

Comparing the Accuracy of Three Different Impression Materials in Making Duplicate Dies

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Abstract:

Background: Marginal adaptation is very important in cast restorations. Maladaptation leads to plaque retention, reduction of mechanical and esthetic properties. The aim of this study was to evaluate the precision of three different impression materials (including: Additional silicone [AS] and condensational silicone [CS] and polyether [PE]) for duplicating master dies.

Materials and Methods: Three master dies from an acrylic tooth model-with supragingival and shoulder finishing line was made by using PE: Impergum, CS: Speedex, and AS: Panasil separately. The Ni-Cr copings were prepared from master dies separately. They were placed on the acrylic model and the mean marginal difference was recorded by using a stereomicroscope. Then 30 duplicate test dies were made by using the same impression materials and the marginal gaps were recorded. The comparison was done by one-way ANOVA and SPSS software (Version 13) at a significant level of 0.05.

Results: The mean marginal difference of four walls from Impergum (38.56 μ m) was the lowest than Speedex (38.92 μ m) and Panasil (38.24 μ m). The Impergum had the highest capability in making duplicate dies ($P > 0.05$).

Conclusion: The Impergum impression material manifested the highest capability in making a better marginal adaptation of duplicate dies but further studies are needed to make a precise decision.

Key Words: Dimensional changes, duplicate dies, impression materials, marginal adaptation

Introduction

Achieving optimum function and esthetic of restorations is very important, especially in replacing a missing tooth. Furthermore,

temporary restorations are essential for preservation of the tooth structure in the meantime of preparing cast models.^{1,2}

Marginal adaptation of a cast restoration can influence its durability due to: Lower accumulation of plaques in margins, enhancing structural properties (stability, resistance, low thickness of cement, and etc.), and higher esthetics.

There are several factors which can affect the accuracy of definitive impression like: Quality of preparation (undercuts and tapering), impression technique, soft tissue management, and quality of wax pattern and casting.³⁻⁷

Several elastic impression material silicones are available for dental use: Synthetic elastomeric materials (polysulfide [PS], additional silicone [AS] and condensational silicone [CS], and polyether [PE]); and hydrocolloids. PE and silicones are accurate with high stability. They can maintain their accuracy even 1-week or later, however, they are technique sensitive; for instance PE should be stored in <50% humidity.^{8,9}

Johnson *et al.* conducted a study to evaluate four types of impression materials (CS, AS, PS, and PE), based on different model location, repetition, and time of pouring. Their results showed low dimensional changes during pouring and repetition for all of the impression materials.¹⁰

Chen *et al.* evaluated the effective factors on impressions accuracy during different storage times and proportion of inorganic fillers. They used three types of alginates, five commercial silicones, and two experimental silicones impression materials. They found greater accuracy and stability with AS materials.¹¹

In another study, Endo *et al.* surveyed the dimensional accuracy of stone dies provided from standardized impressions with polyvinylsiloxanes (PVS), new PE (P2), and conventional PE (Impergum) impression materials. They stated that dimensional accuracy of new PE was comparable to conventional PE impression material after short-term storage.¹²

Some other studies about these impression materials have been done recently¹³⁻¹⁵, but debates about the accuracy of these impressions still remain.

In some circumstances, such as fracture or crack in margins of a die, clinicians are obligated to provide repetitive impressions and duplicated dies to improve marginal adaptation. If an

impression material characterizes printing an accurate and precise details of the surface, all provided duplicated dies could have well marginal adaptation with the master die.^{10,16,17} It seems that the best approach to make a duplicate cast is to make a second impression.¹⁸ However, the ability of impression materials to make duplicate dies with successive accuracy has not been investigated widely. Hence, the aim of this study was to evaluate the accuracy of three types of impression materials (PE: Impergum, CS: Speedex, and AS: Panasil) with focusing on providing duplicated dies.

Materials and Methods

Preparing master dies

In this observational-analytical study, an acrylic model of upper premolar tooth was prepared based on conventional shoulder type marginal preparation, supragingivally. The finish line was circumferential 1 mm rounded shoulder with a 90° cavosurface angle.

Some grooves were prepared on mesial, distal, lingual, and buccal surfaces of the model beneath the margins for making measuring guidelines. For making special trays, two layers of wax were placed on the model to enhance the space for impression materials. Then three special trays were prepared with three occlusal stops 24 h before making impressions. Two step impression technique was administered for Panasil and Speedex. Furthermore, the Impergum impressions were made by using one-step impression technique. Three master dies were made by these impression materials: (A) Panasil Contact Plus (Kettenbach, Eschenburg, Germany), (B) Impergum (3M ESPE, Saint Paul, Minnesota, USA), and (C) Speedex Coltene (Asia Chemi Teb Co; Tabriz, Iran, under the license of Coltene-Switzerland). The manipulations were based on manufacturers' instruction. 20 ml of water were mixed with 100 g of Stone Type IV (Vel-mix; Kerr, Romulus, MI, USA,) and vibrated for 30 s for bubble evacuation. Three master removable dies were provided by using metal pins. 1-h later, the stone casts were separated from the impressions and stored 24 h for final setting.

Casting procedure

The three master dies were trimmed and finishing line was marked by a red pencil. Three layer of relief agent were placed on each master die in order to have appropriate metal casting. The wax patterns were prepared by blue inlay wax (Schuler Dental, Ulm, Germany) on each master die to make metal casting. An index of silicone putty was made from the wax patterns to ensure uniformity of the patterns.

Sprue wax of diameter 2.5 mm was attached to the top surface of each pattern and angled. Each wax pattern was invested immediately in phosphate-bonded investment (Moldavest Exact, Heraeus Kulzer., Germany) with the powder-liquid ratio as 60 g per 12 ml. The investment material was mechanically spatulated under vacuum for 90 s. The wax patterns were carefully painted with the investment mixture. Cellulose acetate

ring liner was used for lining and the ring was filled with the investment material under mechanical vibration. The rings were placed in an oven (Vulcan 3-550 PD Burnout Furnance, Dentsply Neytech., Burlington, NJ, USA). The heat was increased 7°F every minute and maintained in 600°F for 30 min. Then the heat was reached to 1500°F and heating was continued for 1-h. Casting was accomplished in an induction centrifugal casting machine (Ducatron serie 3, Ugin Dentaire, France) using Ni-Cr alloy (Verabond II; AALBA Dent, Cordelia, CA, USA), according to the manufacturer's recommendations.

Measuring technique

The metal casts were polished and examined for any obvious positive defects to be removed by a small round carbide bur (Teeskavan, Tehran, Iran). Then, they were placed on their particular master dies for confirming well marginal adaptation. After that, the metal castings were transferred to the prepared acrylic model and observed under a stereomicroscope (Miticam480, Motic instruments Inc., CA, USA) under ×500 magnification. Discrepancies in mesial, distal, buccal, and lingual margins were compared on prepared guideline grooves.

Duplicated dies preparation

A total of 30 successive impressions were then made, ten for each of the three impression material. Dies were fabricated with the same procedure as already described, and the same stone and delays. These dies were assumed as the test duplicate dies (Figure 1). Neither die hardener nor die relief was applied. Each casting from each of the master dies was placed on each of the test dies which were made from the same respective impression material. The marginal discrepancy was recorded with the use of the described measuring technique.

Statistical analysis

The marginal discrepancies from test dies and acrylic model were collected and subjected to one-way ANOVA for statistical analysis by using and SPSS software version 13 at a significant level of 0.05.

Results

Table 1 shows the mean marginal discrepancies of the dies. Panasil represented significant discrepancies in mesial and buccal margins ($P < 0.01$). Impergum showed the difference only in distal margins ($P = 0.001$). However, the most discrepancies were found in Speedex ($P < 0.001$).

Furthermore, the difference of mean overall discrepancy was significant only in Speedex group ($P < 0.001$). The mesial margins of all groups showed the highest discrepancy (Impergum: 38.56 µm; Panasil: 38.24 µm; Speedex: 38.92 µm).

Discussion

The goal of this study was to evaluate the accuracy of three common impression materials (PE: Impergum, CS: Speedex, and AS: Panasil) for making duplicated dies.

Table 1: The mean discrepancies in different margins (um) which were prepared by different impression materials when compared to the original acrylic model.

Type of impression material	Buccal	P	Lingual	P	Mesial	P	Distal	P	Overall	P
Impergum										
Duplicated die	29.52	0.08	35.73	0.11	38.56	0.90	36.69	0.001	35.13	0.10
Model	27.62		33.60		38.46		33.13		34.79	
Panasil										
Duplicated die	32.78	0.01	34.10	0.98	38.24	<0.001	36.99	0.06	34.78	0.06
Model	31.50		31.10		31.82		35.37		34.20	
Speedex										
Duplicated die	36.36	0.001	35.86	<0.001	38.92	0.09	38.14	<0.001	37.32	<0.001
Model	32.78		30.97		38.43		34.96		33.97	



Figure 1: Duplicated dies which were prepared by three types of impression materials (Speedex, Panasil, and Impergum).

Marginal gaps greater than 25-35 um are unacceptable based on ADA specifications.¹⁸ The marginal gaps were 15-38 um in present study, while one study assumed wider gaps acceptable for restorations clinically.¹⁰

Due to different methods and materials, achieving a technique which can provide a precise duplicate die seems to be

inconceivable. Dimensions of fabricated dies could be affected by several factors like: impression technique, delay in pouring stone, type of stone, mixing time, etc.^{6,13,17,19}

As the results showed, gaps in margins prepared by Impergum were founded to be the lowest ($P > 0.05$). Wadhvani *et al.* conducted a study about the accuracy of the cast provided by PEs and PVS.¹⁶ Their results were different from this study as they reported PEs manifested expansions in all dimensions; but mesiodistal and occlusogingival dimensions showed lower gaps in PVS working dies. In that study, the occlusogingival dimensions were measured. Furthermore, they evaluated the impact of using disinfections for 20 min. Present study confirms the discrepancy in distal margin ($P = 0.001$).

It is assumed that polymerization shrinkage during setting did not influence the regions which were nearer to the border of tray with a strict connection (meaning buccal and lingual).¹⁶

PEs is hydrophilic and storing in humid condition is contra-indicated. Hence, the difference between two studies might be due to humidity factor. It is stated that PE impressions should be stored in an environment with a relative humidity below 50%.²⁰

In another study by Walker *et al.*, dimensional accuracy and surface detail reproduction were observed in two hydrophilic PVSs and two types of PEs during dry and moist conditions.²¹ Their results were somehow similar to the present study. They reported that all impression materials produced satisfactory detail reproduction under dry conditions; however, the evidence suggests that PE is more likely to produce superior detail reproduction in the presence of moisture. Aquasil and Genie Ultra were used as PVS in that study, while Panasil and Speedex were used in the present study which might be another reason for different results.

In another study, German *et al.* found similar results too. They evaluated the flow and accuracy of Impergum and three other PVSs. Final report showed that Impergum exhibited the highest initial flow and the most accurate impressions.²²

In another observation, Thongthammachat *et al.* evaluated the effect of different types of trays and impression materials,

and multiple time of pouring on the dimensional accuracy of dental casts. They used AS and PE to make impressions from a metal master model. They found different results as they reported that Silicone impressions had better dimensional stability. Furthermore, PE should be poured within 24 h. They claimed that types of tray (stock or custom) did not have adverse effect on accuracy of the casts⁷ in contrast with results of another study which showed that dimensional accuracy was significantly affected when plastic stock trays were used.²³

According to the study by Chee and Donovan,²⁴ capturing finish line in putty will cause inaccuracy and lack of reproducibility. One-step impression technique would inevitably capture the finish line in the putty. Hence, two-step impression technique was used for Panasil and Speedex in this study as these impression materials consist of putty and wash, and our finish line was supragingival. However, one-step impression technique was used for Impergum regarding to manufacturer instruction with considering the fact that no putty is involved for this impression material. Furthermore, custom trays were used for all the impressions for consistency and accuracy.

Since using materials without adequate knowledge of their characteristics might lead to impair outcome; and choosing an impression materials depends on the subjective choice of the operator,²⁵ more researches are needed for confirming the result of this study. Furthermore, it is suggested to observe more types of impression materials and different storage conditions to reach more definitive conclusion in future studies.

Conclusion

Although different types of impression materials with different physical properties are available, some types (like Impergum, Panasil, Speedex) have more aficionados. Based on the result of present study, Impergum (PE) showed the best accuracy in duplicated dies among Panasil (AS), and Speedex (CS). Furthermore, Speedex showed the lowest accuracy in duplicated dies. However, it is suggested to evaluate different types of impression materials with different techniques of making an impression to achieve more precise conclusion in future studies.

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