

EVALUATION OF FLEXURAL STRENGTH OF COMPOSITE BY ADDITION OF DENTAL AMALGAM POWDER: A PILOT STUDY

¹MUMTAZ UL ISLAM

²TAHIR ALI KHAN

³MOHTADA HASSAN

⁴AIMAN KHAN

⁵NAYAB AMIN

⁶RAHAM ZAMAN

ABSTRACT

Dental composites are showing versatility in the field of restorative dentistry. Strength is main issue for their use especially in stress bearing area. Present study was aimed to evaluate the flexural strength of dental amalgam incorporated nano filled hybrid composite. Mechanical incorporation of a commercially available dental amalgam powder in nano filled hybrid composite was performed through amalgamator. Specimens were prepared and analyzed according to ISO standard No. 4049. Specimens analyzed were six (n=3) for each group. Null hypothesis for the study was no difference in the flexural strength of a commercially available dental composite and the prepared one which was rejected by the test statistics. Flexural strength of the control material was 90 Mpa while for the test material was 106.12 Mpa. Results showed a marked difference in the values of flexural strength of both the materials. Flexural strength can be increased by incorporating dental amalgam powder. Dental amalgam powder is a potential candidate for a high flexural strength and antibacterial composite. The study needs more trials on different aspects and evaluation of mechanical properties.

Key Words: Dental composite, Flexural strength, Metallic incorporated composite, Composites.

INTRODUCTION

Dental composite filling materials are used in posterior teeth worldwide.¹ Composite direct filling materials are gaining more popularity and acceptability as restorative materials especially in posterior teeth.² This feature is due to the properties contrasting to the indirect restorations like, less invasive procedure, conservative approach towards tooth substance, low cost, less time and clinically comparable performance.³ It was evaluated in different studies that composite restorations show excellent results in premolar teeth in comparison to molar ones.⁴ Higher failure rates were also found to be related with posterior composites.⁵

Cause of failure was reported to be the fracture of the restoration.⁶ Occurrence of fracture is due to the stress over the restoration.⁷ Annual failure rate of composite is three times greater than amalgam as described by Bernardo et al (2007). Amalgam was found to be much stronger than composite restoration on the basis of annual failure rates.⁸ Failure was found to be the result of fracture of the restoration due to the degradation of the filler content and other mechanical properties.⁹ High filler loading was accessed as a road towards increase in the longevity of the restoration. Hybrid composites therefore, considered to be more appropriate as posterior restorative composites due to their high fracture strength.¹⁰

Improvement in the quality is the basic aim of the research. Attempts have been done to make a composite material which can be ideally used.¹¹ Mechanical properties of dental composite restorative materials were found to be associated with filler content. Strength is a considerable problem with posterior composites. Present pilot study will be a convincing protocol to researchers aiming to do something new in the field of composite restorative materials.

Aim of this pilot study was to prepare a dental composite material with improved mechanical properties

¹ Mumtaz ul Islam, BSc, BDS, MHR, Sardar Begum Dental College and Hospital, Gandhara University, University Town, Peshawar, Pakistan Cell: +923339360524

E-mail: drmumtazulislam@gmail.com

² Professor Dr Tahir Ali Khan, BDS, MDSc, MHR, Sardar Begum Dental College and Hospital, Gandhara University

³ Associate Professor Dr Mohtada Hassan, BDS, MDSc, Islamabad Dental College, Islamabad

⁴ Assistant Professor, Dr Aiman Khan, BDS, MPhil, Sardar Begum Dental College and Hospital, Gandhara University

⁵ Dr Nayab Amin, BDS, Sardar Begum Dental College and Hospital, Gandhara University

⁶ Senior Lecturer Dr Raham Zaman, BDS, MPH, Bacha Khan Medical College, Mardan

Received for Publication: May 14, 2015

Approved: June 4, 2015

by incorporation of dental amalgam powder in to it. Both test and control materials were then evaluated at universal testing machine. Comparison was performed on the basis of flexural strength due to the diversity of three point bending test. Due to the usefulness of flexural strength determination for composite filling materials this test was employed. Nano filled hybrid composite filling material was used in this study because of its high performance in posterior teeth.¹²

METHODOLOGY

This experimental study was conducted in science of dental material department Gandhara University and Central Research Laboratory, Peshawar University.

MATERIAL SELECTION AND PREPARATION

Commercially available dental amalgam powder was purchased and treated with acetone in an ultra sonic bath for a complete cycle. Then it was heat treated in an electric oven at 90°C for 24 hours for complete removal of acetone.

MIXING OF MATERIALS

The treated material was then poured in a capsule which was clean and free of any amalgam or mercury. Dental amalgam powder and dentine bonding agent were added in the capsule in a ratio of 80% by weight of amalgam (Fig 1). Capsule was sealed by sticky wax to stop the spillage of the material through it. Mixing was commenced through an amalgamator (Fig 2). Speed of amalgamator was set at low and it was given a time of 10 seconds to ensure thorough mixing of both the constituents. A commercially available nano filled hybrid dental composite was taken in another capsule. Composite and prepared material was added in a proportion of 1:0.05 grams by weight. The material was then fixed in amalgamator and activated it for mixing at high speed for 99 seconds.

PREPARATION OF SPECIMENS

Prepared material was then taken to the stain less steel mold which was prepared according to the ISO specification No. 4049 for specimen production. A glass slab was placed under the mold material was filled in the slot and another glass slab was pressed on the mold filled with the material. Through this process the excess material comes out of the mold then the material was cured using the window technique. Curing time was kept 30 seconds for each portion under the light source. Curing was done from both of the sides of the specimen. After the curing was complete the glass slabs were removed. Glass slab when removed from the mold takes about half of the material adhered to it (Fig 3). It was an indication of under cured material in the mold. Which was confirmed by half of the material remained in the mold (Fig 4).

CHANGING THE RATIO OF MATERIALS

This failure at the beginning of the study makes a huge distraction about the feasibility of the study. Calculations were again computed regarding the proportions of the materials as this was found to be the main cause through critical evaluation of the procedure. Now again the material was prepared with a relatively less proportions of dental amalgam powder. At this time a ratio of 1:0.01 grams was taken. Specimens were prepared according to the procedure described previously.

DETERMINATION OF FLEXURAL STRENGTH

Specimens were taken to central research laboratories for evaluation of its flexural strength through three point bending test (Fig 5). Test was done on a universal testing machine.

Formula for Flexural strength is

$$\sigma = 3FL/2WH^2$$

Universal testing machine was fixed at a crosshead speed of 0.5mm per minute using a span of 20mm Force recorded to produce the fracture for specimens produced by nano hybrid composite filling material Nexcomp (Meta Biomed Co; Ltd. Korea) was 24 Newtons (Group A). Distance between the supports (fixed at 20 mm). Mean width of the specimen measured before testing was 2±0.02mm. Mean height of the specimen between the tension and compression surfaces was 2±0.03mm.

RESULTS

General observations

Group A:

Frequency, Percent, Valid Percent and Cumulative Percent age was calculated through SPSS version 16 (Table 1). All the three specimens provided a different value of load which was resisted by the material before fracture.

Group A presented a mean value of load applied to specimens before fracture as 24 Newton. Minimum and maximum load applied before the fracture occurred was 23 and 25 Newton. Standard deviation of group A was one (Table 2).

Group B:

A different frequency and percentage was obtained than group A (Table 3).

Mean force recorded to produce the fracture for specimens produced by the dental amalgam incorporated material was 28.33 Newton. Minimum and maximum values were 28 and 29 Newton with standard deviation of 0.57 (Table 4).

TABLE 1: GROUP A FREQUENCIES AND PERCENTAGES

Valid	Fre- quency	Per- cent	Valid Percent	Cumulative Percent
23	1	33.3	33.3	33.3
24	1	33.3	33.3	66.7
25	1	33.3	33.3	100.0
Total	3	100.0	100.0	

TABLE 2: MEAN, MINIMUM, MAXIMUM AND STANDARD DEVIATIONS OF GROUP A

N	Valid	3
	Missing	0
Mean		24.0000
Median		24.0000
Mode		23.00a
Std. Deviation		1.00000
Variance		1.000
Minimum		23.00
Maximum		25.00

TABLE 3: GROUP B FREQUENCIES AND PERCENTAGES

Valid	Fre- quency	Per- cent	Valid Percent	Cumulative Percent
28	2	66.7	66.7	66.7
29	1	33.3	33.3	100.0
Total	3	100.0	100.0	

TABLE 4: MEAN, MINIMUM, MAXIMUM AND STANDARD DEVIATIONS OF GROUP B

Valid	3
Missing	0
Mean	28.3333
Median	28.0000
Std. Deviation	.57735
Variance	.333

TABLE 5: PAIRED SAMPLES COMPARISON OF BOTH GROUPS

	Mean	N	Std. De- viation	Std. Error Mean
Pair Group A	24.0000	3	1.00000	.57735
Group B	28.3333	3	.57735	.33333

TABLE 6: PAIRED SAMPLES CORRELATIONS

	N	Correlation	Sig.
Pair 1 Group A & B	3	.000	1.000



Fig 1: Weighing dental amalgam powder



Fig 2: Sealed capsule



Fig 3: Fractured material attached to the glass slab

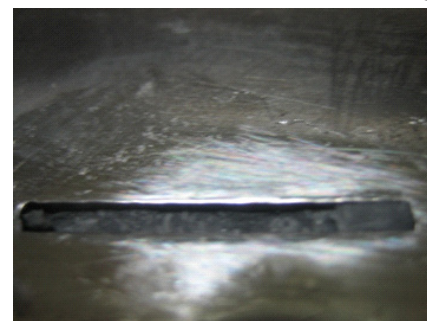


Fig 4: Fractured material in the mold



Fig 5: Prepared specimens

TABLE 7: PAIRED SAMPLES T TEST

Paired differences								
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	Df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Group A & B	-4.33333	1.15470	.66667	-7.20177	-1.46490	-6.500	2	.023

Flexural strength obtained for both groups

By calculating the values obtained, the flexural strength for group A was 90 MPa.

Flexural strength of the group B was 106.12 MPa which was quite higher than group A.

There was a significant difference between the two groups on the basis of test statistics.

PAIRED STATISTICS

Paired sample statistic also provided a marked difference of 4 Newton when compared both the groups (Table 5). Paired samples correlation was found 0.00 and significance on the basis of correlation was one (Table 6). Two tailed t test showed a test statistic value of 0.02 which is less than 0.05 which is our p value (Table 7). Results showed a significant difference between the two groups. The study will have a potential of rejecting the null hypothesis.

DISCUSSION

This pilot study was performed to test the feasibility of a study aimed to evaluating flexural strength of a nano filled hybrid composite filling material by incorporation of dental amalgam powder. The proposed ratio was 1:0.05grams by weight of prepared composite in to the parent composite. This was found to be much higher and in spite of increasing the flexural strength of material it decreases the depth of cure. Which was addressed and it comes out to be a complete study which is reported through this publication.

Results obtained through this study were in accordance of previous conclusions that filler content can increase the strength of composite filling materials.^{13,14} Materials were prepared with same loading ratio of fillers and different microstructures by manufacturers and these are available commercially.¹⁵ Composites after research and innovations in their formulation and presentations still lacking strength to withstand the loads at stress bearing areas. Materials were used to reinforce the composite materials.¹⁶ Current study is in continuation of the research process to determine the effects of dental amalgam powder in to the composite.

Problem with the composite filling material was

found to be the fracture resistance is much lower than amalgam. Incorporation of dental amalgam powder is a novel idea. Particles of dental amalgam produce reinforcement of the composites in improving its flexural strength. Results of increase in flexural strength due to filler particles were consistent with other studies.¹⁷ Mechanical properties were improved by incorporation of 70% zirconium silicate micro and nano particles in composite. Improvements in compressive, tensile (diametrial) and flexural strength were evaluated and confirmed to be positive.¹⁸

Titanium oxide incorporated composites are used in orthodontic bonding system.¹⁹ Present study evaluated the dental amalgam powder incorporated composite.

A problem found with incorporation of dental amalgam powder was increased curing time. Standard curing time adopted in studies was 20 seconds.²⁰ Almost all materials found to be cured after 20 seconds curing time was found in another study. Manufacturers of different commercially available materials were also provided the minimum curing time for curing of composites. Curing for a sufficient time was advocated in studies to achieve maximum benefits.²¹

CONCLUSION

It should be concluded through the pilot study and test statistics that incorporation of dental amalgam powder increases the flexural strength of the composite material.

ACKNOWLEDGEMENT

A special thanks to Madam Aneela Mumtaz without her help and support this research work could not be possible.

REFERENCES

- Burke FJT. Amalgam to tooth-coloured materials implications for clinical practice and dental education: governmental restrictions and amalgam-usage survey results. *Journal of Dentistry*. 2004; 32: 343-50.
- Da Rosa Rodolpho PA, Cenci MS, Donassollo TA, Loguercio AD, Demarco FF. A clinical evaluation of posterior composite restorations: 17-year findings. *J Dent*. 2006; 34: 427-35.
- Manhart J, Chen H, Hamm G, Hickel R. Buonocore Memorial Lecture. Review of the clinical survival of direct and indirect

- restorations in posterior teeth of the permanent dentition. *Oper Dent.* 2004; 29: 481-508.
- 4 Opdam NJ, Bronkhorst EM, Roeters JM, Loomans BA. Longevity and reasons for failure of sandwich and total-etch posterior composite resin restorations. *J Adhes Dent.* 2007; 9: 469-75.
- 5 Bernardo M, Luis H, Martin MD, Leroux BG, Rue T, Leitao J, et al. Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial. *J Am Dent Assoc.* 2007; 138: 775-83.
- 6 Pallesen U, Qvist V. Composite resin fillings and inlays. An 11-year evaluation. *Clin Oral Investig.* 2003; 7: 71-79.
- 7 Hansen EK, Asmussen E. In vivo fractures of endodontically treated posterior teeth restored with enamel-bonded resin. *Endo Dent Traumatol.* 1990; 6(5): 218-25.
- 8 Opdam NJ, Bronkhorst EM, Roeters JM, Loomans BA. A retrospective clinical study on longevity of posterior composite and amalgam restorations. *Dent Mater.* 2007; 23(1): 2-8.
- 9 Da Rosa Rodolpho PA, Donassollo TA, Cenci MS, Loguercio AD, Moraes RR, Bronkhorst EM, et al. 22-year clinical evaluation of the performance of two posterior composites with different filler characteristics. *Dent Mater.* 2011; 27: 955-63.
- 10 Kim KH, Park JH, Imai Y, Kishi T. Fracture toughness and acoustic emission behavior of dental composite resins. *Eng Fract Mech.* 1991; 40: 811-19.
- 11 Moraes RR, Garcia JW, Barros MD, Lewis SH, Pfeifer CS, Liu J, et al. Control of polymerization shrinkage and stress in nanogel-modified monomer and composite materials. *Dent Mater.* 2011; 27: 509-19.
- 12 Kramer N, Garcia-Godoy F, Frankenberger R. Evaluation of resin composite materials. Part II: in vivo investigations. *Am J Dent.* 2005; 18: 75-81.
- 13 Tsuruda H. Effect of filler shape, particle size and filler content in composite resins on shrinkage stress during setting. *The Journal of the Japanese Society for Dental Materials and Devices.* 1994; 13: 575-85.
- 14 Willems G, Lambrechts P, Braem M, Celis JP, Vanherle G. A classification of dental composites according to their morphological and mechanical characteristics. *Dental Materials.* 1992; 8: 310-19.
- 15 JA De Souza, S. Goutianos, M. Skovgaard, B.F. Sorensen. Fracture resistance curves and toughening mechanisms in polymer based dental composites. *Journal of the mechanical behavior of biomedical materials.* 2011; 4: 558-71.
- 16 Xu HHK. Dental Composite Resins Containing Silica-fused Ceramic Single-crystalline Whiskers with Various Filler Levels. *Journal of dental research.* 1999; 78: 1304-11.
- 17 Bukovinszky K, Molnar L, Bako J, Szaloki M, Hegedus C. [Comparative study of polymerization shrinkage and related properties of flowable composites and an unfilled resin]. *Fogorvosi szemle.* 2014; 107(1): 3-8.
- 18 Buruiana T, Melinte V, Popa ID, Buruiana EC. New urethane oligodimethacrylates with quaternary alkylammonium for formulating dental composites. *Journal of materials science Materials in medicine.* 2014; 25(4): 1183-94.
- 19 Heravi F, Ramezani M, Poosti M, Hosseini M, Shajiei A, Ahrari F. In Vitro Cytotoxicity Assessment of an Orthodontic Composite Containing Titanium-dioxide Nano-particles. *Journal of dental research, dental clinics, dental prospects.* 2013; 7(4): 192-98.
- 20 Kopperud HM, Johnsen GF, Lamolle S, Kleven IS, Wellendorf H, Haugen HJ. Effect of short LED lamp exposure on wear resistance, residual monomer and degree of conversion for Filtek Z250 and Tetric EvoCeram composites. *Dent Mater.* 2013; 29(8): 24-34.
- 21 Schattenberg A, Lichtenberg D, Stender E, Willershausen B, Ernst CP. Minimal exposure time of different LED-curing devices. *Dent Mater.* 2008; 24(8): 1043-49.