# THE EFFECT OF DIVERSE WATER TYPE ON THE WATER POWDER RATIO OF VARIOUS DENTAL GYPSUM PRODUCTS

[1]RAO SUBHAN
[2]KHURRAM PERVAIZ
[3]SOFIA MALIK
[4]ZIAULLAH CHOUDHRY

## ABSTRACT

*This study was performed in order to calculate the outcome of diverse type of water on the ratio of water and powder of varied gypsum products which have a key role in normal day dentistry.*

*In this study four different water types namely distilled, mineral water (aquafina), de-ionized and slurry were selected which were used to mix with two different types of gypsum products(stone and plaster).*

*The results show a statistically significant divergence at $p \leq 0.05$ in the ratio of water and powder of gypsum products, when it was mixed with diverse water type distilled, mineral water (aquafina), de-ionized and slurry] that was used in the study.*

*Factors which control the setting beauty of gypsum product can be divided into those, controlled by manufacturer as well as those commended by operator (water / powder ratio, mixing time , temperature, type of water used).The water necessity for the product of dental gypsum varies according to the type of water used for mixing. Among the four water types used in this study the most enunciatedecline in water necessity for gypsum products, accomplished with the slurry water.*

**Key Words:** *water types, water powder ratio and gypsum product.*

## INTRODUCTION

Gypsum, chemically known as Calcium Sulphate Di-hydrate (CaSO4.2H2O is naturally occurring white powdery mineral as well as one of the most commonly used materials in the dental life. If we talk about its standardization, American Dental Association (ADA) steps in and classifies gypsum products in to five types (ADA type I-V). These include impression plaster, model plaster, dental stone, high- strength dental stone and high-strength & high-expansion dental stone.[1,2] All these products are chemically identical but showing there divergence in their particle size, powder water ratio and manipulation[3] Gypsum materials are chosen as a die material for the reason that is easy manipulation, economic disposition compatibility and their passion towards most impression materials.[4] With all moldable and compatible qualities still have some negative qualities like, inadequate compressive strength, dimensional instability, technique sensitivity and susceptibility to abrasion, are some of the shortcomings of gypsum products.[5]

The gypsum materials used for a long time to make models dies and cast in dentistry.[6] The gypsum products doubtless served this profession with some minoramendments.[7] A number of studies had been endeavor to move towards an enhanced system in use of die as well as model construction[8], properties of gypsum were sloping mostly, because of the decreased requirements of gauging water.[9] To improve gypsum properties many attempt had been done by the use of various additives in order to put on several amendments associated to their chemical, physical, mechanical as well as additional properties.[10,11]

[1] Dr Rao Subhan, DD, MDS (Trainee), Lecturer, Department of Science of Dental Materials, Dental Section Dow International Medical College, Dow University of Health Sciences, Email: docrao2002@yahoo.com

[2] Dr Khurram Parvez Sardar, BDS, MDS, Vice Principal, Assistant Professor, MDS Supervisor (Dental Materials), MDS, MSc Subject Coordinator, Department of Science of Dental Materials, Dr Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow Univesity of Health Sciences Email: dr_khurramparvez@hotmail.com

[3] Dr Sofia Malik, BDS, MSc (Science of Dental Materials), Assistant Professor, Department of Science of Dental Materials, Dental Section Dow International Medical College, Dow University of Health Sciences Email: drsofiamalik@gmail.com

[4] Dr Ziaullah Choudhry, BDS, MSc (Prosthetic Dentistry), Assistant Professor Prosthodontics Department, Dental Section, Dow International Medical College
Email: choudhryziaullah@gmail.com **Corresponding Author:** Dr Ziaullah Choudhry, BDS, MSc, Prosthetic Dentistry, C-243 Block, 14 Gulistan-e-Jauhar, Karachi Email: choudhryziaullah@gmail.com

**Received for Publication:** March 29, 2016
**Revised:** May 26, 2016
**Approved:** May 28, 2016

Water powder ratio plays its role as an important factor in the quality of gypsum materials[12,13] many experiments have been done to improve mechanical properties of dental stone and they have main concerned towards the decrease of gauging water requirement.[14,19] Accurate understanding of gypsum properties should be undertaken while all materials are mixed at the same consistency.[20] Although particle size and the total surface area are the chief factors in determining the amount of gauging water.

## METHODOLOGY

- Two types of dental gypsum products used in this study (plaster and stone). Two types of plaster (Al-Ahliya Co. for gypsum industries Ltd, and Al-Alaf Co. for gypsum industries Ltd ) and two types of stone (Elite, Zhermack SPA-450, Italy and Dental stone China Me-hecoco.P.R. China).
- Mixing water; four types of mixing water has been used in this study (Distilled water, mineral water, slurry water and deionized water). It's a control specimen, distal water has been used to analyze the water/powder ratio requirements for dental gypsum products used in this study.
- Water analysis data has been gathered from Dow International analysis department, Ojha Campus (Table 1).
- Mixing procedure used in the preparation of the test specimens trail the ADA specification No. 25 of gypsum products (1975).[20] The mixing water temperature was maintained at 25°C.
- Mechanical mixer was used for mechanical mixing for 20 seconds. The preparation of test specimens and test procedures were conducted under laboratory environment of 25 ± 2.0 and a relative humidity.

Slurry water was prepared by placing the dental cast made from plaster (mixed with plaster specimens) or from stone cast (mixed with stone specimens) in water for continues 72 hours. The water-powder ratio was measured by means of modified vicat apparatus. Its an ISO standard of measuring the setting time. Three hundred grams of test sample were added to a known volume of 4% sodium citrate in distilled water and then mixed mechanically with vacuum. The mixture was then poured into the ring mold (vibrated slightly to remove air bubbles) and then it was struck level with spatula at the top of the mold. The conical plunger of the modified vicat apparatus was wiped clean with a moist cloth before each determination, and then it lowered to the surface of the sample. The scale was read then the plunger released quickly by opening the thumbscrew. After the plunger settled reading on the scale were noted again. The difference in scale reading was millimeters of penetration. Determinations were made at minutes after the start of the mix. Three penetrations averaged for each determination. The average of three determinations (9 penetrations) was taken as a measure of consistency. The water powder ratio that gives the consistency specified in Table 2 was used as a correct water-powder ratio for that sample (ADA specification No. 25, 1975).[21]

## RESULTS

The mean and standard deviation of water powder ratio of gypsum products mixed with different types of water were listed in the Table 3. This table reveals that the water requirement of each type of gypsum specimens used in this study varies according to the type of mixing water. The most pronounced decrease in water powder ratio of both stone and plaster was achieved with slurry water (Table 3).

TABLE 1: CHEMICAL ANALYSIS OF THREE WATER TYPES

| Type | Distilled water | Mineral water | Deionized water |
|---|---|---|---|
| Sodium | 0 | 13 | 0 |
| Magnesium | 0 | 13 | 0 |
| Sulfate | 0 | 52 | 0 |
| Carbonate | 0 | 54 | 0 |

TABLE 2: TESTING CONSISTENCY

| Type | Cone Penetration |
|---|---|
| II plaster, mold | 32±2 |
| III dental stone | 32±2 |
| IV dental stone, high strength | 32±2 |

TABLE 3: THE EFFECT OF DIFFERENT WATER TYPES ON WATER POWDER RATIO OF GYPSUM PRODUCTS

| Gypsum products | Distilled water | Slurry water | Mineral water | Deionized water |
|---|---|---|---|---|
| Elite stone | 31 | 26 | 28 | 34 |
| Dental stone | 35 | 32 | 35 | 32.5 |
| Elite plaster | 56 | 49 | 58 | 57.5 |
| Zhermack plaster | 46 | 42 | 50.3 | 52 |

One way analysis of variance (ANOVA) revealed that there was a statistically significant difference at $p \leq 0.05$ on the effect of water type on the water requirement of all gypsum products that is used in this study.

## DISCUSSION

This study weighs up the effect of setting on gypsum by changing W/P ratio and changing water types. In this study we used two types of dental stones, two types of plaster and four type of water. The time between start of mixing water and gypsum and completion of setting is called setting time. This time more often than not determined by one kind of penetration test and based on the ADA specification #25, this was determined with standard Vicat apparatus.[22]

Setting time of different dental stones depends on factors such as water-powder ratio, time and speed of spatulation, temperature of water and environment, composition of water and powder, humidity of environment and the colloidal system. Factors that reduce setting time are reduced water-powder ratio, increase time and speed of spatulation, adding Terra Alba, increase salt such as sodium chloride or 0.4 potassium sulfate and increase the temperature of water.

Calcium sulphate hemihydrates (gypsum) is an ionic solid and is therefore essentially hydrophilic.[23] The surface interactions play an appreciable part in determining the water requirement; this can act through changing the condition of the grains and forces between the grains.[24]

Analysis of the mean and standard deviation Table 3 reveals that slurry water produces the most pronounce decrease in the water powder ratio of both stone and plaster specimens. This can be explained according to the crystallization theory.[23,32,33,34] Increasing the nucleus of crystallization (calcium sulfate dehydrate) that present in slurry water enhances the wetting of gypsum crystals by water and thereby decreasing their water powder ratio.

According to this study, a decrease in water powder ratio of stone specimens was noted when mixed with mineral water as compared with that when mixed with distilled water Table 3. Mineral water contains large amount of calcium carbonate ions (CaCO3) (Table 1) and this salt highly soluble in water makes mineral water a soft water; this means that salt makes mineral water easily dispensable between the particles of stone powder (it provides sites for nucleation of the newly formed dehydrate) and thereby decreasing their water powder ratio. While for plaster mineral water increases its water requirement, this difference may be due to the difference in physical properties of dental stone and plaster or the addition of chemical materials during manufacturing that makes distilled water more easily dispensable between gypsum particles and thereby decreasing their water requirement.[18]

## CONCLUSION

Some properties of dental gypsum are reliant upon their different forms and can be used to amend the physical properties of gypsum like, strength and abrasion resistance. Factors which control the setting properties of gypsum product can be divided into those, controlled by manufacturer as well as those commended by operator (water/powder ratio, mixing time, temperature, type of water used). By increasing the W/P ratio retards setting by decreasing the concentration of crystallization nuclei.

It was concluded that different factors significantly affect W/P ratio of gypsum products, most pronounced effects being observed by use of slurry water. In using slurry water we need less W/P ratio and accelerate the setting reaction.

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## CONTRIBUTIONS BY AUTHORS

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|---|---|---|
| 1 | **Rao Subhan M Khan:** | Acquisition of data, clinically performing procedures on patients, drafting of manuscript, drafting of abstract. |
| 2 | **Khurram Pervaiz:** | Topic selection, study conception and design, analysis and interpretation of data, discussion writes up, critical revision. |
| 3 | **Sofia Malik:** | Critical revision, referencing.. |
| 4 | **Zia Ullah Choudry:** | Critical revision. |