

## Measurement of surface roughness of the stone cast poured on different impression materials

Munther N KAZANJI\*  
Lamia T REJAB\*\*

### ABSTRACT

The aim of this study was to determine the mean roughness values of the stone casts surfaces that were poured from two different gypsum products (ZETA and QD) dental stones on the three different impression materials (Supersil, Neogenate and Xanthano).

Ten patients were selected to perform this study, for each patient six impressions were recorded. Sixty stone casts were poured and examined to evaluate surface roughness values. The stone casts were tested for surface roughness values with surface-roughness-measuring instrument, Profilometer (Perthometer).

The data were statistically analyzed using ANOVA and Duncan's multiple range test.

The results of this study showed that there were a significant differences in the mean roughness values of the stone casts among the three different impression materials and two different dental stones used at a level of ( $P \leq 0.05$ ).

It was concluded that the smoothest surface of the stone cast were obtained from poured ZETA stone on Supersil impressions, while roughness surface were observed on the stone casts produced from poured QD dental stone on Xanthano impressions.

*Key Words:* Impression material, surface roughness, stone cast.

---

\*Munther Najeeb KAZANJI; BDS, MSc: Lecturer.

\*\*Lamia Taha REJAB; BDS, MSc: Assistant Lecturer.

Department of Prosthetic Dentistry, College of Dentistry, University of Mosul, Mosul, IRAQ.

### الخلاصة

إن الهدف لهذه الدراسة هو قياس خشونة سطح القالب الجبسي الناتج من صب منتوجين مختلفين من الجبس (QD و ZETA) مع أنواع مختلفة من مواد الطبقات (Supersil, Neogenate, Xanthano).

تم اختيار عشر مرضى بمواصفات محددة لهذه الدراسة. إذ حضر ستون قالب جبسي لتحديد قيمة خشونة سطح القالب. وقد تم قياس خشونة السطح باستخدام جهاز قياس خشونة السطح (Profilometer).

تم التحليل الإحصائي للبيانات المتحصل عليها باستخدام التصميم العشوائي الكامل واستخدم اختبار دنكن المتعدد المدى لاختبار الفروقات المعنوية بين المتوسطات تحت مستوى احتمال 5%.

أظهرت النتائج أن هناك اختلاف معنوي بين قيم خشونة سطوح قوالب الجبس لمواد الطبقات الثلاثة المختلفة ونوعي مادة الجبس إذ أظهرت الدراسة أن أقل قيمة لخشونة السطح ظهرت من خلال صب الجبس نوع (ZETA) مع مادة الطبقة (Supersil) وأعلى قيمة كانت لصب مادة الجبس نوع (QD) مع مادة الطبقة نوع (Xanthano).

## INTRODUCTION

Gypsum products probably serve the dental profession more adequately than any other materials used in dentistry<sup>(1)</sup>. Gypsum products offer a number of advantages as model and die materials, they are accurate, dimensionally stable and easy and convenient to use<sup>(2,3,4)</sup>. The accuracy of cast and impression materials is primarily determined by the manner by which they are handled<sup>(5,6,7)</sup>. Detail reproduction and accuracy of working cast is related to the compatibility between the cast and impression materials<sup>(8,9)</sup>.

The precision fabrication of dental prosthesis is directly dependent on the quality of the working cast<sup>(10,11)</sup>. When materials used intraorally smooth surface would be desirable to minimize tissue trauma. Some authors considered surface roughness as primary irritant causing microtrauma to the tissue and indirectly contribute to tissue damage by harboring microorganisms<sup>(12)</sup>.

Surface topography of the gypsum cast is influenced by many factors including types of impression materials, gypsum product powder particle-

sizes, water/powder ratio, spatulation methods, plasticity of the mixture and humidity<sup>(13, 14, 15)</sup>.

The aim of this study was to determine the surface roughness of the master stone casts of the two different stones materials poured on the three different impression materials.

## MATERIALS AND METHODS

Three types of impression materials were used (Supersil, Neogenate and Xanthano). Each impression material was poured with two different dental stone type III (ZETA and QD) dental stones. The tested materials are listed in tables (1) and (2).

Table (1): Impression materials used in the study

Impression Materials	Trade Name	Manufacturer	Batch Number
Silicone rubber base (light body)	Supersil	Dorident Australia	Base 160199 Catalyst 122001
Zinc-oxide/eugenol impression paste	Neogenate	Septodent France	Base HI 203 Catalyst HI 051
Impression plaster	Xanthano	Bayer Leverkusen Germany	S 15102

Table (2): Gypsum products used in the study with manufacturers recommended water / powder ratio

Gypsum Products Trade Name	Manufactures	Batch Number	W / P Ratio
QD kaffir D	Quayle Dental England		30/100
ZETA	Selenor Italy	GSGIA 0701	31/100

Ten fully edentulous male patients were selected for this study, their age ranged from 45-55 years. The criteria for the selection of these patients were include the following: the patients have no history of any systemic

disease, no signs and symptoms of any oral abnormalities, no sever under cut on the maxillary arch and have no previous dentures<sup>(16,17)</sup>.

The patient was asked to rinse his mouth with tap water before recording the impression, then the impression was recorded. The impression materials were mixed according to manufacturer instruction, hand spatulated. Upon removal of the impression from the patient mouth, the impression was rinsed with distilled water; to remove saliva, blood and debris, then was shaken to dry. The impression was boxed before pouring. Each type of impression materials was poured with the two different dental stones. Six impressions were recorded for each patient, and six master stone casts were poured. The total numbers of the master stone casts were sixty for the ten patients selected.

The impression was poured with dental stone within the first thirty minutes after removal from the patient mouth<sup>(18)</sup>. Xanthano impressions were immersed in separating medium, which was dilute solution of soap for 10 minutes before pouring with dental stone<sup>(19)</sup>.

The contents of gypsum powder container should be agitated before using to insure uniform distribution of all ingredients<sup>(20)</sup>. The dental stone were mixed according to manufacturers recommended water / powder ratio, using distilled water. Mechanically spatulated under vacuum for 30 seconds, then stone was gently vibrated into boxed impression and allowed to set. The impressions were separated from the master stone cast 1 hour after the start of mix. Neogenta and Xanthano impressions were immersed in hot water for 10 minutes to facilitate their separation from the stone cast. The casts were stored at room temperature ( $23 \pm 2C^0$ ) and relative humidity of ( $50 \pm 10\%$ ) until tested for a minimum 24 hour later<sup>(21,22)</sup>.

The surface roughness of the master stone casts was measured with profilometer (perthometer S5P, Perthen, West Germany).

The most appropriate parameter that describe the characteristics of surface texture are maximum roughness ( $R_{max}$ ), the average roughness depth ( $R_z$ ) and roughness average ( $R_a$ )<sup>(23,24)</sup>.

( $R_{max}$ ):- is the maximum of the five peaks to valley height within the measuring length.

( $R_z$ ):- is the mean of peak to values from the five successive sample length.

( $R_a$ ):- is the arithmetic mean deviation of the profile from a mean line through the profile curve.

Six measurements for each roughness parameter were made on each cast in different location on the maxillary alveolar arch over a tracing distance of 1.5 mm.

The mean and standard deviation of the roughness values (R max, Rz and Ra) were calculated for the stone cast. The results were statically analyzed with one-way analysis of variance (ANOVA), followed by Duncan's multiple range test to determine significant different between the surface roughness values at ( $P \leq 0.05$ ) level of significance.

## RESULTS

The results of this study indicated that the surface roughness values of the stone casts for the three impression materials were significantly different among the two dental stones (table 3 and figure 1).

Table (3): Duncan Multiple Range Test for (Rmax, Rz and Ra) values of the different dental stone casts poured on different impression materials

Stone Casts	Rmax				Rz				Ra			
	No	M	SD	Group	No	M	SD	Group	No	M	SD	Group
Supersil + ZETA Stone	10	7.69	0.80	A	10	4.62	0.49	A	10	0.65	0.14	A
Supersil + QD Stone	10	11.39	0.37	B	10	8.58	0.45	B	10	1.36	0.05	B
Neogenat+ ZETA stone	10	11.21	0.61	B	10	7.38	0.45	C	10	1.18	0.07	C
Neogenat+ QD stone	10	12.87	0.58	C	10	9.56	0.26	D	10	1.54	0.07	D
Xanthano+ ZETA stone	10	19.07	1.46	D	10	13.94	0.95	E	10	2.39	0.28	E
Xanthano+ QD Stone	10	23.01	1.48	E	10	16.29	1.34	F	10	3.03	0.22	F

Means for each parameter with different letters are significantly different.

Rmax : Maximum roughness

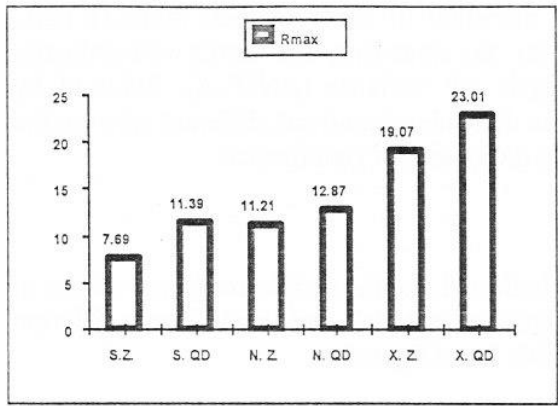
No. : Number of samples

Rz : Average roughness depth

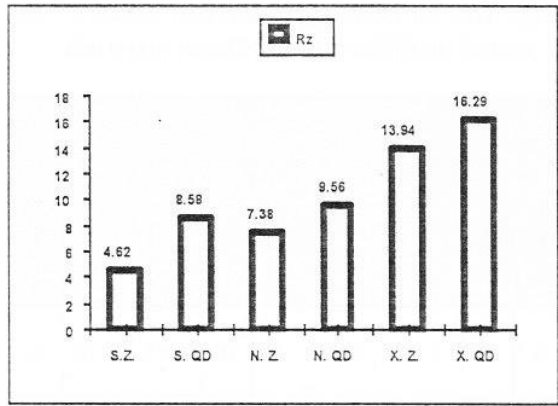
M : Mean

Ra : Roughness average

SD : Standard deviation



Impressions + Stones  
 S.Z. : Supersil + ZETA  
 S. QD : Supersil + QD  
 N.Z. : Neogente + ZETA  
 N. QD : Neogente + QD  
 X.Z. : Xanthano + ZETA  
 X. QD : Xanthano + QD



Rmax : Maximum roughness  
 Rz : Average roughness depth  
 Ra : Roughness average

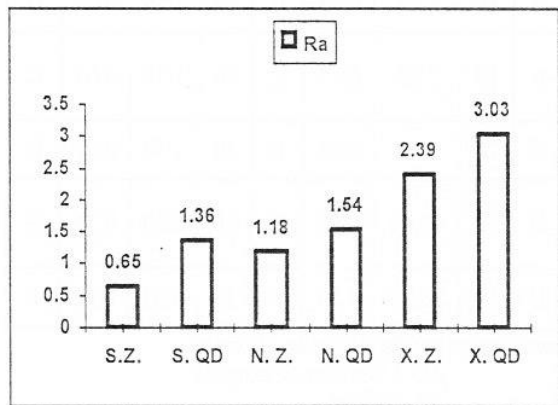


Figure (1): Means of Rmax, Rz and Ra values of the different dental stone casts that poured on different impression

## DISCUSSION

Results can vary considerably depending on the mixture of the dental materials. The precision of working casts depending on the quality of the impression materials, the cast materials and the interaction between the two products<sup>(25)</sup>.

The differences in the surface roughness values of the stone casts that poured in different impression materials can be related to that, there were differences in chemical and physical properties between different impression materials on which they were poured, as well as differences in their compatibility to gypsum products and the manner by which they were handled<sup>(26, 27)</sup>.

It seems from the result the stone casts with smoothest surface are those poured on Supersil impressions while the roughest surfaces are found on casts poured on Xanthano impressions. This finding has come in agreement with Woefel<sup>(28)</sup>. This can be explained in that the Supersil impression is a type of an addition silicone rubber base (elastomeric) impression material. Veres *et al.*<sup>(12)</sup> reported that the silicone elastomeric impressions. Xanthano impression is an impression plaster, which is essentially dental plaster (Plaster of Paris). The surface of the set gypsum is porous in microscopic level, and this porosity of set gypsum causes the surface to be rough<sup>(29)</sup>, so these differences in the surface roughness of the impressions can be the cause of the difference in the surface roughness of the stone casts that poured from these impressions.

The differences in the quality of the stone casts surface roughness that poured on the different impressions can be related to the manner by which the impression were handled in that the Xanthano impression needed separating medium before poured with dental stone and it was also needed as Neogenate impression to be immersed in hot water for 10 minute to facilitate their separation from stone casts while the Supersil impression needed no separating medium, no immersion in hot water to be separated from stone cast. These steps may considered as possible source of increasing the surface roughness of the stone cast. This finding agreed with Rudd<sup>(30)</sup>, and Breault *et al.*<sup>(31)</sup>. It must be emphasized that maximum advantage can be obtained only by careful attention to correct handling during the clinical and laboratory procedure<sup>(32)</sup>.



## CONCLUSION

1. There were significant differences in the quality of the surface roughness of the stone casts among the three different impression materials and the two different dental stones.
2. The smoothest surface of the stone casts were obtained from Supersil impressions and those poured with ZETA dental stone.

## REFERENCES

- 1-Craig RG. Restorative Dental Materials. 10<sup>th</sup> Edn. Mosby Company. 1997. Ch: 11, 12.
- 2-Sanad MEE, Combe EC, Grant AA. Hardening of model and die materials by an epoxy resin. *J Dent.* 1980; 8(2): 158-162.
- 3-Derrien G. Comparison of transverse strength and dimensional variations between die stone, die epoxy resin, and die polyurethane resin. *J Prosthet Dent.* 1995; 74(6): 569-574.
- 4-Chaffee NR, Bailey JH, Sherrard DJ. Dimensional accuracy of improved dental stone and epoxy resin die materials. Part I: single die. *J Prosthet Dent.* 1997; 77(2): 131-135.
- 5-Gunther G. Evaluation of a rubber-base impression material. *J Prosthet Dent.* 1978; 39(1): 95-98.
- 6-Barghi N. A predictable and accurate technique with elastomeric impression materials. *Am J Dent.* 1999; 12 (4): 161-163.
- 7-Fenske C. The influence of five impression techniques on the dimensional accuracy of master models. *Braz Dent J.* 2000; 11(1): 19-27.
- 8-Claudio PF. Accuracy, detail reproduction, and hardness of gypsum casts produced from silicone impression treated with glow discharge. *J Prosthet Dent.* 1990; 70 (5): 457-464.
- 9-Eriksson A, Ockert EG, Linden LA. Irreversible hydrocolloids for crown and bridge impressions: effect of different treatments on compatibility of irreversible hydrocolloid impression materials with type IV gypsum. *Dent Mater.* 1996; 12 (2): 74-82.
- 10-Schaffer H, Dumfahrt H, Gaasch K. Distance alterations of dies in sagittal direction in dependence of the die material. *J Prosthet Dent.* 1989; 78(5): 531-532.



- 11-Robinson PB, Dunne SM, Millar BJ. An in vitro study of a surface wetting agent for addition reaction silicone impression. *J Prosthet Dent.* 1994; 71(4): 1337-1382.
- 12-Veres EM, Wolfaardt JF, Becker PJ. An evaluation of the surface characteristics of a facial prosthetic elastomer . Part I : Review of the literature on the surface characteristics of dental materials with maxillofacial prosthetic application. *J Prosthet Dent.* 1990; 63(2): 193-197.
- 13-Lorren RA, Salter DJ, Fair - Hurst CW. Review of dental materials. *J Prosthet Dent.* 1976; 36(2): 176-181.
- 14-Morford HT, Tames RR, Zardiackas LD. Effect of vacuum and pressure on accuracy reproducibility, and surface finish of stone casts made from polyvinyl siloxane. *J Prosthet Dent.* 1986; 55(4): 466-470.
- 15-Mazzetto MO, Roselino-RB, Gabrielli F. Comparative study of capacity of elastomers in reproduction and transmission of details to gypsum models. *Rev Odont.* 1990; 4 (2): 144-149 (Abstract).
- 16-Hatim NA. Volumetric changes in acrylic denture base material. M.Sc Thesis submitted to the University of Baghdad. 1988.
- 17-Al- Jalili SN. The effect of chlorhexidine in the disinfection of alginate impression and dental stone casts. M.Sc Thesis submitted to the University of Baghdad. 1994.
- 18-Ahmad SH. The effect of storage time on accuracy and dimensional stability of addition Silicon impression materials. M.Sc Thesis submitted to the University of Mosul. 2000.
- 19-Muller J, Gotz G, Horz W. An experimental study on the influence of the derived casts on the accuracy of different recording materials. Part II: Polyether, acrylic resin, and corrected wax wafer. *J Prosthet Dent.* 1990; 63(4): 389-395.
- 20-American Dental Association Specification. Guide to Dental Materials and Device. 1974-1975. Ch 9: 86-96.
- 21-Woodward JD, Morris JC, Khan Z. Accuracy of stone casts produced by perforated trays and non perforated trays. *J Prosthet Dent.* 1985; 53(3): 347-350.
- 22-Veres EM, Wolfaardt J, Fand Beckeer PJ. An evaluation of surface characteristics of a facial prosthetic elastomer. Part II: The surface texture. *J Prosthet Dent.* 1990; 63(3): 325-331.
- 23-Marinello CP. Influence of heat treatment on the surface texture of an etched cast nickel-chromium base alloy: An evaluation by Profilometric records. *J Prosthet Dent.* 1986; 56(1): 431-434.

- 24-Peutzfeldt A. Effect of disinfecting solution on surface texture of alginate and elastomeric impressions. *Scand J Dent Res.* 1990; 98(1): 74-81.
- 25-Derrien G, Menn GL. Evaluation of detail reproduction for three die materials by using scanning electron microscopy and two dimensional profilometry. *J Prosthet Dent.* 1995; 74(1): 1-7.
- 26-Wiktorsson G. Quality of stone dies produced by different impression materials. *Swed Dent J.* 1983; 7: 77 – 83.
- 27-Lepe X. Effect of mixing technique on surface characteristics of impression materials. *J Prosthet Dent.* 1998; 79 (5): 459-502.
- 28-Woefel JB. Contour variation in impression of one edentulous patient. *J Prosthet Dent.* 1962; 12: 233.
- 29-Craig RG, O'Brien WJ, Powers JM. Dental Materials. 6<sup>th</sup> Edn. Mosby Company. 1996. Ch: 8, 9.
- 30-Rudd KD. Comparison of effects tap water and slurry water on gypsum casts. *J Prosthet Dent.* 1970; 24: 563.
- 31-Breault LG, Paul JR, Hondrum OS. Die stone disinfection: Incorporation of sodium hypochlorite. *J Prosthet Dent* 1998; 7(1): 13-16.
- 32-Combe EC, Grant AA. The selection and properties of materials for dental practice. *Brit Dent J.* 1973; 134: 197-200.