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Study of Surface Hardness of Gypsum Casts Made with Slurry Water: An in Vitro Study

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Abstract
Aim: *To determine surface hardness of the gypsum casts made with slurry water.*
Materials and Method: *Three types of Gypsum Products were used as Type II, Type III and Type IV. 10 casts, of each Type were poured. In these, 5 obtained with distilled water and 5 with slurry water. Surface hardness was determined using Rockwell superficial hardness tester.*
Results: *Measuring surface hardness for Type IV gypsum casts, the average of A(D) and A(S) do not show any significant variation ($p>0.05$). In Type III gypsum casts average of B(D) is significantly lower compared to B(S) ($t = 3.07$, $d.f = 8$, $p<0.05$). In Type II gypsum casts average values of C(S) are significantly higher than C(D) ($p<0.01$).*
Conclusion: *Significant increase in surface hardness for Type II and Type III gypsum casts made with slurry water were seen.*
Keywords: *Gypsum, Rockwell hardness, Slurry water, Surface hardness*

I. Introduction

Research workers have repeatedly exerted their efforts to improve the surface properties (like surface hardness & abrasion resistance) of the working models made of gypsum products. Within the confines of dental laboratory, waste product like slurry water, flowing out of the drainage pipe of model trimmers of which we are quite oblivion may be fruitful in obtaining better casts & models in terms of surface harness. The objective of our study was to determine surface hardness of the casts made with gypsum products and slurry water.

Morrow Robert M et al stated that a complete denture depends on an artificial stone cast for its dimensions, contours & ultimate clinical success. The surface of a cast should be hard, dense and free of any grinding sludge left by the cast trimmer.[1].Fan P.L & Powers J.M.quoted that the surface mechanical properties as surface hardness, surface roughness, effect of scratching & abrasion resistance of a die influence its ability to withstand forces associated with fabrication of a restoration.[2]

Hardison J D & Mitchell R J enumerated the methods for improving die stone (type IV) abrasion resistance include the use of die hardeners solns, sealant solutions, resin coatings and electroplating.[3] Diakoyami I N et al in a study found that surface hardness of dental stone is increased significantly when prepared with aqueous solutions of potassium salts (K_2SO_4, KCl, KF, KBr, KNO_4, KMnO4, $K_2Cr_2O_7$). The most effective hardening soln is K2SO4 in concentrations of 0.5-5%.[4] According to Mason Harold J. stone dies may be made harder & tougher by impregnating them with an acrylic resin slurry.[5]

Shen C, Mohammed H and Kamar A in a study found that slurry water, a dihydrate found to accelerate the set of gypsum and create an increase in strength.[6]. Kaiser David A and Nicholis Jack I in a study concluded that specimen casts made with slurry water and improved stone showed no greater than made with distilled water. Surfaces of the specimens made with slurry water were significantly harder than those of specimens made with distilled water.[7]

Fairhust C. W. stated that calcium sulfate dihydrate itself in the form of slurry water acts as a potent accelerator of the setting time because it provides nuclei of crystallization of the dihydrate.[8] Doshi B. and Gangadhar S.A. reviewed that slurry water dissolves the surface of gypsum cast less than tap water so to maintain the accuracy of the cast and the prosthesis.

Use of slurry water is must.[9] Harris Paul E. & Hoyer Scott concluded in a study that the die hardeners as cyanoacrylate did not increase the surface hardness of the gypsum materials but it may have play a role in preventing brittle fracture of the die margin.[10]

II. Materials And Methods

Three types of Gypsum Products were used for the study as Model Plaster (Type II), Dental Stone (Type III) & Improved Stone (Type IV). These products, their manufacturers and/or distributors, and batch numbers are listed in **Table 1.**

A metal maxillary dentulous model fabricated from typhodont model no: S-562 (Columbia Dentoform **Corp:** Long Island, N.Y.) was selected as the standard master model. A flat surface of 4mm diameter was made on the palate. The impressions was made with irreversible hydrocolloid [New Imprint, Dental Products of India Ltd., Mumbai, India]. Three acrylic resin vertical stops had been attached on the stock tray borders maintaining uniform thickness of alginate impression material on the occlusal surface of teeth.

Distilled water was recommended for mixing gypsum products, because it eliminates contamination of the mix with calcium and other minerals often found in tap water.[11] Slurry water was collected from a cast trimmer and allowed to stand for 48hours. The water then obtained was diluted as one part of slurry water and three parts of distilled water, immediately before adding stone. [7]

10 casts, each of model plaster, dental stone & improved stone were poured. In these 5 obtained with distilled and 5 with slurry water. So, in all 30 casts were prepared for the study. Different groups made in study are described in detail in **Table Ii**. Casts prepared were coded for identification. Surface harness of the occlusal surface of the model obtained were determined using Rockwell superficial hardness tester with R scale. (Fig 1) The values obtained were then subjected to student t test for statistical analysis.

III. Results

Table Iii shows in Type IV gypsum casts average of A(D) and A(S) did not show any significant variation ($p>0.05$). In Type III gypsum casts average of B(D) was significantly lower compared to B(S) ($t = 3.07$, $d.f = 8$, $p<0.05$). In Type II gypsum casts average values of C(S) were significantly higher than C(D) ($p<0.01$) as can be seen from this table. The graphs I-III show the comparison of surface hardness values obtained for the three gypsum groups casts made with distilled and slurry water.

IV. Discussion

Gypsum products are extensively used in dentistry for a variety of purpose ranging from construction of study models and casts duplication of soft and hard tissues of oral cavity required for crown & bridge work, fabrication of complete dentures or maxillofacial rehabilitation. Besides having extensive use in Prosthetic Dentistry, it is used widely in other branches of dentistry as well. Accuracy of stone cast is an essential requirement, which paves way to success of a dental prosthesis. Surface hardness is another very important property for gypsum cast that corresponds to the reproduction of intimate surface details of recorded or facial structures in the working cast which can be transferred to the finished prosthesis.

Many workers have studied the surface properties of gypsum products, but very few literature have evaluated the hardness of the gypsum cast made with slurry water. Kaiser Kaisier D.A. and Nicholis J. I. in a study found dental stone casts made with slurry water had surfaces significantly harder than those made with distilled water. He obtained the hardness values using Rockwell tester and 15 x tests. The hardness values of the study casts made with distilled water and slurry water were 58.663 and 61.747 respectively.[7] In our study, Rockwell tester with R scale was used to measure the surface hardness of all the three types of gypsum casts. Hardness values of Type III, dental stone with distilled water were 52.73. The same groups when made with slurry water showed significant rise in hardness to 55.33.

Powers J. M. and Sakaguchi R. L. (2006) stated that when attempts were made to increase the hardness of gypsum products by impregnating the set gypsum with epoxy resins, increase in hardness were obtained for model plaster but not for dental stone or high strength stone. In our study we observed that values for hardness of study casts were significantly raised for Type II, model plaster, when we used slurry water. The value obtained of Type II made with distilled water was 23.93. There was enormous rise in hardness when made with slurry water, values obtained were 38.332. Type III gypsum casts also showed significant rise in hardness values when casts were made with slurry water than that made with distilled water. Such rise in hardness value in Type II gypsum casts was greater than that of Type III gypsum product. There was no significant rise in hardness values for Type IV, improved stone, when made with slurry water.

V Conclusion

Significant increase in surface hardness was observed for Type II and Type III gypsum when mixed with slurry water. While no significant increase in surface hardness was found for die stone.

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Tables

6.1 Table: I

Materials Used

	Material	Trade name & Mark	Batch No.	Study code	Manufacturer
Type IV	Improved stone	Kalrock	80602	A	Kalabhai Karson (P) Ltd.
Type III	Dental stone	Kalstone	80467	C	Kalabhai Karson (P) Ltd.
Type II	Model plaster	Universal Dental Plaster	786	E	Liluah

6.2 Table II

Description Of Groups

GROUP	TYPE	MATERIAL	METHOD
A (D)	TYPE IV	Kalrock	Mixed with distilled water
A (S)	TYPE IV	Kalrock	Mixed with slurry water
B (D)	TYPE III	Kalstone	Mixed with distilled water
B (S)	TYPE III	Kalstone	Mixed with slurry water
C (D)	TYPE II	U.D. plaster	Mixed with distilled water
C (S)	TYPE II	U.D. plaster	Mixed with slurry water

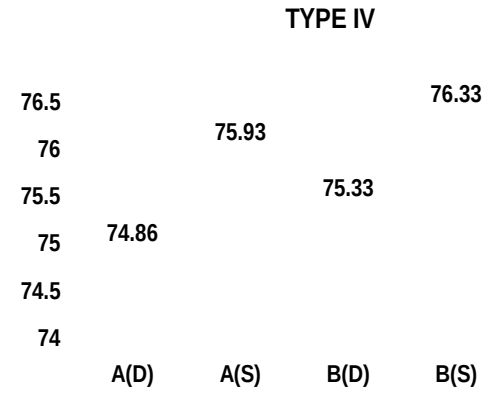
6.3 Table III

Comparison Of Surface Hardness

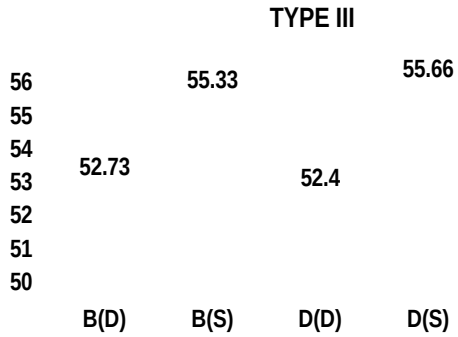
GROUPS	**A (S)**	**A (S)**
TYPE IV	**'t' value**	**'p' value**
A (D)	0.12	n.s.
TYPE III	**B (S)**	**B (S)**
	't' value	**'p' value**
B(D)	3.07	p<0.05
TYPE II	**C(S)**	**C (S)**
	't' value	**'p' value**
C (D)	20.05	p<0.001

Graphs

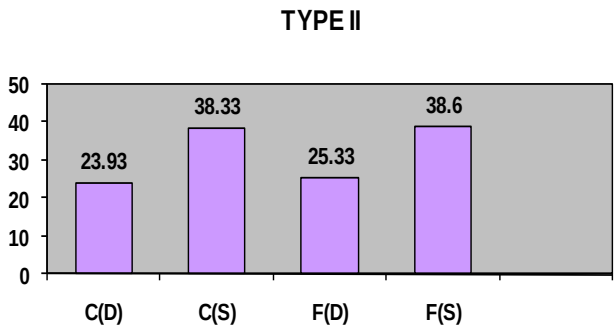
Graph I-III shows Comparison of surface hardness
Graph I



Graph II



Graph III



Figures And Table Legends
Figure 1 : Rockwell Hardness Tester Apparatus
Table: I :Materials used
Table II : Description of groups
Table III : Comparison of surface hardness
Graph I-III : : Comparison of surface hardness of Type I, Type II and Type III gypsum respectively.