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Research Article

Comparison of Surface Detail Reproduction of Alginate Impression Material and Type III Dental Stone

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Abstract

The compatibility of current alginate impression materials and dental stone is not completely understood. The purpose of the present study was to determine compatibility of commercially available alginate impression materials dental stones. A stainless steel die certified according to ISO specification No.1563 was used to make specimens for evaluation of surface detail. The mixed alginate impression was poured into a ring mold, and the test block was pressed down onto the material, and then removed after the material is set. The dental stones were mixed according to manufacturer's instructions. The mixed dental stone was added to the impression in small increments. The casts were allowed to set for 1 hour at ambient room temperature of 20°C +- 2°C and 50% +- 10% relative humidity. The casts were examined under low angle light at X 10 magnification with a stereo zoom microscope (Motic MLC-150C Microscope Cold Light Source) for the entirety of the 0.05-mm-wide line. Among the fifteen combination we found that Neocolloid and Elite model found the best at significance level (p = 0.05). Hydrogum 5 and Elite rock shows the 2nd best combination and Hydrogum 5 and Elite model shows the third best combination. The results of this study should be used as a guide in determining compatible impression materials and dental stone.

Keywords: *Dental Alginate; Dental Stone; Compatibility*

Introduction

Plaster and stones are used in dentistry most commonly outside the oral cavity [1]. They are used to mount casts [2,3]. Stones are used to produce to make study cast and to form dies on which wax pattern of restoration can be finished [4,5]. A stone is also used as an additive to dental casting investments, where it serves as a binder [6]. Gypsum products are used mainly for making positive reproductions or replicas of the oral structures [6]. These replicas are called cast, dies or molds [1,4,7]. The desirable properties for making casts, models or die are accuracy, dimensional stability, and ability to reproduce fine details, strength and resistance to abrasion, compatibility with the impression material, color, biological safety and ease of use [8-10]. The important properties of gypsum product include quality, fluidity at pouring time, setting time, linear setting expansion, compressive strength hardness and abrasion resistance and reproduction of details [1,2]. Dental casts and die materials, especially for fixed prosthodontics procedures, are required to accurately reproduce the impressions they are made from, providing all the fine details, in addition to being dimensionally stable and resistant to abrasion [9,11].

Several materials that closely fulfill these requirements have been used to fabricate dies. Among these products are dental stone, epoxy resins, as well as dies electroplated with metals like copper and silver [9,10,12]. Additionally, a blend of stone and investment material has been proposed to fabricate refractory dies [5,9,10,13]. Improved dental stones, however, have been by far the most popular in fabricating working casts and removable dies, because of their reasonable cost, ease of manipulation, and ability to produce consistent results [8,9,12,14].

The dimensional accuracy of cast and die materials has been the subject of several *in vitro* investigations over the past decade, with some conflicting findings.

Some studies reported that improved dental stone provided a similar degree of dimensional accuracy in reproducing a complete arch when compared to epoxy resin [14]. However, other investigators found that epoxy resin exhibited considerable shrinkage compare to gypsum products and suggested that technique modifications were required to obtain castings that would adapt to tooth preparations if epoxy resin were to be used as die material [3,9,13]. Some researchers measured the linear expansion of 6 ADA types IV and V improved dental stone materials and reported that all stone products showed higher mean linear expansion [3,5,15,16].

Materials and Methods

Five irreversible hydrocolloid impression materials were used in this study (Table 1) generally used for prosthetic and orthodontic purpose. A range of dental stone were chosen (Table 2) to relate the practices routinely used in commercial dental laboratories. Impression materials and dental stones were portioned, mixed and manipulating according to the manufacturer instruction by operator.

Materials	Abbreviation	Lot no.	P/W ratio	Manufacturer's
Hydrogum 5	HG5	87437	14g/30ml	Zhermack/Italy
Cavex CA 37	CA	AA063	18g/39ml	Cavex/Holland
Neocolloid	NC	908881	18g/36ml	Zhermack/Italy
Megapan	MG	20100508	18g/40ml	Mega Dentist/China
Alginoplast (Tulip)	TLP	6984031	22g/50ml	Heraeus/Holland

Table 1: *Alginate impression materials used in this study.*

Materials	Abbreviation	Batch no.	Water powder ratio	Manufacturer's
Elite rock	ER	R0489	20ml/100g	ZHERMACK
Elite model	EM	U136188A	30ml/100g	ZHERMACK
Kopo Hard (CKH-52)	KH	1630008	32ml/100g	KUANG PANG

Table 2: *Dental stones used in this study.*

A stainless steel die certified according to ISO specification No.1563 was used to make specimens for evaluation of compatibility. The stainless steel test die has a highly polished surface approximately 30 mm in diameter, on which are inscribed 3 parallel lines, x, y and z to a depth of 50, 20 and 75 µm respectively, for evaluation of surface details. Reproduction of the surface details of the stone casts made from the alginate impression will be determined according to the International Organization for Standardization (ISO) specification 1563 for Dental Alginate Impression Materials. Prior to fabricating each specimen, the surface of the stainless steel test die was cleaned with cotton gauze soaked in methyl alcohol, rinsed with distilled water, and gently dried with compressed air. The mixed alginate impression was

poured into a ring mold, and the test block was pressed down onto the material, and then removed after the material is set. The specimens were stored in distilled water at 37°C.

The dental stones were mixed according to manufacturer's instructions. The water was placed in a vacuum mixing bowl, and the powder was slowly added. The powder was allowed to soak and then hand spatulated for 10 seconds. The mixed dental stone was added to the impression in small increments placed on a mechanical vibrator (Vibromaster; BEGO, Bremer, Germany). The vibration frequency and amplitude were set at 6000 cycles/min to prevent formation of air bubbles. The collar was covered with a glass slab to ensure that the base was parallel to the test surface. The casts were allowed to set for 1 hour at ambient room temperature of 20°C +- 2°C and 50% +- 10% relative humidity. The casts were examined under low angle light at X 10 magnification with a stereo zoom microscope (Motic MLC-150C Microscope Cold Light Source) and graded A to F according to the evaluation criteria (Table 3).

Rating	Criteria
A	20 µm line is sharp.
B	20 µm line is less distinct and some breaks in designated areas or surface is somewhat grainy.
C	20 µm line is very indistinct but is present.
D	20 µm line is approximately 50% present.
E	20 µm line not present or surface of die full of voids.
F	Impression and die material will not separate or surface

Table 3: *Evaluation criteria.*

Statistical analysis

Statistical analysis is done by using SPSS version 23. The result was subjected to Kruskal Wallis non-parametric test with level of significance ($p < 0.05$). Post hoc analysis is done to check the best combination.

Results

A surface quality of 450 specimens was expressed as a median surface rating for all combination of materials (Table 4).

Rating						
Impression Material/Dental stone	**A**	**B**	**C**	**D**	**E**	**F**
Hydrogum 5/Elite Rock	21	7	2			
Hydrogum 5/Elite Model	22	5	3			
Hydrogum 5/Kopo Hard	2	18	6	4		
CA 37/ Elite Rock	15	13	1	1		
CA37/ Elite Model	14	14	1	1		
CA 37/ Kopo Hard	11	9	7	3		
Neocolloid/Elite Rock	11	8	6	5		
Neocolloid/Elite Model	23	7				
Neocolloid/Kopo Hard	14	14	2			
Megapan/ Elite Rock	11	9	6	3		
Megapan/Elite Model	9	9	7	4		
Megapan/ Kopo Hard	6		9	5	3	1
Tulip/Elite Rock	17	6	5	2		
Tulip/ Elite Model	8	12	6	4		
Tulip/ Kopo Hard	7	12	4	4	3	
(n = 30) Impression Material/Dental Stone combination.						

Table 4 *Rating analysis of impression material/dental stone.*

Study was carried out to ensure that the selected impression materials are compatible with dental stones. The results indicate a significant difference $p < 0.001$.

Among the fifteen combination we find that Neocolloid and Elite model found the best at significant level ($p = 0.05$) which produces the 20 µm sharp line. Hydrogum 5 and Elite rock shows the 2nd best combination and Hydrogum 5 and Elite model shows the third best combination. Tukey post hoc test results for combination of impression material and dental stone are shown in figure 1.

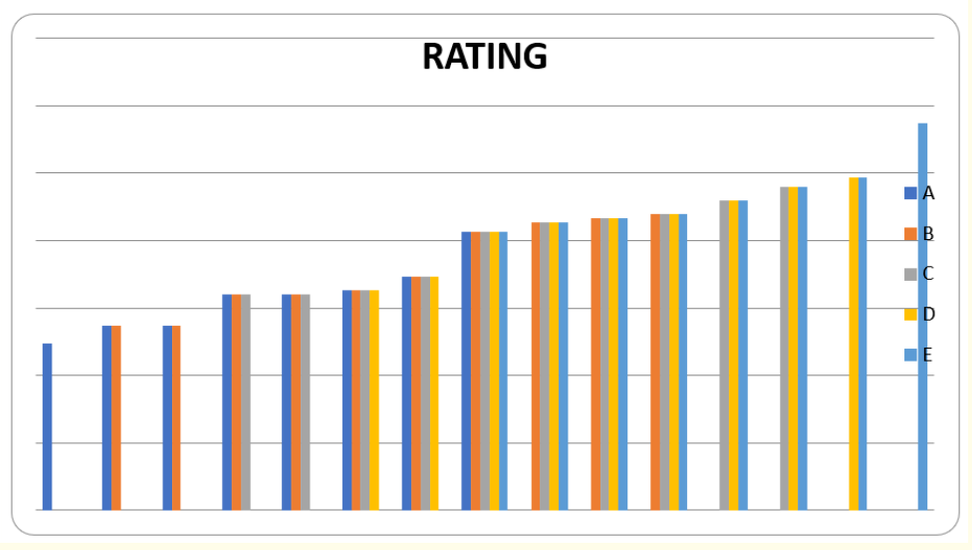

Figure 1: *Tukey post hoc test result of combination of impression material and dental stone. NC_EM, Neocolloid and Elite Model; HG5_ER, Hydrogum 5 and Elite rock; HG5_EM,Hydrogum 5 and elite model; CA_ER, CA 37 and Elite rock; NC_KH, Neocolloid and Kopo Hard; CA_EM,CA 37 and Elite Model; TLP_ER, Tulip and Elite Rock; CA_KH,CA 37 and Kopo Hard; MG_ER, Megapan and Elite Rock; NC_ER, Neocolloid and Elite Rock; TLP_EM, Tulip and Elite model; MG_EM, Megapan and Elite Model; HG5_KH,Hydrogum 5 and Kopo Hard; TLP_KH, Tulip and Kopo hard and MG_KH, Megapan and Kopo Hard.*

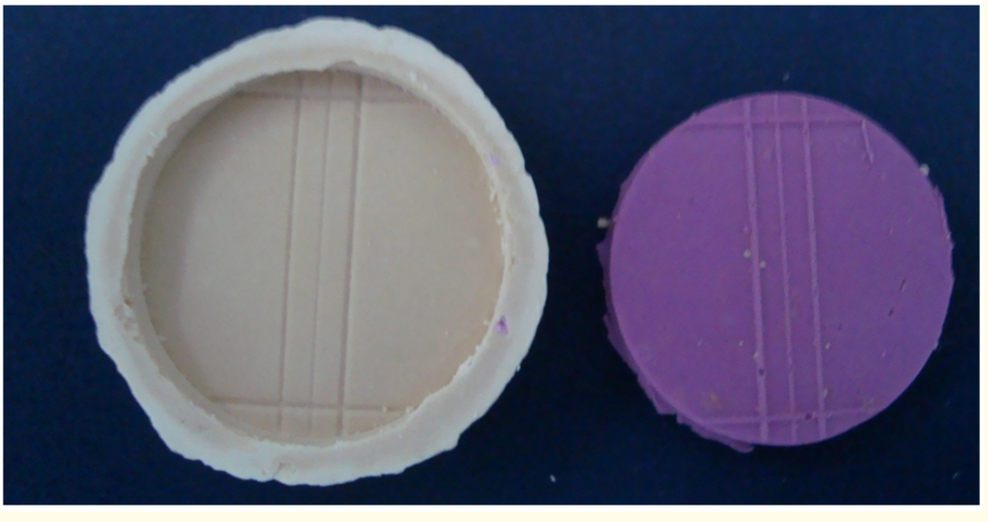

Figure 2: *Samples made from alginate and stone.*

Discussion

The results of this study indicate that rating of the combinations of impression materials which are compatible with each other and should be used to make cast. Neocolloid impression material worked well in combination with Elite model dental stone, but megapan impression material should not be used when Kopo hard material are used for the cast. The poor surface detail reproduced by the megapan may partially account for the poor fit of the restorations made with the megapan impression material. Factors of abrasion resistance, surface texture, and hardness of the cast may be more important than groove reproduction as indicators for laboratory use [4,10,17]. Technical factors can influence groove reproduction in regard to compatibility with gypsum. If the impression material did not record the grooves of the metal test block, the imperfect impression that results could produce a defective test cast. The results of this study should be used as a guide in determining compatible impression materials and which combinations should be avoided. However, other factors such as dimensional stability, and interactions between the cast material and impression material should also be considered when choosing an impression material and dental stone. Some studies suggest that waxes, glycerin or glycols are present in impression materials which interfere with gypsum materials and the set is inhibited [11,18-20].

Conclusion

Five new commercially available impression materials and three dental stone were used in this study and within the limitation of the study we conclude that: Neocolloid and Elite model appeared to be the most compatible with all combination. Elite rock shows the most compatible dental stone among all dental stone used in this study.

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