EC DENTAL SCIENCE
Research Article

The Effect of Sterilization on Dimensional Stability of Addition Silicone Impression Material

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Abstract

Objectives: This study was done for assessing dimensional stability and accuracy of an addition silicon impression material with autoclaving.

Methods: 20 impressions for a master model is done with heat resisting plastic trays. The 20 impressions were divided into 2 groups regarding the how they are disinfected: Group 1: (number = 10) Control group, undisinfected impressions (C.G), Group 2: (number = 10) impressions were autoclaved (A.G). Then, pouring was done using extra hard stone (type IV), casts were produced. Impressions dimensional stability and accuracy were assessed indirectly by casts reproduced from impressions taken to the master model by the use of travelling microscope.

Results: Cross arch distance (A): resin master model cross arch distance (A) was (41.36 mm). Cross-arch distance of stone casts Control group (C.G): was 41.553 ± 0.170 mm. Autoclaving group (A.G): distance (A) in stone models was 41.718 ± 0.242 mm. ANOVA proved statistically significant different shrinkage between groups (P-value= 0.006). Dimensional changes in the cross-arch distance of the groups. Cross arch distance changes in stone models of C.G. was 0.191 ± 0.170 mm. dimensional changes in models with A.G. was 0.365 ± 0.242 mm.

Conclusion: Autoclaving of polyvinyl siloxane impression does not affect its accuracy.

Keywords: *Sterilization; Silicone; Stability*

Introduction

Impression taking with accurate material and technique lead to achieving properly fitted prosthesis. Elastomeric impression materials are useful for registering the full details of abutments and soft tissues. Contamination is the state of the impression transferred from the dental office to the technician. This contamination is from the salivary and bloody field in the oral cavity. Crossing the infectious diseases like AIDS, hepatitis-B and C virus and Corona virus is a problem. So it is required to prevent transferring of diseases through impressions sent to the technician. From the methods of disinfecting the impression, the use of chemicals as sodium hypochlorite, and glutaraldehyde. In addition, experiments on the use of ultraviolet radiation and microwave radiation for impression disinfecting was done. No technique is the ideal until now. Disinfecting targets elimination of pathogens on impression. Nevertheless, unfortunately there is a possibility to cause dimensional changes in the impression due to Chemico or physical reactions between the material and the disinfectant.

Avoiding cross infection between the clinic and laboratory is important, so the recommendation is disinfecting as soon as possible after impression taking. Nevertheless, some materials could be distorted with disinfection and then other ways are used according to the type of material. Therefore, these obstacles using regular methods led to evolution of novel autocalvable materials. Nevertheless, how does the sterilizing method affect the accurate dimensions and accurate features being reproduced must be studied more.

Disinfecting impression could be done, but autoclave using for elastomers could be used effectively for sterilizing.

Enhanced wettability was attempted through the modification of impression material chemistry with addition of intrinsic surfactant and increasing its hydrophilicity. Because of their hydrophilicity, however, the possibility exists that they could distort during the disinfection process if left in contact with the disinfection for too long, therefore they may be better sterilized. The aim of this research was to assess how dimensions could be stable and how accurate could details be reproduced for a novel addition silicon elastomer with sterilizing process.

Materials and Methods

In this study, an epoxy resin master model was duplicated from a modified dentate mandibular model (Figure 1), which was consisted of a dentatemandibular arch with modifications. Three copper cylindrical ring inserts one on each occlusal surface of the right and left first molars and one on the lingual surfaces of the mandibular incisors provided reference points for measuring cross-arch dimension (41.36 mm), and anteroposterior dimension (21.06 mm). In addition, the master model contained stainless steel die for full metal crown preparation in the position of the mandibular right premolars area. The stainless steel die was machined with 6-degree angle of convergence, and (4.23 mm) occluso -gingival height with (0.5 mm) gingival chamfer finish line. Heat resistant addition silicon impression material was used for making 20 impressions for the master model using heat resistant plastic stock trays. The 20 impressions were divided into two groups control and sterilization (Figure 2-5).

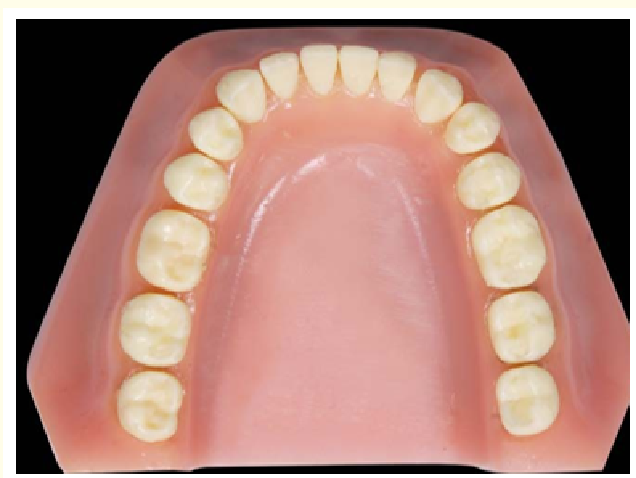

Figure 1: *A dentate acrylic mandibular model.*

Figure 2: *Modified acrylic mandibular model.*

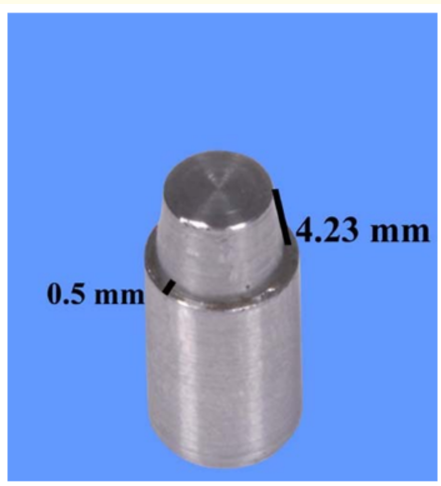

Figure 3: *Stainless steel die.*

Figure 4: *Top view of the Modified mandibular model.*

Figure 5: *Side view of the Modified mandibular model.*

Group 1

(n = 10) Control group, untreated impressions (C.G).

Group 2

(n = 10) Impressions were sterilized by the autoclave (A.G).

After all impressions treatment, they were poured with extra hard stone (type IV) to get stone casts. After insertion of the three copper cylindrical rings and the stainless steel die on the dentate mandibular model, a duplicate impression material was used to make an impression for the modified dentate acrylic model. After complete setting of the duplicate material (2 minutes) as recommended by the manufacture, the impression was visually inspected by the aid of magnifying lens to determine that the reference marks were clearly reproduced, and to ensure absence of any voids or defects. Then, the copper cylindrical rings and the stainless steel die were removed from the acrylic dentate mandibular model and fixed in their places in the duplicate impression with sticky wax to avoid their movement during pouring the epoxy resin (Figure 6).

Figure 6: *Epoxy resin master model.*

Dimensional accuracy and detail reproduction of the impression material were evaluated indirectly through the recovered improved stone casts from impressions of the master model using the travelling microscope (Figures 7, 8, 9).

Distance A

- **Cross arch distance:** From the first right mandibular molar to the first left mandibular molar (41.36 mm).

Distance B

- **Antero posterior distance:** From the mandibular first left molar to the lingual surface of central incisors (21.06 mm).
- Occluso-gingival height of the stainless steel die (4.23 mm)
- Finish line thickness of the stainless steel die (0.5 mm).

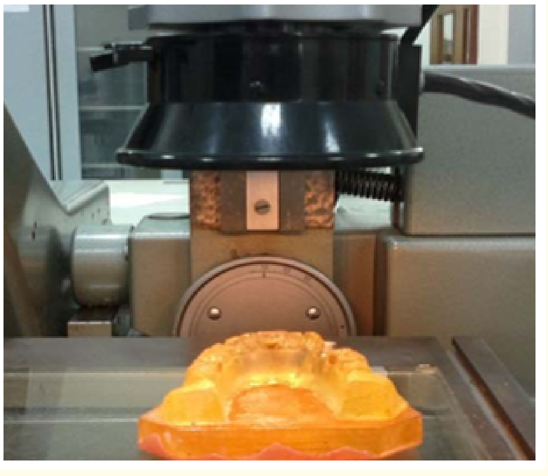

Figure 7: *Top view of master model under the traveling microscope.*

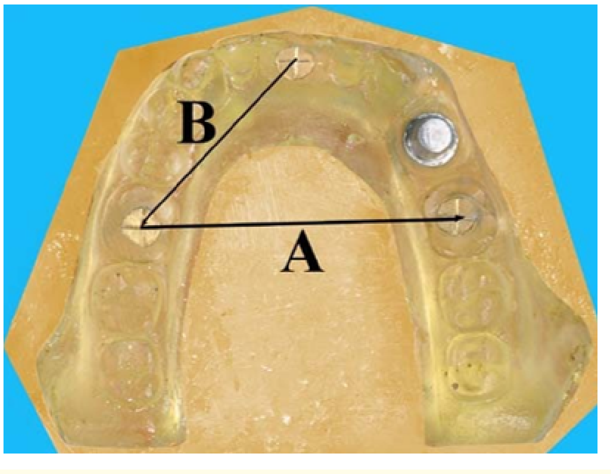

Figure 8: *Epoxy resin master model with certain distances.*
Distance A: Cross arch distance from first right to first left molars (41.36 mm)
Distance B: Antro-posterior distance from central incisors to lower first left molar (21.06 mm).

Figure 9: *Side view of Epoxy resin master model showing the stainless steel die with (4.23 mm) occluso-gingival height and (0.5 mm) finish line thickness.*

30 impressions were made using one commercially available heavy and light body autocalvable impression material (Affinis) in a special plastic heat resistant stock trays supplied by the manufacture (Figure 10).

Figure 10: *Impression of the master model.*

Group 1

Control group (C.G) Impressions were not subjected to any treatment after their setting and were poured with type IV extra hard stone, after 24 hours according to the manufacturers instruction.

Group 2

Autoclaving group (A.G.) the 10 impressions were placed in sterilization bags and inserted in the autoclave for 15 minutes at 134˚ C, according to manufacturer's instructions. After autoclaving, the impressions were removed from the sterilization bag and left for 24 hours then poured with the extra hard stone according to the manufactures instruction (Figure 11).

Figure 11: *Impressions in the sterilization bag.*

Impressions of both groups (control and autoclaving) were poured after 24 hours from their setting according to the manufacture instruction with extra-hard stone type IV. The poured impressions of each group were then inverted after 30 minutes over a rubber base former filled with extra hard stone and, allowed to set for 1 hour according to manufacturer s instruction. The base allowed all casts to be placed on the traveling microscope with the same horizontal orientation. After 60 minutes, the casts were separated from the impressions and inspected for any porosity or irregularities in the critical areas related to the measuring reference points and the prepared die using a magnifying lens (Figure 12).

Figure 12: *Improved stone cast.*

The dimensional stability and detail reproduction of the impressions were assessed indirectly by measuring several relevant dimensions on the improved stone casts recovered from the impressions of the epoxy master model. Traveling microscope was used to measure the distances on the improved stone casts of each group and the measures were compared with those of the master model, as well as, those of the control group. Travelling microscope have removable arm which allow easily movement to measure the reference points and the same arm can increase or decrease the focus to measure the occlusogingival height and finish line thickness of the stainless steel die. The following dimensions were measured on the improved stone casts of each group (Figure 13).

- Distance A: Cross arch distance: from the mandibular first right molar to the mandibular first left molar
- Distance B: Anteroposterior distance from the mandibular first left molar to the lingual surface of central incisors
- Occluso-gingival height of the stainless steel die. 4- Finish line thickness of stainless steel die.

Each dimension was measured 3 times and an average was taken for each value. One examiner carried out all measurements.

Figure 13: *Improved stone cast under the traveling microscope.*

Results

One-way ANOVA is used for comparing dimensions of the 2 groups and the master model. Tukey's post-hoc test is used to pair- wise compare between groups with ANOVA significance. Posterior distancing, occluso-gingival length and finish line thickness) with stone model dimensions form the dimensions changes. Dimensions changes was non-parametric. Therefore, Kruskal-Wallis test was done for comparing the 2 groups. It is the non-parametric test instead of the one-way ANOVA. Mann-Whitney U test done to pair-wise compare the groups if Kruskal-Wallis test gives significance. To be significant the level should be $P \leq 0.05$. Analysis was done with PASW Statistics 18.0® (Predictive Analytics Software) to be used with Windows. How the method affects how accurate the dimensions:

- Cross arch length (A): Epoxy resin master model cross arch length (A) is (41.36 mm).
- Length of the cross-arch distance of stone casts: (Table 1, Figure 14).
- Control group (C.G): mean and standard deviation values of length (A) in stone models of C.G. are 41.553 ± 0.170 mm.
- Autoclave group (A.G): mean and standard deviation values of length (A) in stone models of A.G are 41.718 ± 0.242 mm. ANOVA test revealed statistical difference in amount of shrinking among the groups (P-value = 0.006).

C.G		A.G		Master model	P-value
Mean	SD	Mean	SD		
41.553[a]	0.170	41.718 [a]	0.242	41.362 [b]	0.006*

***Table 1:** Mean, standard deviation (SD) for one-way ANOVA test to compare the cross arch distance of master model and stone models measurements.*
**: Significance at P ≤ 0.05, Mean with difference in letters indicates significance after statistics.*

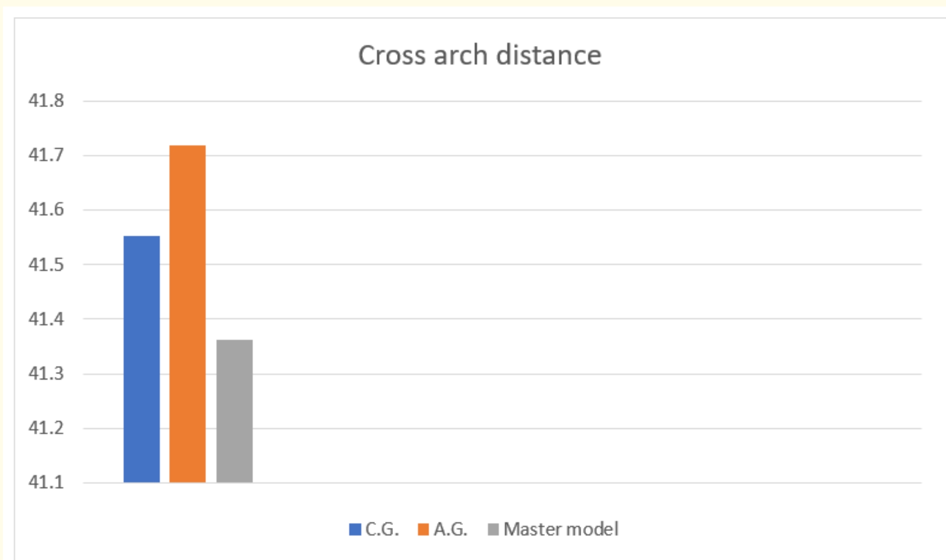

***Figure 14:** Bar chart representing means of cross arch distance measurements of master model and stone models.*

Measuring dimensions changing as the cross-arch length with the 2 groups. Mean and standard deviation for cross arch length difference with stone models of C.G. are 0.191 ± 0.170 mm. However, dimensions changing with stone models with A.G. are 0.365 ± 0.242 mm (Table 2, Figure 15).

C.G		A.G		P-value
Mean	SD	Mean	SD	
0.191 [b]	0.170	0.356 [a]	0.242	0.034*

Table 2: *Mean, standard deviation with Kruskal- Wallis test to compare the dimensional changes of cross arch distance (A) in the two groups.*

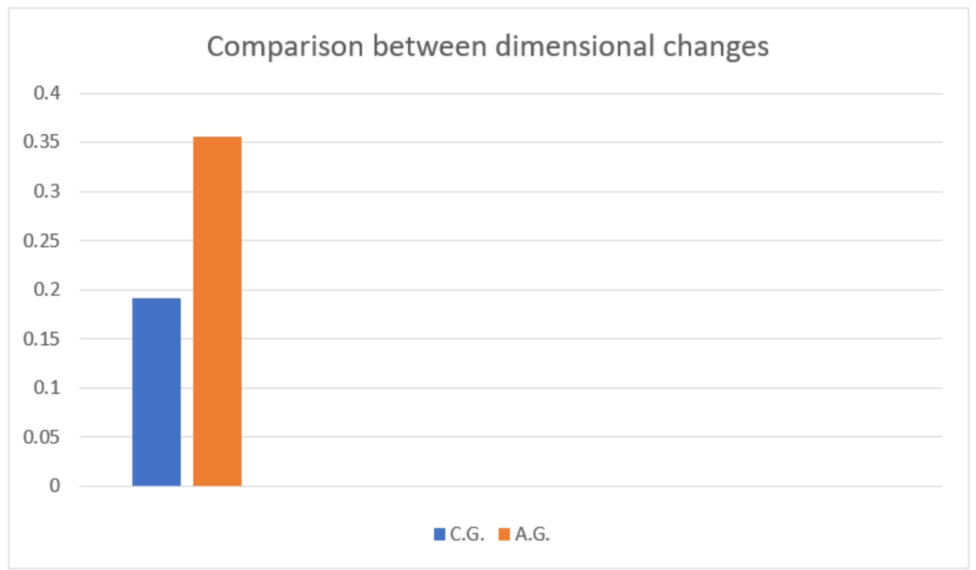

Figure 15: *Bar chart representing comparison between dimensional changes in cross arch measurements in the two groups.*

Percent (%) of how dimensions changed for the cross-arch length with the 2 groups.

Percent of how dimensions changed with C.G. is 0.46%, but for A.G. is 0.86%.

Antero-posterior length (B)

Measuring of the antero-posterior length with the master model is (21.06 mm).

Measuring of the antero-posterior length with stone casts with 2 groups are shown at (Table 3, Figure 16), Control group (C.G) mean and standard deviation for anteroposterior length (B) with stone models for C.G. are 20.981 ± 0.770 mm. Autoclaving group (A.G): mean and standard deviation for anteroposterior length (B) for stone models of A.G. are 19.842 ± 0.412 mm.

C.G		A.G		Mastermodel	P-value
Mean	SD	Mean	SD		
20.981 [b]	0.770	19.842 [c]	0.412	21.600 [a]	0.013*

Table 3: *Mean, standard deviation (SD) for one-way ANOVA test to compare the Anteroposterior distance for master model and stone models measurements.*

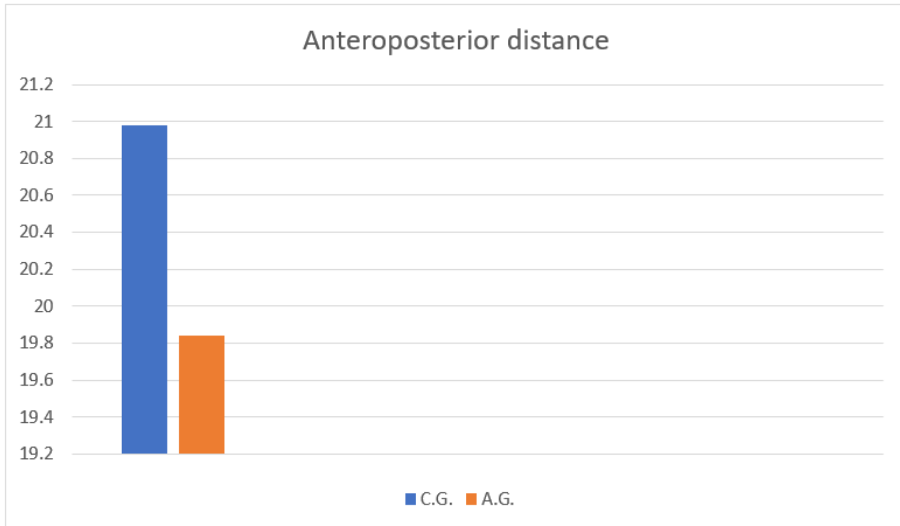

Figure 16: *Bar chart representing mean Antero posterior distance of master model and stone models measurements.*

Measuring for how the dimensions changed for anteroposterior length for the two groups: mean and standard deviation for how Antero posterior length changed for stone models of C.G. are 0.619 ± 0.770 mm, those obtained from S.G. were 1.758 ± 0.412 mm. Pair-wise compared the two groups showed S.G. with statistics significance proving higher mean dimensional change (less accurate).

Thickness of the finish line

How thick the finish line for the stainless steel die is with the epoxy master model is (0.5 mm).

Measuring for how thick the Finish line is for stone casts with the 2 groups.

- **Control group (C.G):** Mean and standard deviation with how thick is the finish line with stone models for C.G. are 0.552 ± 0.056 mm.
- **Autoclaving group (A.G):** Mean and standard deviation for how thick the finish line is with stone models of A.G. are 0.587 ± 0.023 mm. Pair-wise test compared 2 groups showing no significance among 2 groups; revealing significance in more thick the finish line is compared to the master model.

Measuring how the dimensions changed regarding how thick is the finish line for the 2 groups, mean and standard deviation for how the finish line thick is changed with stone models for C.G. is 0.052 ± 0.038 mm. But, how dimensions changed with stone models for A.G.is 0.087 ± 0.038 mm.

Percent (%) for how dimensions changed for how thick is the finish line for the 2 groups Percentage for C.G. is 9.4%, but for A.G. is 14.8%.

Occlusogingival length

The occlusogingival length for the stainless steel die with the epoxy resin master model is (4.23 mm).

Measuring for the stone casts of the 2 groups.

- **Control group (C.G):** Mean and standard deviation for occlusogingival length for die of improved stone models for C.G. is 4.392 ± 0.117 mm.
- **Autoclaving group (A.G):** Mean and standard deviation for occlusogingival length for the die of stone models of A.G. is 4.292 ± 0.078 mm.

Measuring how dimensions changed for the occlusogingival length for the 2 groups, mean and standard deviation for how length changed for stone models for C.G. is 0.154 ± 0.117 mm. But how dimensions changed for stone models of A.G. is 0.054 ± 0.078 mm. Kruskal-Wallis test revealed no significance variance among groups (P-value = 0.330).

Percent (%) for how dimensions changed for the occlusogingival length for the 2 groups Percentage of how dimensions changed for C.G. is 3.63%, but for A.G. is 1.27%.

Discussion

Impressions are infected after removal from patient's mouth. Therefore, there should be an infection control protocol during its transfer in the clinic and between the clinic and lab. From the guidelines is to use the autoclave for sterilization, to destruct all spores and microbial life. The impression material used in the study is polyvinyle siloxane. Addition silicone has excellent properties and accuracy. Also from its advantages is that there is no byproduct produced. They have moderate working time; can be removed from the cast with no difficulty [1]. The use of hydrophilic impression material intraorally is of great importance nowadays [2]. Rigidity of the trays and the delivery system of the impression material is an important point to decrease the dimensional changes [3] that is why a rigid tray is used in this study. It was found that using tray adhesive is useful and increases dimensional stability [4] that is why it is used here. The master model here was made using epoxy resin to facilitate removal of the impressions and holding the markers in its place safely.

In the control group impressions were poured without any intervention, the other group the impressions were sterilized in the autoclave and this was in accordance with Kotwal., *et al*. in 2021 [6]. Autoclaving for 15 minutes with 134°C is enough to kill microspores. The hypothesis was that there is no difference between the accuracy of impressions with no treatment and with autoclaving. This was approved in our study, as this was in accordance with Kotwal., *et al.* in 2021 [6] who found that autoclaving is a successful method for sterilizing impressions. In addition, Basmaci., *et al.* in 2021 recommended sterilization of impressions by autoclave as a recommended protocol especially in the pandemic era of coved 19 [7]. Also, Millar and Deb in 2014 stated that no significance found or difference between how impression changed after autoclaving regarding addition and condensation silicone [8]. Furthermore, autoclaving was approved for disinfecting vinyl polysiloxane impressions by Al Kheraif in 2013 [9] and Ramakrishnaiah., *et al*. [10] in 2012. Kamble., *et al*. in 2015 [11] as well reported the effectiveness of steam autoclave use instead of chemicals as disinfectants for elastomers. However, Thota., *et al*. in 2014 stated that autoclaving is very powerful disinfectant for condensation and addition silicone and this is not applied on hydrophilic materials [12]. According to AlZain in 2021 in a systematic review, it was concluded that autoclaving produced some changes to addition silicone impression but within the permissible limit according to the ADA [13]. Also in another study by Asopa., *et al.* in 2020, it was found that autoclaving is more preferred than gluteraldehyde disinfection with addition silicone impression material [14]. Devi., *et al.* as well in 2019 found that autoclaving elastomeric impression material is the most effective way of disinfection and does not affect its accuracy [15].

It is recommended to do more studies on different types of impression materials regarding its accuracy after autoclaving.

Conclusion

It could be concluded that autoclaving is a successful method to disinfect polyvinyl siloxane impressions.

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