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RESEARCH ARTICLE

DIMENSIONAL ACCURACY OF DIE STONE AND DIE SILICONE AN INVITRO COMPARATIVE STUDY

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ABSTRACT

Background: Die for making indirect restoration is vital. Die silicone material is user friendly and fast. But does it compare to Die Stone in accuracy.
Aim: to compare the accuracy of reproduction of details between Die stone and Die Silicone.
Methods: A metal die with known dimensions is made. Impressions are made with Polyether impression material. Dies are made out of Die Stone and Die Silicone. The Dimensions of the reproduced details are measured and compared.
Results: Both Die Stone and Die Silicone produce comparable results.
Conclusion: As Die Silicone is fast setting and easy to use, when Dies are required at the earliest, like during making of indirect restoration on the Chairside, Die Silicone can be the material of choice.

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INTRODUCTION

Direct and indirect processing of prosthesis relies on two important parameters, the impression and the die system. Novel impression materials and improved die materials are available in the market to give an accurate replica of the impressed surface. The gold bench mark for such die materials is the Type 4 gypsum product, the Die Stone. But one of the drawbacks of die stone is its "ready to use time". We have to wait for it to set and dry out if necessary before it can be used for Direct or indirect restoration processing. ISO types IV (high strength, low expansion) and V (high strength, high expansion) improved stones are the commonly used die materials as they are dimensionally accurate, low-cost, user friendly (Chaffee *et al.,* 1997) but alternatively copper plated, resin-impregnated gypsum, epoxy, polyurethane resins were found superior than improved dental stones (Kenyon *et al.,* 2005) but they were not as user friendly and lacked ability to reproduce details. To overcome this drawback, newer materials were developed. One such material is the Die Silicone. Die Silicone is a material which flow well and sets almost immediately and can be used even when the patient is on the chair. But the Die Silicone, as the name implies is a polymer. One of the properties of a polymer is that there is a change in volume during polymerization, known as polymerization shrinkage. This could be detrimental to the accuracy of the die.

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So a study was initiated to check whether the Detail reproduction property of the Die Silicone is in par with that of Die Stone.

MATERIAL AND METHODS

The study was initiated after the Ethical Clearance of the Institutional Review Board was obtained.

The method that was followed was as follows.

- A master die is made of known standard value.
- Making of Special tray.
- An impression is made.
- Die is made with both Die Stone and Die Silicone.
- The Accuracy of detail reproduction is compared.

Master die

The master die was prepared as per Anuraag Sharma *et al.,* (2013). The Dimensions are as follows (Pic. 1).

- Height from shoulder margin 12mm
- Shoulder width 2mm
- Height of the shoulder 2mm,
- Base diameter 15mm
- Taper 7 degree.

Picture 1 Picture 2 Picture 3 Picture 4 Picture 5

Table 1. Paired sample t-test to compare mean values between Metal Die and Stone die

Die	Variables	N	Mean	Std. Dev	t-Value	P-Value
Stone	Metal A-B	10	6.1520	.11233	1.673	0.129
	Stone A-B	10	6.2630	.17480		

Die	Variables	N	Mean	Std. Dev	t-Value	P-Value
Stone	Metal C-D	10	10.1690	.11170	21.549	<0.001
	Stone C-D	10	9.4310	.13503		

Table 2. Paired sample t-test to compare mean values between Metal and Silicone die

Die	Variables	N	Mean	Std. Dev	t-Value	P-Value
Silicone	Metal A-B	10	6.1520	.11233	5.945	<0.001
	Silicone A-B	10	5.9110	.05646		

Die	Variables	N	Mean	Std. Dev	t-Value	P-Value
Silicone	Metal C-D	10	10.1690	.11170	23.928	<0.001
	Silicone-D	10	9.0880	.05266		

Two mutually perpendicular lines intersecting at the Center of the occlusal surface and terminating at their intersections with the occlusoaxial line angle were scribed into the occlusal surface. Two lines, each in a plane perpendicular to the long axis of the die, were scribed circumferentially into the Surface of the axial wall of the die, one line located 1 mm Gingival(pic 1-C-D) from the occlusoaxial line angle and the other1 mm occlusally (Pic 1-A-B) from the axiogingival line angle. A line was scribed along the vertical axis of the die. This line intersected one of the perpendicular lines crossing the Occlusal surface and the two circumferential lines previously scribed into the axial wall. This was also similar to another study by Bailey *et al.,* (1998).

Making of Special tray

The special tray was fabricated using self cure acrylic resin. An even thickness of spacer wax was adated previously to maintain an even thickness of the impression material for better result. Relief holes was given for better flow and adaptability of the material during impression making (Pic-2).

Impression making

Impregnum Soft, Polyether Impression material was used. The base and catalyst of the impression material were mixed with stainless steel spatula as per manufacturer's instructions, until a homogenous color was obtained. Then the impression materials were loaded in special trays and the impression of the die was made (Pic-3). Before making the impression, a tray adhesive for applied on the inner surface of the special tray.

Making the die using die stone: 10 such impressions were poured using die stone. Die stone was measured with a water powder ratio of 0.18 ml/100 gm. It is mixed using a mechanical mixer under vacuum pressure and poured immediately into respective impressions (Pic-4).

Making the die using die silicone

Remaining 10 impressions were poured using die silicone. Die silicone is supplied in syringe material and injected using gun. The material was allowed to set and then retrieved (Pic-5).

Making the measurements

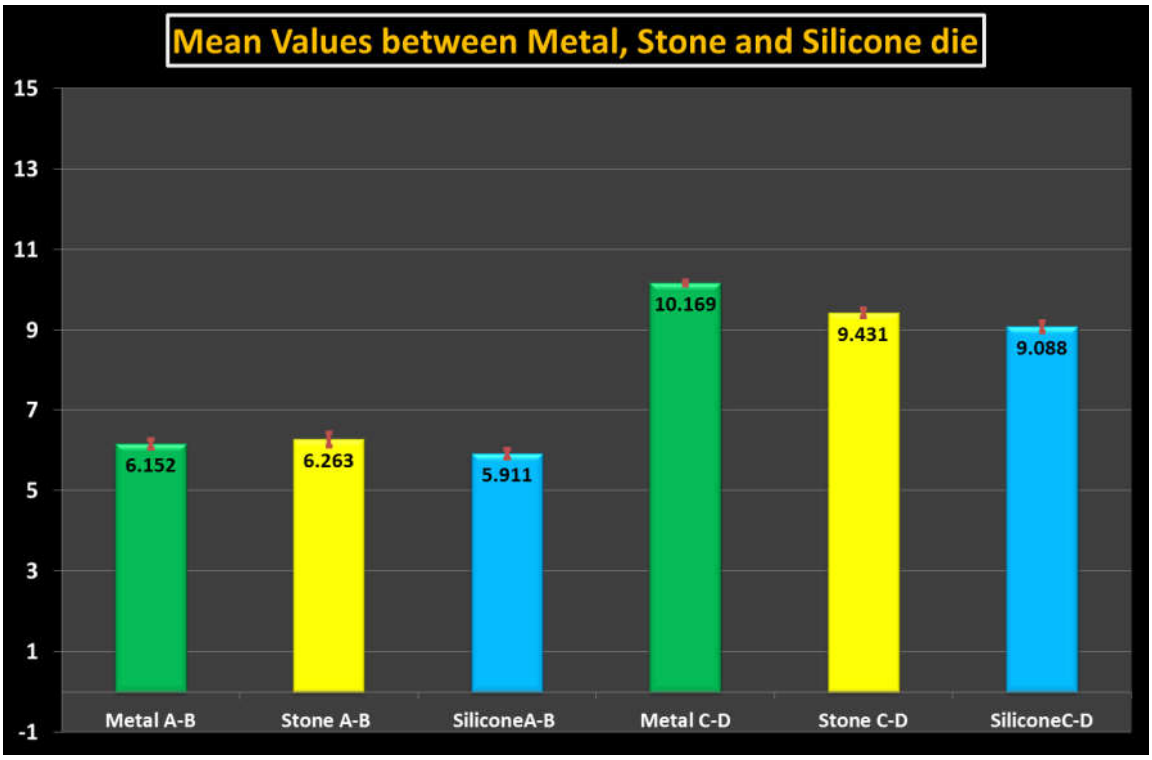
Measurements were taken immediately using travelling microscope. They were measured from A-B and then from C-D.

Statistics

The measurements made were tabulated separately for the Metal die, Die stone die and Die silicone die. They were statistically analyzed. Descriptive statistics was done to find the Mean and standard deviation. Student t-test was done to compare the accuracy of the Die Stone to that of Die Silicone.

RESULTS

The results show that the mean of measurements in the AB dimension showed that the Stone exhibited a mild increase in dimension but the Silicone die exhibited a mild reduction in dimension. (6.1520, 6.2630, 5.9110 mm of the metal, Stone, Silicone Die respectively). On the CD dimension, the Stone and the Silicone die exhibited a mild reduction in dimension. (10.1690, 9.4310, 9.0880 mm of the metal, Stone, Silicone Die respectively). But the differences were not statistically significant. Table 1, 2 and Graph 1.



Graph 1.

DISCUSSION

Several studies have being done to evaluate the recent changes in material development, with interest in those being used in dentistry. The type and property of die materials such as dimensional accuracy, detail reproduction, abrasion resistance and hardness, have been investigated in the dental literature (Prisco *et al.,* 2009). Special focus is usually on Polymers as they are more users friendly and more versatile for varied usage. Lack of durability during handling in laboratory of die stone (Harry *et al.,* 1981) adds to one of the reason for application of die silicone which can be manipulated even in chair side. Epoxy resin die materials had a net shrinkage, but the gypsum-based materials had a net expansion (Paquette *et al.,* 2000) that can alter the accuracy of final prosthesis. Type IV resin impregnated dental stone and copper-plated dies are dimensionally more accurate than conventional type IV and V dental stone die materials (Nandini *et al.,* 2013). But Die Silicone is employed to prove its reproducibility superior to above said materials. The fit and Accuracy of a Prosthesis is a key factor for the long-term prosthetic treatment success and therefore to avoid misfit, all clinical and laboratory procedures must be followed (Rafael Pino Vitti, 2013). This study uses materials according to manufacturers instruction to avoid error. The excellent physical, mechanical properties and absence of byproducts of polyether impression material contributes for its dimensional accuracy. Application of an adhesive is recommended for preventing detachment during removal (Rafael Pino Vitti, 2013). Polyether was employed in our study. It was initially available in a single regular viscosity and available as heavy and light bodied systems (Manoj *et al.,* 2013). Reports from previous studies shows undesirable dimensional changes and inaccuracies of stone casts due to uneven thickness and different techniques of impression materials (Suprabha Rathee *et al.,* 2014). In an Italian study by Rosario Prisco *et al.,* 2009 in 2008, it was found that Silicone die material exhibited significant shrinkage. In a recent study by Lillywhite *et al.,* 2015, it was found to have improved a lot.

With recent development it was hypothesized that this material could have overcome this disadvantage. So a study was designed to evaluate and compare Die stone and Die Silicone material. A metal die was made for which a customized special tray was fabricated. Polyether impression material was used to make 20 impressions. Then 10 impressions were poured with die stone and the other 10 with die silicone respectively. The various dimensions on the Metal die, Die stone die and the Die Silicone die were measured using Travelling Microscope and results were statistically analyzed. The result showed a mild contraction on the AB dimension and a mild expansion of stone die and on the CD dimension for both the Die Stone and Die Silicone exhibited a mild contraction, when compared to the Metal die. But these differences were not statistically significant.

Conclusion

Though newer materials emerge into dentistry still there is a need for proper material to accurately reproduce the details for direct and indirect restoration in Prosthodontics. From this study, it can be deduced that both die stone and die silicone are equal in their ability to reproduce details. But the user friendly nature of the Die silicone and the speed in which it is ready for use, makes it a material of choice over the other.

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