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Evaluation The Dimensional Accuracy Of Dental Dies With Two Different Casting Materials: An In-Vitro Study

Research Article

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Abstract

Objectives: This study evaluate the linear dimensional accuracy of two dental casting materials (Plaster type IV DK MUNGYO and industrial modified Epoxy resin).
Materials and Methods: Standard master model with two cylinders printed by 3D printer was used to create 30 impressions using a polyvinyl siloxane impression material and randomlydivided into two groups (n = 15) according to the type of casting material, After the setting/polymerization of the casting material, the dimensional stability was measured in terms of the diameter from the obtained dies and from the standard master model using a profile projector (BATY SM-350)
Results: Results were analyzed by T-Student test, revealed that there are significant difference between thetwo groups in the diameter of the two cylinders , Industrial modified Epoxy resin showed statistically lower mean diameter values, compared with the other group, no significant difference between the two groups in the distance between cylinders was observed, comparing with the master model the two groups were smaller in dimension .
Conclusion: Based on the results obtained and the methodology applied, the group industrial modified Epoxy resin showed satisfactory values because even if there was a significant difference in relation to the type IV dental stone group in diameter of the two cylinders this difference was very small and, in many cases, may be clinically acceptable.
However, further studies should be conducted with this material.

Keywords: Epoxy Resins; Type IV Dental Plaster; Dimensional Accuracy.

Introduction

Prosthetic dental medicine is the way to restoring function in patients with missing teeth. During that process, it is a must to control dimensional changes of the materials used is in order to have a successful treatment. Therefore, casted models should have dimensions as close as possible to those of the prepared teeth. Dental casting is an important stage in the process of prosthetic rehabilitation [1].

Each step of a prosthetic rehabilitation must be carefully accomplishedto yield a satisfactory final result. Therefore, to obtain accurate and precise models with no deformation, it is important to obtain accurate impressions [2, 3] and to use stable and accurate die materials.

making an accurate casting is depending on many factors such as appropriate impression material and technique, accuracy of die material, and waxing and casting procedures [4], An perfect die material should have many important characteristics, such as dimensional accuracy, details reproduction, acceptable hardening-time, minimum expansion, abrasion and compression resistances, easy and logical manipulation, low toxicity, compatibility with the impression materials, and low cost [3, 5] the reproduction of details is an important characteristic of both impression and die materials [6]. There are several commercially available die materials, such as type IV and V gypsums, epoxy resin, polyurethane resin and metallic resin materials. The most routinely used gypsum materialis type IV dental stone because of its low setting expansion, high resistance to compression strength, sufficient hardness and good ability to reproduce details [7].

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As an alternative to gypsum, polyurethane resin and epoxy resin, have been shown to present better abrasion resistance and detail reproduction, compared with improved dental stones [5, 6, 8]. However, studies assess their dimensional accuracy have shown contrast results [9, 10].

Resin die materials have abrasion resistances and excellent detail reproduction that are superior than those of gypsum. Despite these advantages, the shrinkage of resin diematerials during polymerization has limited their Use and acceptance [11], Certain mechanical features of resin-based die materials have focused increased attention upon these materials as possible alternative for gypsum products [12, 13] resin casts have been introduced as a practical alternative to plasters models and a possible alternative to type IV plaster [14], The need for high quality and durable prosthetic has motivate the specialty of prosthodontics to research better materials in order to make high quality aesthetic and functional appliances. This article presents comparison between models made from plaster type IV and industrial modified Epoxy resin in terms of linear dimensional changes.

Methodology

for the present study, a 3D printed resin models was used as a master die, the master die has two cylinders with the same height 5 mm , the first cylinder diameter was 5 mm (R1), and the second 8 mm (R2) with distance between them 9 mm (D), stimulated a total crown of premolar and molar and missing molar. Fig(1)

individual trays were used with PVC pipes to standardize the size of impression and die materials used High-viscosity polyvinyl siloxane impression material (Elite HD+, Zhermack, Italy) was used in the first stage of the impression to make light relief in the trays.

After that, the light base was injected with a syringe in the tray for the final impression of the master model.

All impressions were allowed to polymerize at 37°C in 100% humidity for one hour. A total of thirty impressions were obtained, After that, the impressions were randomly divided into two groups (n = 15) according to the die material used, as follows:

- Dental stone group (type IV dental stone, DKMUNGYO, South Korea)
- Modified industrial Epoxy resin (Issaco, China)

The type IV dental stone was mixed with the manufacturer's recommendation water:powder ratio(24 ml/100 g) under a vacuum of 700 mm Hg for a 40-second spatulation period.

The dental stone was vibrated into the impression and allowed to set forone hour at room temperature and humidity before taking off the impression.

For modified industrial epoxy resin group, the casts were made separetley in accordance with the manufacturers' recommendations.

The material was allowed to cure for two hours. After one day, the diameter for both cylinders, and distance between them of the obtained dies were measured using a BATY SM-350 Profile Projector (Camberley, England) and software readings were performed. Statistical analysis was performed using T-Student test (α= 0.05).

Results

The mean values and standard deviation of first cylinder diameter (R1) and the second one (R2) and the distance between them (D) of each evaluated die are shown in table (1).

Diameter values of first cylinder (R1) ranged from (4892 ± 54 micron) (type IV plaster) and (4821 ± 32 micron) (industrial modified epoxy resin) while it was (4942 micron) on the master model. The second cylinder values (R2) ranged from (7864 ± 67 micron) (type IV plaster) and (7766 ± 52 micron)(industrial modified epoxy resin) and 7873 micron of the master model.

The distance between cylinders (D) values ranged from (9033±72

Figure 1. 3D master model with two cylinders and there's dimensions.

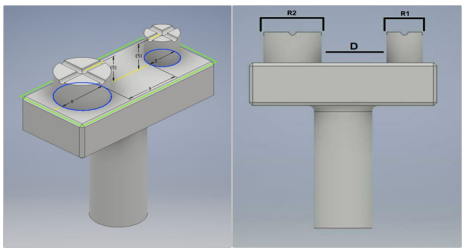

Figure 2. Graphical presentation of the mean dimensional change values of type IV plaster and industrial modified epoxy resin.

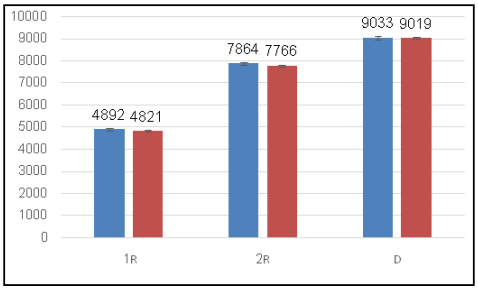

Table 1. Mean values (micron), standard deviations (micron) and the lowest and the highest values of two cylinders and distance between them andConfidence interval 95% for the mean of each evaluated material.

Confidence interval 95% for the mean		The highest value	The lowest value	Standard deviation	mean	Group	dimensions
The lowest value	The highest value						
4862	4921	4995	4784	54	4892	type IV plaster	R1
4804	4839	4878	4765	32	4821	industrial modified epoxy resin	
7827	7901	7974	7744	67	7864	type IV plaster	R2
7738	7795	7896	7694	52	7766	industrial modified epoxy resin	
8993	9072	9154	8899	72	9033	type IV plaster	D
8995	9044	9089	8951	44	9019	industrial modified epoxy resin	

micron) (type IV plaster) and (9019 ± 44 micron) (industrial modified epoxy resin) and 9016 on the master model.

Significant difference was observed between groups, R1 and R2 in the type IV plaster group has higher mean values respectively 70 and 98 micron comparing with industrial modified epoxy resin.

The mean values of R1 in the type IV plaster group were lower than master model in about 50 micron, while in industrial modified epoxy resin group were lower than the master by 121 micron, Significant difference in R2 between industrial modified epoxy resin group and master model by 107 micron, while there is no significant difference between type IV plaster group and master model in R2 dimension.

No significant difference between the groups and the master model in D dimension.

Discussion

Dental plaster has been used for many years to cast dental models and for laboratory procedures in the field of prosthetic dentistry [15]. However, there are many disadvantages to its use in the fabrication of dies and casts, for example: insufficient tensile and compression strength, potential variability in fine detail reproduction, poor abrasion resistance, and need for waiting period beforestartingthe laboratory procedures [16], some polymer-based products have been studied as an alternative to plaster products. Cost and ease of use are importantfactors in guiding selection of a die material. In the current study, impressions for test models were taken using additional silicone, according to its excellent dimensional stability,and compatibility with the materials used and its superiority to reproduce fine details [17]. According one author, a common insufficiency is failure to follow basic principles to the manipulation of impression materialsIn all impression techniques, the addition silicones produced more accurate stone casts than produced by condensation silicones [18], There is a need for compatibility between impression materials and casting materials for reliable models. There must be no interaction between the impression materials and involved casting materials, which is one of the reasons why plaster productsare widely used [19].

Industrial modified epoxy resins showed generally lower mean values inthe evaluated parameters, compared with those forthe master model (Table 1). industrial modified epoxy resinwas associated with lower mean diameter valuesThis can be explainedby the fact that, during polymerization this type ofmaterial presents shrinkage.

Before polymerization this materials is composed of reactive monomers that are linked by Van der Waals forces. which have meandistance between monomers at this situationabout 4 angstrom, which produces a minimal potential energy. However, after polymerization, monomers are linked by covalent bond, and the mean distance between monomers is decreased by 20%, which results in asignificant volumetric shrinkage [7]. for that, dies acquiredfrom epoxy resins mostly presented lowermean values, compared with those for the masterdie.

In contrast, dies obtainedfrom type IV stone had the propensity to expand, as observed in previous studies [9, 20], during The process of gypsum crystallization an expansive growth of crystals from a core of crystallization is occurred [7], Based on the involving of dehydrate crystals, the growth of the core crystals can syndicate and block the growth of close crystals, when this process is repeated by thousands of crystals during their growth, an external tension will be occurred that leads to setting expansion of the mass, and the product of the gypsum reaction is larger than its external volume but smaller in crystalline volume [7].

Based on these features of gypsum, restoration modifications are more easily accomplished when there is a minor expansion to the die [9].

Both groups of this study produced dies smaller than master models in parameter, it was supposed that pressure within the material due to the confinement may produce smaller dies like reported by [21, 22] according to this study, gypsum dies were in another study reported to be smaller than the standard model [22-24].

Modified industrial epoxy resin was used in thisstudy to determine whether it is feasible to add supplementary material for the routine everyday dental practice.modified industrial epoxyis relatively cheap, compared withthe epoxy resins commercially used in dental practices, it is not promoted as a dental industry material,

and can be found at building material stores.

Conclusion

Based on the results obtained and the methodologyapplied, the groupindustrial modified Epoxy resin showed satisfactoryvalues because even if there was a significant differencein relation to the type IV dental stone group in diameter of the two cylindersthis difference was very small and, in many cases, may be clinically acceptable.

However, further studies should be conductedwith this material.

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