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The effect of 30% at-home bleaching on surface hardness of esthetic restorative materials

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Abstract

in vitro study to evaluate the effect of an at-home bleaching product on the surface hardness of three composite restorative materials.

The aim of this study was to evaluate the effect of at-home bleaching on the surface hardness of the tooth colored restorative materials.

Thirty specimens were prepared; 10 specimens of each material 5 specimens control of each group. All specimens were stored in distilled water at room temperature for 24 hrs before testing. A universal testing machine (Micromet micro hardness testers) was used for testing brinell surface hardness for the three groups& for every tested material. Three tested materials was assessed by ANOVA& further exploration between all possible paired combination of tested material was assessed by bonferroni adjusted t-test p value less than 0.05 was considered statistically significant .

The statistical analysis showed that at home bleaching technique have statistically significant effect of the micro hardness of composite resin.

At-home bleaching agents have a softening effect on some tooth colored restorative material, and the patient must be aware before using them.

Key words: bleaching, surface hardness, tooth colored restorative materials

Introduction

Esthetic dentistry, particularly tooth whitening, is one of the most rapidly growing areas in dentistry, and vital tooth bleaching is a popular treatment Modality. [1, 2]

Bleaching is not new, The earliest agent reportedly used was oxalic acid, described by Chappel 1877.[3,4] Following experiments with various forms of chlorine, Harlan described in 1884 what is believed to be the first use of hydrogen peroxide, which he called hydrogen dioxide[3,4].

How well bleaching works depends upon the cause of the stain; where, how deeply, and how long the stain has permeated the structure of the tooth; and how well the bleaching agent can permeate to the source of the discoloration and remain there long enough to release deep stains. [4]

10 to 15 percent carbamide peroxide bleaching agents are the most widely used at-home products.[5] although at-home vital bleaching has been researched widely since 1989, it is a relatively new treatment and some doubts remain with regard to its use. Researchers have shown that at-home bleaching is a safe technique with regard to its effect on tooth structure [6,7]but some concerns remain regarding its possible effect on restorative materials [8,9]

The material used for dental restorations must have long-term durability in the mouth. One of the most important physical properties of restorations is surface hardness.[10] The hardness of a material is a relative measure of its resistance to indentation when a specific and constant load is applied.[11] In addition, surface hardness is the mechanical property used most frequently to characterize the wear resistance of materials. Microhardness has been shown to be an adequate indicator of the degree of conversion of resin-based composite. The degree of polymerization may be associated with the clinical performance of resin-based composite materials. [12]

The purpose of this study was to evaluate the effect of at-home bleaching on the surface hardness of three different tooth colored restorative materials.

Materials & methods

We selected for this study three resin-based composite materials, hybrid, microhybrid, &nano hybrid material, which represents the commonly used restorative material (Rembrandt xtra comfort, take home kit 3o% den_mat USA Products) was the bleaching agent.

Specimen Preparation

A total of 30 specimens were prepared. Ten specimens of each material were made used for the at-home bleaching test, 5 of each served for bleaching &5 for control group. The specimens were prepared utilizing cylindrical Teflon split molds (10 mm diameter and height of 5 mm). The mold was placed on a transparent matrix strip and a glass microscopic slide. The material was injected directly in to the mold until it was intentionally overfilled. The material was covered with another matrix strip Light pressure was applied to expel excess material from the mold. Each specimen was light-cured through the top and bottom glass slide for the duration recommended by the respective manufacturer. The set cylindrical specimen was separated from the mold. . All specimens were stored in distilled water at room temperature for 24 hrs. After drying the specimens, a Universal Testing Machine (Micromet microhardness tester) was used for testing brinell's surface hardness. The specimens were placed on the platform with the surface under testing facing the diamond indenter. A load of 500 g was applied to the surface for 30 seconds. Three indentations, which were not closer than 1 mm to the adjacent indentations or the margin of the specimen, were made on the surface of each specimen. The surface hardness for the control group was tested at the end of the experiment.

At-home Bleaching Test

At-home bleaching material (kit 30% carbamide peroxide) was coated on both surfaces of the 10 specimens of each material then stored at room temperature in a light proof container

for 1hrs as recommended by the manufacturer. The specimens were then washed and stored in distilled water. This procedure was repeated for10 days. Surface hardness was tested at the end of the mentioned duration.

Brinell hardness Test

The Brinell hardness testing machine, a hardness steel ball was pressed in to the surface of specimen under a known load ,for definite period of time

The Brinell hardness test method consists of indenting the test material with a 10 mm diameter hardened steel or carbide ball subjected to a load of

500 kg to avoid excessive indentation. For at least 30 seconds. The diameter of the indentation left in the test material is measured with a low powered microscope. The diameter of the impression is the average of two readings at right angles and the use of a Brinell hardness number table can simplify the determination of the Brinell hardness. A well structured Brinell hardness number reveals the test conditions, and looks like this, "75 HB 10/500/30" which means that a Brinell Hardness of 75 was obtained using a 10mm diameter hardened steel with a 500 kilogram load applied for a period of 30 seconds. . Compared to the other hardness test methods, the Brinell ball makes the deepest and widest indentation, so the test averages the hardness over a wider amount of material, which will more accurately account for multiple grain structures and any irregularities in the uniformity of the material. This method is the best for achieving the bulk or macro-hardness of a material, particularly those materials with heterogeneous structures.

Statistical analysis:

Data were analyzed using SPSS13 computer software. An expert statistical advice was sought for differences in mean hardness between controls and bleaching group in each material was assessed for statistical significance using independent samples t-test. Such a difference is attributed to the effect of bleaching. The percent change in hardness attributed to bleaching was computed by dividing the difference in mean by the mean hardness of control group and then multiplied by 100. The 95% confidence interval of difference in mean was also shown to give an idea about the expected differences in reference population. The difference in mean hardness between the 3 tested materials was assessed by ANOVA. When ANOVA model showed a statistically significant difference further exploration for the site of statistical significance between all possible paired combination of tested materials was assessed by Bonferroni adjusted t-test. P value less than 0.05 was considered statistically significant.

Results

The result of the brinell micro hardness testing are presented in table 1 shown in figure 2,3.

statistical analysis showed there were significant difference between the control groups ($p<0.001$) also significant difference between control groups with bleached hybrid ,microhybrid ($P=0.007$,<0.001) respectively non significant difference of control groups with bleached nano hybrid restorative material ($P=0.46$) .

The tested at home bleaching agent appeared to have a greater hardness effect 52.4% on micro hybrid while reduction effect on hardening 21.4% of hybrid, the nano hybrid have the least hardening reduction changes 9%.

ANOVA for the experimental groups revealed statistically non significant differences among the three materials P= (0.5).

Discussion

Ten days of treatment were used to simulate the home applied vital bleaching the hardness of resin based composites exposed to bleaching product has been reported to increase [13] decreases [14]&remain unchanged[15, 16]

Some studies have shown that composites are unaffected by the bleaching[1.] Burger and Cooley (1991)[17] reported a significant increase in the mean microhardness of microfilled, macrofilled and hybrid type composite resin after long-term exposure to carbamide solutions. Bailey and Swift (1992)[18] found the microhardness of the hybrid and microfilled composite resins to decrease. Turker and Biskin (2002)[19] found that the king of the carbamide peroxide had a role to the effect on the restorative materials.

Bleaching agents affect lightening of discolored tooth structure through decomposition of peroxide into free radicals.[13] the free radicals break down large pigmented molecules, that reflect a specific wavelength of light and are responsible for the color stain in enamel, into smaller less pigmented molecules through oxidation and reduction.[13, 20.]

In this study bleaching with 30% CP have statistically significant effect on the micro hardness of two type of restorative material we used.

Micro hybrid show a great percent of increasing of micro hardness 52.4% this could be contributed to the type, size &volume fraction of the filler particles &degree to which the filler is bounded to the resin matrix, this result agree with the finding of urabe etal;(1999)[21] who found that the increasing in the surface hardness values related to the increasing in the filler sizes and also with finding of cefaly etal; (2005)[22]&corer etal;(2005),[23] who reported that the hardness of composite related to type of fillers , with a harder filler particles exhibited higher surface hardness while disagree with finding of Li etal;(1985)[24] who reported that the surface micro hardness of different types of composite was less depend on the size of filler particles.

While the hybrid resin material show an average reduction of surface micro hardness -21.4% & this could be related to oxidation & degradation of the resinous matrix of composite resin [25], bleaching agents have a great effect on the resinous matrix of composite [26]hydrogen peroxide could be diffuse the organic matrix of composite resin [27]and because of that hydrogen peroxide is an oxidizing agent and has the ability to produce free radicals ,HO and O; the free radicals are very reactive having unpaired electrons, unstable attacking the organic molecules to achieve stability [28]accelerating the degradation of composite resins.[29]

These result agree with Hannig etal;(2006) [30] in which they showed that a significant decreased in the hardness hybrid resin after bleaching also agree with Gurgan &Yalcin (2004),[31] who observed a reduction in the surface hardness .

Nano hybrid composite resin material show no statistically significant changes on surface hardness it show mean surface hardness effect of 9%.

Such wide variation in data suggest that some tooth colored restorative materials may be more susceptible in alteration of micro hardness while certain bleaching agents are more likely to cause the alteration[8] &this is may be attributed to different ph values of bleaching agent which mostly close to the neutral.[32]

conclusion from this study achieved that the bleaching agent may soften some tooth colored restorative material

Alpha dent hybrid restorative material has significantly less surface hardness after bleaching.

1. Micro hybrid has higher surface hardness than hybrid &nano hybrid after bleaching.
2. The tested at home bleaching agent appear to have softening effect on hybrid & nanohybrid restorative material.

References

1- Nathoo SA, Chmielewski MB, Kirkup RE: Effect of colgate platinum professional tooth whitening system on micro hardness of enamel, Dentin, and composite resins. Comp- cont- Educ- Dent .1994; 15: 627-630.

2- Luk K, Tam L, Hubert M: Effect of light energy on peroxide tooth bleaching. J-Am-Dent-Assoc (JADA) .2004; 135: 194 -201.

3- Zaragoza V Bleaching of vital teeth:Technique. Estomodeo 1984: (9) 7-30.

4- Goldstein RE In-office bleaching: where we came from, where we are today. J Am Dent Assoc 1997:128 (4): 11S-18S.

5- Haywood VB. The Food and Drug Administration and its influence on home bleaching.CurrOpinCosmetDent1993(1):12–8.

6- Al-Qunaian TA, Matis BA, Cochran MA.In vivo kinetics of bleaching gel with three-percent hydrogen peroxide within the first hour.Oper Dent 2003;28(3):236–41.

7- Zekonis R, Matis BA, Cochran MA, Al Shetri SE, Eckert GJ, Carlson TJ. Clinical evaluation of in-office and at-home bleaching treatments. Oper Dent 2003;28(2):114–21.

8- Swift EJ Jr, Perdigao J. Effects of bleaching on teeth and restorations. Compend Contin Educ Dent 1998;19(8):815–20.

9- Polydorou O, Hellwig E, Auschill TM. The effect of different bleaching agents on the surface texture of restorative materials. Oper Dent 2006;31(4):473–80.

10- Okada K, Tosaki S, Hirota K, Hume WR. Surface hardness change of restorative filling materials stored in saliva. Dent Mater 2001;17(1):34–9.

11- Mandikos MN, McGivney GP, Davis E, Bush PJ, Carter JM. A comparison of the wear resistance and hardness of indirect composite resins. J Prosthet Dent 2001; 85(4):386–95.

12- Vargas MA, Cobb DS, Schmit JL. Polymerization of composite resins: argon laser vs conventional light. Oper Dent 1998; 23(2):87–93.

13- Taher NM. The effect of bleaching agents on the surface hardness of tooth colored restorative materials. J Contemp Dent Pract 2005;6(2):18–26.

14- Müjdeci A, Gökay O. Dental effects of home bleaching gels and whitening strips on the surface hardness of resin composites. Am J Dent 2005; 18(5):323–6..

15- Campos I, Briso AL, Pimenta LA, Ambrosano G. Effects of bleaching with carbamide peroxide gels on microhardness of restorative materials. J Esthet Restor Dent 2003; 15(3):175–82.

16- Garcia-Godoy F, Garcia-Godoy A, Garcia-Godoy F. Effect of bleaching gels on the surface roughness, hardness, and micromorphology of composites. Gen Dent 2002;50(3):247–50.

17- Burger KM, Cooley RL. Effect of carbamide peroxide on composite resin. J Dent Res 1991: 70, 570.

18- Bailey SJ, Swift EJ. Effects of home bleaching products on composite resins. Quintessence Int 1992:23 (7): 489–494.

19- Turker SB, Biskin T The effect of bleaching agents on the microhardness of dental aesthetic restorative materials. J Oral Rehabil 2002: 29 (7):657-661.

20- Oltu ü, Gürgan S: Effect of three concentrations of carbamide peroxide on the structure of enamel.J- Oral Rehabil. 2000; 27: 332-340.

21- Urabe H, Nomura Y, Shirai K, Yoshioka M &Shintani Hetal Effects of filler content &Size on Properties of composites resin on microwave curing .J Mter Med 1999:10(6):375-378.

22- Cefaly DFG ,Ferraezi GADO, T apety CMC ,Lauirce GRP &Navarro MFDL :Microhardness of Resin Based materials Polymerized with LED and Halogen curing units. Braz Dent J 2005:16(2):98-102.

23- CorerAB SinhoretiMAC, Sobrinho LC,TangoRN,Schneider LFJ&Consani S:Effect of the increase of energy density on Knoop hardness of dental composites light cured by conventional QTH,LED&xenon plasma arc.2005: Braz Dent J 2005:16:218-242.

24- Li Y, Swartz ML,Phillips RW,Mook BK&Roberts TA:Effects of filler content &Size on Properties of composites .J Dent Res1985:64(12):1396-1401

25- Attin T, HanningC,Weiegand A& AttinR: Effect of bleaching on restorative material and restorations ___a systemic review.J Dent Mat2004;20:825-861

26- Cehreli ZC, Yazici R, Garcia-Godoy F. Effect of home-use bleaching gels on fluoride releasing restorative materials. Oper Dent 2003:28 (5): 605-609.

27- Haywood VB: FrequentlyAsked Qustions About Bleaching .J Compendium 2003:24 (4A):324 -337

28- Brabara JW: Whiter teeth ,Brighter smile .Acess _Special Supplemental Issue/ 1999.September -October :1-12,

29- Hannig C, Duong S, Becker K et al. Effect of bleaching on subsurface micro-hardness of composite and a polyacid modified composite. Dent Mater 2007:23 (2): 198–203.

30- Wattanapayungkul P, Yap AU. Effects of in-office bleaching products on surface finish of tooth-colored restorations. Oper Dent 2003:28 (1): 15-19.

31- Yalcin F, Gurgan S Effect of two different bleaching regimens on the gloss of tooth colored restorative materials. Dent Mater 2005: 21 (5): 464–468.

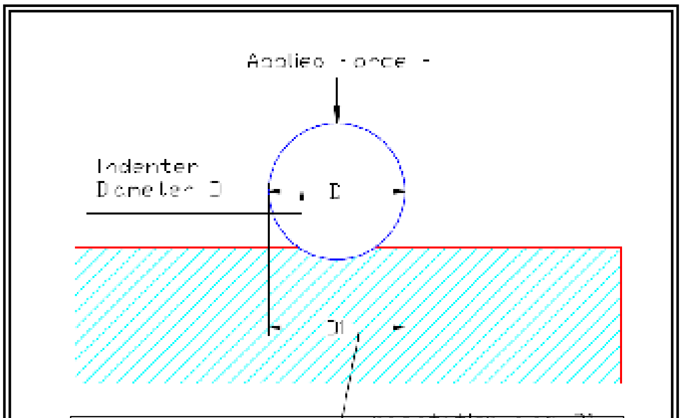
32- Price RB, Sedarous M, Hiltz GS. The pH of tooth-whitening products. J Can Dent Assoc 2000; 66(8):421–6.

Table 1: The mean Hardness by material tested and use of bleaching.

	Use of bleaching		Change attributed to bleaching			
	Control	Bleaching	estimate	95% confidence interval	Percent change	P
Hybrid						
Range	(622.9 - 678.9)	(380.1 - 610)				
Mean	650.5	511.5	-139.0	(-49.5 to -228.5)	-21.4%	0.007
SD	22.1	83.9				
SE	9.89	37.54				
N	5	5				
Micro-hybrid						
Range	(296.7 - 411.5)	(499.2 - 610)				
Mean	361.9	551.6	189.7	(265.5 to 113.9)	52.4%	<0.001
SD	49.4	54.4				
SE	22.09	24.33				
N	5	5				
Nano-hybrid						
Range	(380.1 - 610)	(398.1 - 622.9)				
Mean	525.7	572.8	47.1	(187.8 to -93.6)	9%	0.46[NS]
SD	95	97.9				
SE	42.5	43.77				
N	5	5				

Table 2: P (ANOVA) for difference between the 3 Materials.
Brinell harness BHN: is calculated by dividing the load applied by the surface area of the indentation.

P (ANOVA) for difference between the 3 Materials	**<0.001**	**0.5[NS]**
Effect of Micro-hybrid compared to hybrid		
Change=	-288.6	40.1
95% confidence interval	(-177.6 to -399.6)	(182.1 to -102)
Percent change=	-44.4%	7.8%
P (Bonferroni t-test)=	<0.001	1[NS]
Effect of Nano-hybrid compared to hybrid		
Change=	-124.8	61.3
95% confidence interval	(-13.8 to -235.8)	(203.3 to -80.8)
Percent change=	-19.2%	12%
P (Bonferroni t-test)=	0.026	0.76[NS]
Effect of Nano-hybrid compared to Micro-hybrid		
Change=	163.8	21.2
95% confidence interval	(274.8 to 52.8)	(163.2 to -120.8)
Percent change=	45.3%	3.8%
P (Bonferroni t-test)=	0.004	1[NS]



$$BHN = \frac{F}{\frac{\pi}{2} D(D - \sqrt{D^2 - 1})}$$

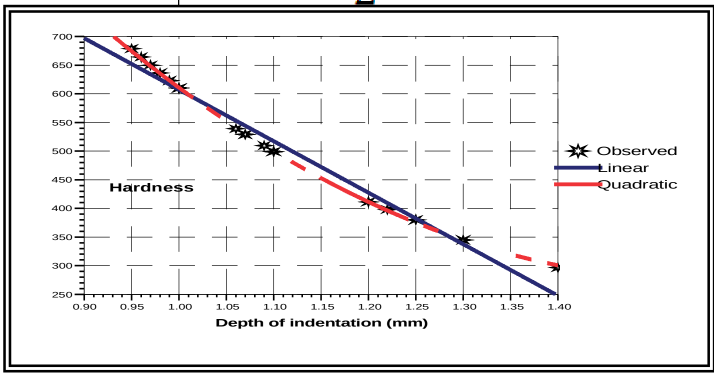


Figure 1: Scatter diagram with fitted regression line for the correlation between depth of indentation and calculated hardness. Two models are compared linear and quadratic.

R^2 for linear model = 0.98 P<0.001

R^2 for Quadratic model = 1 P<0.001

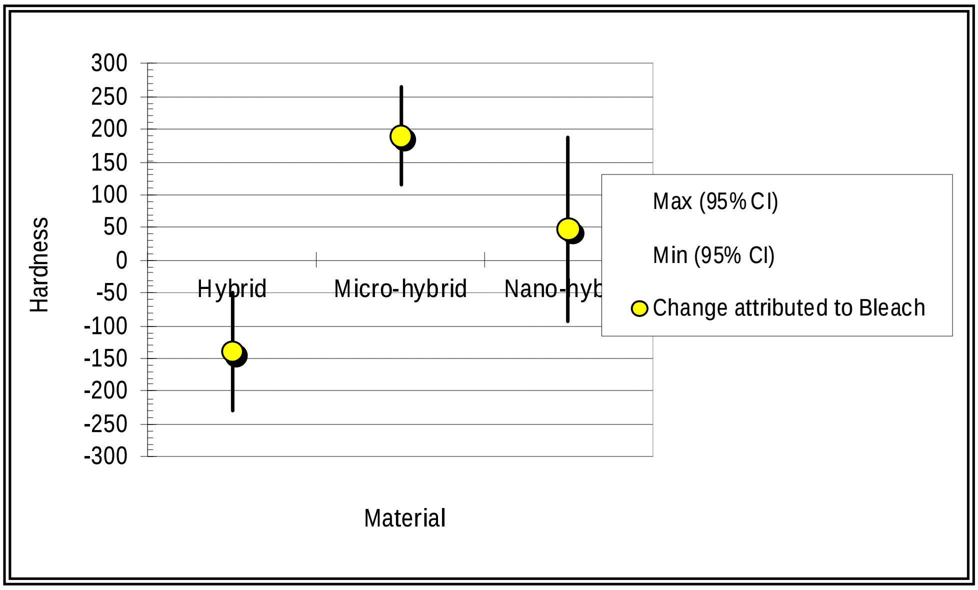


Figure 2: Result of the brinell micro hardness testing.

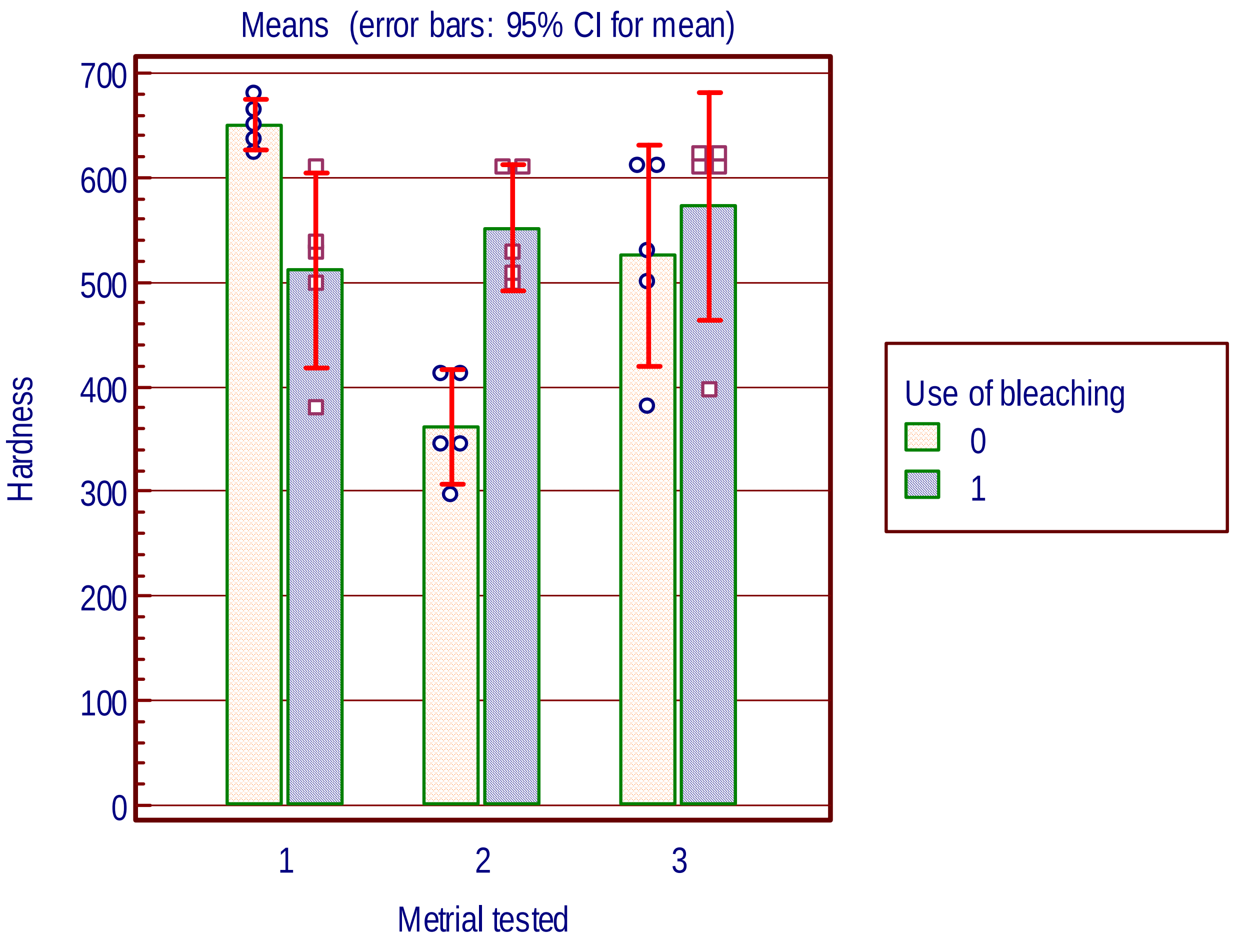


Figure 3: Dot diagram with error bars showing the mean (with its 95% confidence interval) Hardness by material tested and use of bleaching.