every stage of making dentures is crucial. Numerous factors, from flasking to final finishing and polishing of the denture and even after the insertion of the dentures in patient's mouth, could change how the teeth fit together. These various factors leading to changes in positions of teeth can be, the forces applied during flasking that can distort the investment and result in tooth movement, Pressure applied during packing of acrylic heat cure resin in moulds can also cause tooth displacement. Excessive resin flash between two half of flasks may also cause incomplete closure of flasks and change in horizontal as well as vertical relation of teeth to cast. Heating method can also be contributing factor in dimensional change of heat cure acrylic resin as abrupt change in temperature and time may result in residual monomer content in set mass of polymerised resin. After processing, release of residual stresses induced during flasking, packing, curing may also result in dimensional change in processed dentures.

Curing cycle plays a crucial role in change in vertical dimension of occlusion. Dimensional changes can be caused by distortion of heat cure acrylic resin because of three possible reasons; polymerization shrinkage, stress & strain during cooling and deflasking. The release of these residual internal stress & strain along with polymerization shrinkage, thermal contraction during flask cooling and strain accompanying stress release during deflasking may cause dimensional changes in the heat cure acrylic resin. The results of present study for both the groups demonstrated an increase in vertical dimension of occlusion after processing of complete dentures but Group B complete dentures cured with long curing cycle showed a slightly less increase in VDO as compared to Group A dentures cured with short curing cycle. The possible reasons can be: more utilization of monomer in polymerization chain reaction, less amount of residual monomer content and less amount of stress induced in acrylic resin mass. However in short curing cycle abrupt increase in temperature within short duration may cause incomplete conversion of monomer, more residual monomer content resulting in more residual stresses and subsequently greater dimensional changes in processed dentures. Statistically, the results of the present study comparing changes in VDO after short curing cycle and long curing cycle came out to be non significant. This owes to the fact that even though dentures processed with short curing cycle showed slightly higher dimensional changes, but it was possible to correct them with minor occlusal adjustments. Hence, the clinical relevance of these changes does not confirm the superiority of any one curing cycle in terms of dimensional changes in VDO after processing.

Conclusions

Both the groups demonstrated a highly significant increase in VDO after processing of dentures. On comparison between both the groups, non significant results were obtained in the mean difference in VDO just after processing and after finishing & polishing of dentures. The clinical relevance of these changes does not confirm the superiority of any one curing cycle in terms of dimensional changes in VDO after processing.

References

1. Basso MFM, Giampaolo ET, Machado AL, Pavarina AC, Vergani CE. 'Evaluation of occlusion vertical dimension of complete dentures after microwave disinfection',

Gerodontology; c2011. p. 815-821.
2. Dukes BS, Fields H, Morris JC, Jewell A. 'A comparative study of change in vertical dimension of occlusion using different investing mediums', The journal of Prosthetic dentistry. 1983;49(4):568-571.
3. Mosharraf R, Iranmanesh F, Sadeghi E. 'A comapartive study of changes in vertical dimension of occlusion using four different investing mrethods', Journal of Dental Science. 2007;6(1):1-6.
4. Nelson MW, Kotwal KR, Sevedge SR. 'changes in vertical dimension of occlusion in conventional and microwave processing of complete dentures', The Journal of Prosthetic Dentistry. 1991;65(2):306-308.
5. Salloum AM. 'Influence of high expansion dental stone used as investing medium on the changes in occlusal vertical dimension of complete dentures', The Saudi Dental Journal. 2013;25:135-140.
6. Salloum AM. 'Effect of three investing materials on tooth movement during flasking procedure for complete denture construction', The saudi dental journal. 2015;28:36-61.
7. Strohover RA. 'Comparison of changes in vertical dimension between compression and injection molded complete dentures', The Journal of Prosthetic dentistry. 1989;62(6):716-718.
8. Turakhia H, Ram SM. 'Rigid and resilient investing materials- Expected movement of teeth in fabrication of complete dentures an *in vitro* study', The journal of Indian Prosthodontic Society. 2005;5(1):22-25.
9. Steck NS. Measurements of vertical dimension of processed dentures. Journal of Dental Research. 1950 Oct;29(5):616-21.
10. Mahler DB. Inarticulation of complete dentures processed by the compression molding technique. The Journal of prosthetic dentistry. 1951 Sep 1;1(5):551-9.
11. Woelfel CG, Poulton BR. The nutritive value of timothy hay as affected by nitrogen fertilization. Journal of Animal Science. 1960 Aug 1;19(3):695-9.
12. Hardy F. Comparison of fluid resin and compression molding methods in processing dimensional changes. The Journal of prosthetic dentistry. 1978 Apr 1;39(4):375-7.
13. Negreiros WA, Consani RL, Mesquita MF, Sinhoreti MA, Faria IR. Effect of flask closure method and post-pressing time on the displacement of maxillary denture teeth. The open dentistry journal. 2009;3:21.

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