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RESEARCH ARTICLE

EFFECT OF GUM ARABIC AND CALCIUM HYDROXIDE ON SURFACE HARDNESS OF TYPE III DENTAL STONE

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ABSTRACT

Aim: To study the effect of gum arabic and calcium hydroxide on surface hardness of type III dental stone.
Materials and Methods: A metal die with 10mm diameter and 12 mm height was fabricated. Type III dental stone was mixed with additives and one without additives. Vickers hardness was measured for specimens. Data was subjected to statistical analysis.
Results: The Vickers Hardness for type III dental stone with additives was significantly higher ($p<0.001$) compared that without additives.
Conclusion: Surface hardness can be significantly increased by additives i.e. gum Arabic and calcium hydroxide.

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INTRODUCTION

It is important that cast and die materials have adequate surface hardness to resist abrasion when a wax pattern is being carved. (McCabe, 1990) The hardness of set gypsum is dependent on a number of factors. Choice of gypsum product is important, as is the water/powder (W/P) ratio at which it is mixed. Improved die stones are harder and stronger than type III materials because they can be mixed at a typical W/P ratio of 0.21 compared with a W/P ratio of 0.28. Lower W/P ratios give rise to denser gypsum that sets harder. However, two factors limit the W/P ratio that can be used. First, there must be sufficient water to ensure complete hydration of the calcium sulfate hemihydrate. Second, use of too low W/P ratio will lead to a mix of too high a viscosity, so that it will not have adequate flow properties to be able to adequately reproduce the surface detail of impressions. One method of improving impression surface properties is to use gypsum hardening solutions that are applied to the set material. (Toreskog *et al*., 1966; Sanad *et al*., 1980) Gypsum can also be hardened by epoxy resin impregnation. (Sanad *et al*., 1980) Although hardening solutions may be beneficial, their application involves an extra stage in cast or die preparation. An alternative method of hardening is to soak the impression in an aqueous solution of a potassium salt before preparation of a gypsum cast. Soaking of impression in hardening solution may result in loss of details of impression. In some situations gypsum of greater surface hardness was produced. (Diakoyanni *et al*., 1992) Lignosulfonates were found to achieve these results. (Combe and Smith, 1971) Zakaria *et al*. reported some benefits from using two agents, a "liquid dispersing agent" and a "microcrystalline additive," but the composition of these components was not specified. (Zakaria *et al*., 1988) The addition of a mixture of gum arabic and calcium oxide or hydroxide to types II and III gypsum have also demonstrated the same effect. (Sanad *et al*., 1982) Studies to reduce the water requirement of dental gypsum products have been conducted to produce set materials with less porosity, greater density. The purpose of this study was to compare the surface hardness of type III dental stone with additives (1% calcium hydroxide and 0.132% gum Arabic) and type III dental stone without additives. This study is based on a formulation of Sanad *et al*, found to be effective for type II dental stone material and is based on formulation used in construction industry. (Ridge and Boell, 1964)

MATERIALS AND METHODS

A stainless steel cylindrical die with a locking screw was fabricated with 10mm diameter and 12mm height (Fig 1). Die was made with locking screw for easy removal of specimen from the die. Die was fabricated for making specimens of same dimension.

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Fig.1. Metal die with lock screw

Specimens were divided in two groups:

Group 1: Without additives

Fig.2. Retrieved Specimen of Group 1

Group 2: With additives (1.0% gum arabic and 0.132% calcium hydroxide)

Fig.3. Retrieved Specimen of Group 2

Fig. 4. Vickers surface hardness

Fig.5. Making indentation with Vickersmachine hardness measuring machine

Specimens were divided in two groups

For experimental purposes the additives i.e. 1.0% gum Arabic and 0.132% calcium hydroxide were blended with dental stone (Kalstone, Kalabhai, India) after accurately weighing with electronic weighing machine for group 1.

Sample size was decided to be 30 for each group.

Cylindrical die was kept on clean glass slab. Dental stone and water were mixed with accurate w/p ratio with help of glass pipette (w/p ratio- 0.28). Mix was placed in cylindrical die with 10mm diameter and 12mm length. The glass slab was kept on the vibrator to avoid incorporation of air bubbles and obtain homogenous mix. The specimen was retrieved from the die after 1 hour.30 specimens of each group i.e. with and without additives were made. Specimens were dried at temp ≤45°. Hardness was measured using Vickers scale (Fig 4) by applying a 2000gf for 10 sec on surface cast against glass slab (Fig 5). Vickers hardness test was done only after 24 hrs of mixing of dental stone.

Data was subjected to statistical analysis

RESULTS

ANOVA

Source of variation	Sum of squares	DF	Mean square
Between groups (influence factor)	687.1550	1	687.1550
Within groups (other fluctuations)	8.2990	58	0.1431
Total	695.4540	59	

F-ratio	4802.398
Significance level	P < 0.001

Student-Newman-Keuls test for all pair-wise comparisons

Factor	n	Mean	Different (P<0.05) from factor nr
(1) 1	30	16.2587	(2)
(2) 2	30	23.0270	(1)

The mean value of Vickers Hardness for group 1 was 16.2587 and for group 2 was 23.0270.The Vickers Hardness values were statistically significant (p<0.001) between group 1 and group 2.

DISCUSSION

It was found that the hardness values for specimens with additives were more than the specimens without additives. One way ANOVA was done and the values of both groups were found to be statistically different. The result matches the study done by Sanad *et al*. (Ridge and Boell, 1964). Alsadi *et al* did study using same additives. The additives did not improve compressive or tensile strength for the type III materials. In contrast, the improved die stone's hardness was not enhanced by the additives and in some instances a reduction in strength was observed. It was concluded that dental cast materials with superior surface properties can be produced by a simple change of formulation.

Conclusion

The hardness of dental stone can be increased by adding additives.

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