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An evaluation of the Effect of Surface Treatment On Amalgam Repair

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Abstract:

The purpose of this in vitro study was to evaluate the effect of different surface treatments on shear bond strength of repaired amalgam using two types of amalgam. 120 acrylic blocks (2.7cm diameter by 2.0cm high) were constructed from cold cure resin, each one contained cylindrical hole (7mm diameter by 2mm high) on its circular face that filled with amalgam. The samples were divided into immediate repair group and delayed repair group, which was stored and incubated at 37C0 for one month. After aging the amalgam surface of delayed repair was finished with carbide bur and polished with abrasive rubber cup then divided into three groups according to the surface treatment that include group with out surface treatment, group roughened with diamond bur and the last group was abraded with aluminum oxide (50μm) particles size, both immediate and delayed repair were further subdivided according to the type of amalgam used into three subgroups. The repair procedure was done by using a Teflon split mold which containing an opening (3mm diameter by 5mm high) then all the samples were storage and incubated at 37C0 for one week prior to testing.

Testing was done by applying shear force at the interface between the initial and repair amalgam with special designed chisel shape rod by using Zwick testing machine at across head speed of 5mm/min.

Analysis of the results showed that the shear bond strength in immediate repair were significant higher than of delayed repair and the group roughened with diamond bur is higher than group treated with aluminum oxide and untreated group.

The shear bond strength of delayed repair of amalgam is less than that of immediate repair, the surface produced by roughening the samples with a diamond bur will give best strength than the surface treated by aluminum oxide and untreated surface (smooth surface) and the same types of amalgam restorations used in amalgam repair gave better result than different type of amalgam.

Keywords: Shear bond strength, amalgam repair, amalgam surface treatment.

Introduction

Silver-amalgam is the most common restorative material for posterior teeth. The first used of amalgam was recorder in China in the year 659A.D. Dental amalgam has been used successfully for more than a century as a restorative material, it is continues to be one of the most widely

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used restorative materials in dentistry. Due to its ease of manipulation, adequate physical properties, low cost, short time for insertion, clinical longevity, low technique sensitivity and self-sealing ability. Thus it remains the restorative material of choice in many clinical situations.(1)

A defective restoration is most frequently associated with the dentist or patient. Dentists are faced with clinical situations that require the decision to replace or repair an amalgam restoration. These situations involve amalgam or cuspal fracture, inadequate marginal integrity, inadequate inter proximal contact and most frequently occur soon after condensation, in which a marginal ridge of amalgam or inter proximal contact is lost due to fracture.(2)

Amalgam restoration sometimes fractures due to faults made during cavity preparation & restoration procedures or where recurrent caries has rendered a portion of them defective. (1)

Repairing defective amalgam restorations has created controversy in the dental profession based on the compressive, tensile & shear strength Many researchers have studies the strength of repair amalgam with conflicting results, the shear strength of the bond between the old and new amalgam filling material was studied, various factors affecting repair strength such as: time of repair, use of mercury rich interface between the repaired surface, effects of roughening the fractured segment, type of alloy and adhesive resin used(2). The aim of this in vitro study was to evaluate the effect of different surface treatments on the shear strength of amalgam repair using two types of amalgam.

Materials and methods

120 acrylic blocks were used to act as cavities. The block was prepared by using cold cured acrylic poured into a cylindrical metal (2.7cmm diameter by 2.0cmm high), each block contained cylinder hole (7mm diameter by 2mm high) in the center of its circular face (Figure 1a) that filled with amalgam (Degussa or SDI).

Amalgam base prepared by mixed the pre-capsulated amalgam (degussa /SDI) with mechanical amalgamator according to the manufacture instruction, carried with amalgam carrier and condensed with mechanical condenser (Figure 1b) using circular flat tip of 2.0mm in diameter to fill the hole of 80 blocks with degussa and 40 blocks with SDI amalgam until it was slightly over filled, excess amalgam was removed with sharp carver level with acrylic surface.

The repair procedure was done by placement two piece of a Teflon spilt mold (Figure 1c) (act as a matrix for amalgam repair) fixed by ring on the area of previously amalgam prepared thus provides an opening (3mm diameter by 5mm high). The amalgam was condensed through this opening with mechanical condenser (Figure 1d). The a Teflon spilt mold was removed one hour after its placement thus providing a (3mm by 5mm) cylinder of amalgam freshly bond to the previous prepared amalgam base (7mm by 2mm).

The 120 specimens were divided equally into four experimental groups, then each group was further sub divided into three subgroups according to the type of amalgam used, 10 samples for each subgroup.

Group I: Immediate repair 30 samples of the previous amalgam base preparation, the repair procedure was done immediately after initial setting of amalgam base.

Subgroup a: degussa + degussa

Subgroup b: SDI + SDI
Subgroup c: degussa +SDI
Then all the samples were incubated at 37C0 for one week prior to testing.

Delay repaired

The 90 specimens of the previous amalgam base preparation were storage and incubated at 37C0 for one month. After aging the amalgam surface were finished with finishing carbide bur (12 blade),(P.D. Swiss) polished with abrasive rubber cup and pumice for 5 seconds using a slow speed angled hand piece.

Group II: were not treated after polishing the amalgam surface.

Group III: the polished amalgam surfaces were roughened with diamond bur (No. 1145 Towban. Lack word, New Jersey 08701) for 10 seconds in a high speed with air water spray.

Group IV: the polished amalgam surfaces were abraded with aluminum oxide (50μm) for 10 seconds.

The samples in all groups were rinsed for 5 seconds with water and dry by oil free air for 5 seconds.
The whole samples were further incubated at 37C0 for one week prior to testing.

Samples testing

The shear bond strength was evaluated with Zwick universal testing machine using stainless steal chisel shaped rod with across head speed of 5 mm/min. The load cell was set at 100 kg.

The specimens with special fabricated block placed in the lower jaw of the testing device and the chisel end of the rod was positioned at the interface between the freshly placed and the old amalgam.

Results

The minimum and maximum values of shear bond strength in Mpa are presented in table 1

According to the type of amalgam used in different groups, the result shows that subgroup Ia resulted in higher shear bond strength as shown in table 2, followed by subgroup IIIa & subgroup IVa while group IIa shows the lowest values. For subgroup b the result showed the highest value in G.I, G.III and G.IV but G.II is the lowest value respectively While subgroup Ic showed the highest value but IIc is the lowest value while other groups lied between them respectively.

By using analysis of variance (ANOVA) statistical test, table (3) showed that there is a statistically very high significant difference (p value <0.0001) between the mean force among the three groups but in group four is significant.

The LSD test showed high significant difference ($p<0.0001$) between all groups in subgroup a. Also, the LSD test showed high significant difference ($p<0.0001$) between group I &II, I & III, I & IV, II & III, II& IV but non significant difference between group III &IV in subgroup b & c.

Discussion

Dental amalgam continues to be one of the most widely used restorative materials in dentistry. Due to its ease of manipulation, proven longevity and low cost.(3) Dentists are frequently faced with a clinical decision to replace or repair an amalgam restoration. The complete replacement is time consuming, technically difficult and may be potentially damaging to the pulp. (1)

The wide range in the result compared with others can be attributed to various factors affecting repaired strength such as time of repair, use of mercury rich inter face between the repair surfaces, surface treatment before roughening the fracture

segment, type of alloy, type and direction of condensation in addition to the use of adhesive. (4)

Immediate repair

The immediate repaired group was highly significant (p value <0.0001) than that of delayed repair group. (4)

This finding were resulted from free mercury that bond between the two amalgams probably comes from the fresh mix, forming a new inter-metallic compound resulting in significantly higher bond strength. Also, there is no contamination with saliva & no oxidation of the fracture surface of the old amalgam restoration, this in agreement with Terkla et al, 1961 & Miyate 1972 (5,6) who reported that the bond strength of repaired amalgam was half or less than that of an intact amalgam, also coincide with Consani et al, 1977 & Cowan 1983(7,8) whom reported that the use of a mercury rich amalgam mixture at the repair inter face will induced an effective bond between old & new amalgam, but disagree with Jorgnsen & Sito 1986(9) whom contended that the bond strength of repaired amalgam was almost identical to that of intact restoration because in their study they used conventional amalgam with hand condensation while in this study a spherical type of amalgam was used with mechanical condensation.

Delayed repair

There is a significant difference between G.II & G. III, G. II & G. IV, this due to difficulty in condensing the fresh amalgam to the old amalgam in G.II because there is no micro mechanical retention & this coincide with (Terkla et al, 1961)(5) who reported that lack of crystalline growth by the old amalgam. While the result showed no significant difference between G.III & G.IV & this due to increase surface area resulting from the action of the diamond bur & AL2O3 in the remaining amalgam restoration that increased surface area which associated with a roughened surface resulted in some degree of micro mechanical retention to complement the union between the new and old amalgam & this is in agreement with Terkla & others 1961, Gordon et al 1987, Baghers &Chan 1993(5,10-11) whom reported that an elevated strength of repaired amalgam was related to the increased surface area & enhanced mechanical retention and also, coincide with Walker & Reese 1983, Hadavi 1992(12,13) whom reported that improving the bond strength between the fresh and old amalgam after roughening the surface of the samples with a diamond and carbide bur prior to repair.

The roughness of amalgam surface done by aluminum oxide particles causing less increasing surface area compared to that done by diamond bur, the use of 50μm particles size of aluminum oxide powder would potentially increase the shear strength of amalgam repaired and this was in comparable with finding of Mc connell 1993(14) who reported that use of 50μm particles of aluminum oxide powder is a useful technique in amalgam repair but conflict with F Ozen et al, 2002, Jeffrey et al 1996 & Marcelo et al, 2002(1,2,15) who reported that the bond strength of repaired amalgam was increased when use aluminum oxide powder with roughening the surface of the old amalgam.

Subgroup in immediate repair

The result of subgroup a, b & c showed high significant difference between G.I& II, G. I & III & G.I & IV & this due to time of repair in which occur no contamination & oxidation & may be due to composition of the alloy

used, this agrees with Kirk 1962, Consani Ruhnke & Stolf 1977 Hadavi & others 1992(7,13,16), who conclude that the strength of repair amalgam was greater when the same type of amalgam was used and the inter face was un contaminated.

Subgroup in delayed repair

The result in subgroup a showed high significant difference between G.II & III, G. II & IV & G. III & IV but in subgroup b & c, which showed no significant difference between G. III & IV & this may be due to the type & composition of alloy used, that the amount of silver in Degussa is more than in SDI which causing increase the strength, type of surface treatment & free mercury in the fresh amalgam yielded the chemical reaction & this coincide with Israa N. Ali, 1997(17) who reported that when fresh amalgam was condensed on to the existing amalgam, free mercury penetrates from the former thus forming a new inter-metallic compound resulting in higher bond strength.

Conclusions

Under the experimental conditions of this vitro study, the following conclusions were drawn:

1- The shear bond strength of delayed repair samples of amalgam is less than that of immediate group.
2- The surface produced by roughening the samples with a diamond bur will give best strength than the surface treated by aluminum oxide and untreated surface (smooth surface).
3- Same type of amalgam restorations used in amalgam repair gave better result than different types of amalgam

References

1- Fusun Ozer & Dr. Selcuk, (2002); Amalgam repair evaluation of bond strength. Vol.27, no.2, 199-203.operative dentistry.
2- Jeffrey P J.M,(1996); Effect of surface treatment on amalgam repair. Vol.26:416-419.Operative dentistry.
3- Telge Milani Cipriano & Jose Fortunato Ferreira Santos,(1995); Clinical behavior of repaired amalgam restorations: A two years study. Journal Of prosthetic Dentistry; vol.73.no.1.
4- Alfred c Walker. JR & Steven B Reese,(1995);. Bond strength of amalgam to amalgam in a high copper amalgam. Operative dentistry;. 8,99-102.
5- Terkla LG, Mahler. DB & Mitchem,JC ;(1961) :Bond strength of repaired amalgam. Journal Prosth. Dent.. 11 :942-947.
6- Miyate, T (1972);.Bonding of repaired amalgam evaluated by tensile strength & scanning electron microscopic observation. Journal of Prosth. Dent. 28,92-108.
7- Consani S, Ruhnke.(1977); Infiltration of a radioactive solution into joined silver amalgam. A prosth. Dent. 37:158-63.
8- Cowan RD.(1983);Amalgam repair.A clinical technique. J. Prosth. Dent. 49;49-51.
9- Jorgensen KD, Saito T., (1960); Bond strength of repaired amalgam. Acta odontal Scand 26:605-615.
10- Gordon M, Ben Amar A, Liberman R.(1987);Bond strength of mechanically condensed repaired high copper amalgam Quint. Int.18: 471-474 .
11- Bagher;J& Chan,(1993) Repair of newly condensed amalgam restoration . Dent. Journal;. 79 :13-14 .
12- Walker, A.C. Jr & Reese, S.B.,(1995); Bond strength of amalgam to amalgam in high copper amalgam. Operative Dentistry, vol. 8:99-102.
13- Hadavi F, Hey JH, Czech D & Ambrose ER,(1992); Tensile bond strength of repaired amalgam .Journal Of prosth. Dentistry. 67:313-317.
14- McConnell Rj,(1993); Metal resin bonding. J. of California Dental Association. 21:38-42.
15- Marcelo Giannini, Luis Alexandre & Glaucia Maria,(2002). Effect of surface roughness on amalgam repair using adhesive system. Braz. Dent J. 13 (3): 179-183.

16-Kirk EeJ.,(1962);Amalgam to amalgam bond. Dental practice.2:371-2.

17-Nazar MA., Al-Khafaji A. evaluation of the effect of a bonding system for amalgam repair (in vitro study), M.Sc thesis, collage of dentistry, Baghdad University; 1997.

Table (1) Minimum & maximum value of shear bond strength for all tested groups in Mpa.

Groups	a		b		c	
	Min	Max	Min	Max	Min	Max
GI	٨,٢١	٩,٠٦	٥,٢٣	٦,٣٧	٥,٣٨	٥,٩٤
GII	٢,٢٦	٢,٥٥	١,٧٠	١,٩٨	٠,٧١	١,٥٦
GIII	٤,٦٧	٥,٨٠	٣,٥٤	٤,١٠	٣,١١	٣,٦٩
GIV	٣,٢٠	٤,٢٠	٣,٢٠	٣,٨٠	٢,٤٠	٣,٧٠

Table (2) the descriptive statistics of shear bond strength for all tested groups (mean value & standard deviation)

Groups	a		b		c	
	Mean	SD±	Mean	SD±	Mean	SD±
GI	٨,٧٧٥	٠,٢٩٨٣	٥,٩٤٣	٠,٣٢٢٣	٥,٧٤٠٤	٠,٢١٦٧
GII	٢,٤١٩	٠,١٠٤٤	١,٨٢٥	٠,١٢٣٩	١,٢٣٠٦	٠,٢٦٧٣
GIII	٥,٢٢٢	٠,٤١٣٩	٣,٨٠٧	٠,١٩٤٠	٣,٣٢٦٤	٠,٢٠٤٤
GIV	٣,٨٤٠	٠,٣٤٣٨	٣,٦٦٠	٠,١٨٣٨	٢,٩٣٠	٠,٥٢٩٣

Table (3) ANOVA one-way between samples in different groups

Groups	df	F	p-value	Sig.
GI	2	313.666	0.0000	HS
GII	2	97.659	0.0000	HS
GIII	2	135.227	0.0000	HS
GIV	2	16.842	0.001	S

* P<0.005 Significant **P<0.0001 High significant

Table (4) ANOVA one-way between subgroups in different groups

Subgroups	df	F	p-value	Sig
a	3	623.802	0.0000	HS
b	3	671.286	0.0000	HS
c	3	313.136	0.0000	HS

Figure (1) Composition of materials used in the study:

degussa	SDI
Silver 50%	Silver 40%
Copper 20%	Copper 28.7%
Tin 30%	Tin 31.3%

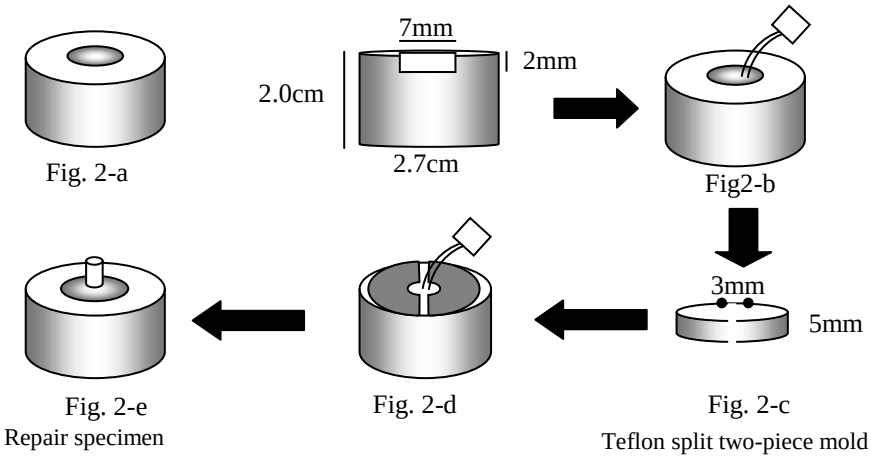

Figure 2.Schematic representation of methodology used to prepare specimens.

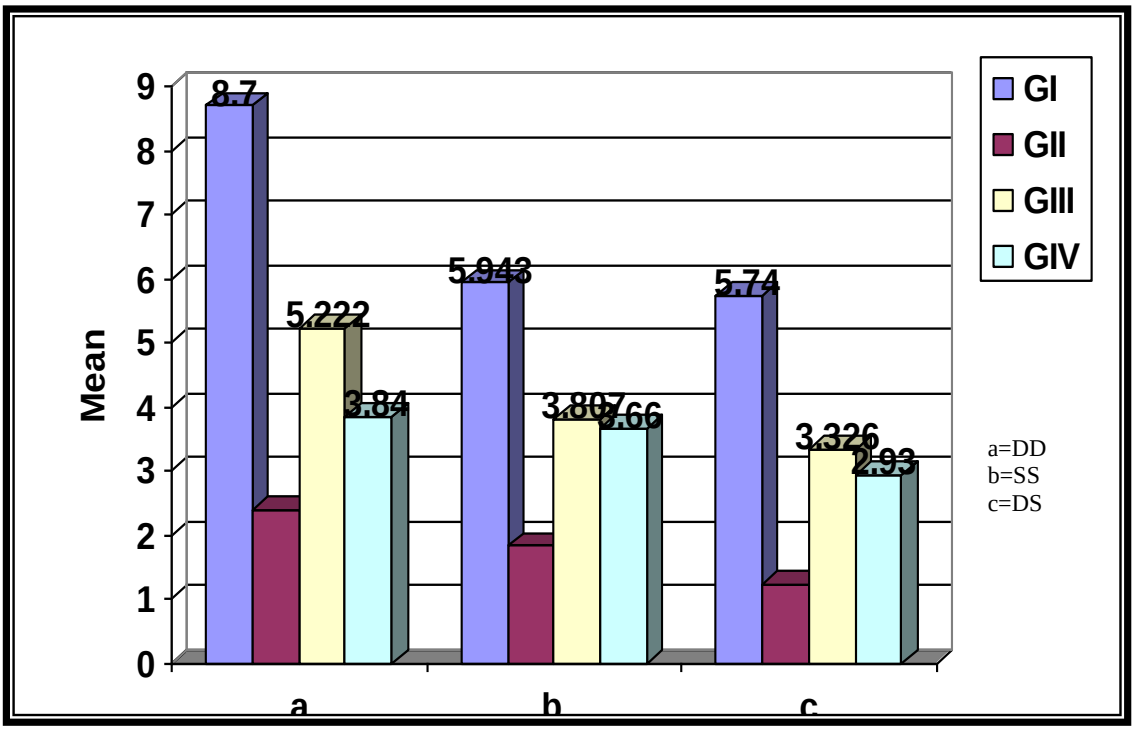

Fig. (3): Graphical presentation between subgroups in different groups.