

The Effects of Magnetic Resonance Imaging (MRI) On Tensile Strength and Indentation Hardness of Acrylic Resin Denture Base Materials

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الخلاصة

الاهداف: تهدف هذه الدراسة الى تقديم تأثير التصوير بالرنين المغناطيسي على بعض الخصائص الميكانيكية (قوة الشد) ، الخصائص الفيزيائية (تغير الحجم) ، ولفترات زمنية مختلفة من التعرض للاشعاع المغناطيسي ولنوع واحد من مادة الاكريليك الراتنجي المطبوخ حراريا (مواد قواعد طقم الاسنان) . **المواد وطرائق العمل:** فقد تم تحضير نماذج بعدد (١١٠) نموذج من مادة طقم الاكريليك الراتنجي المطبوخ حراريا ، ثم تقسيم النماذج الى مجموعتين رئيسيتين وحسب الالوان (اللون الشفاف Clear) (اللون الوردي Pink) وتم تقسيم كل من مجموعتين الرئيسيتين الى اربع مجاميع فرعية ومن ثم تم التعرض الى الرنين المغناطيسي وحسب الفترات الزمنية المعدة مسبقا (٥ ، ١٥ ، ٣٠) دقيقة ومن ثم تم اختبار كل مجموعة من المجاميع لعدد من الصفات والخواص المختلفة ودراسة التأثير الناتج من التعرض للرنين المغناطيسي (الصلادة ، تغير الحجم). **النتائج:** تبين وجود تغير في بعض الخواص الفيزيائية للاكريليك الراتنجي «الشفاف والوردي» عند التعرض للرنين المغناطيسي مع حدوث تغيير بسيط في ترتيب الذرات ضمن المركب. **الاستنتاجات:** التعرض للرنين المغناطيسي ولفترات زمنية مختلفة يؤدي الى تغير في بعض الخواص الفيزيائية وبمختلف الدرجات.

ABSTRACT

Aims: This study aims to evaluate the effect of (MRI) on physical, and mechanical properties of acrylic resin denture base materials. **Materials and Methods:** one hundred and ten samples were the total no. of samples, samples were divided into two groups each group contain two fifty five, the 1st sample group pink and 2nd groups clear heat cured acrylic resin, then the two groups is divided into four sub-groups, follow that the samples were exposed to magnetic resonance image at three different peri-ods of time (5, 15, 30) minutes within control group respectively and samples tested for indentation hardness, tensile strength. **Results:** the results obtained to show that there was a change in the physical properties “heat cured” acrylic resin weather it is “Pink” or “Clear” after exposure to (MRI) and this change happened at different levels and variable degree, also it has shown that there was a slight tendency to change order of a arrangement of atoms within each molecules with no well and clear evidence of altering of the main material itself, at least at circumstances of experiment. **Conclusion:** Exposure to (MRI) at different periods of time lead to altering of physical properties and at different levels of significant.

Key words: (MRI), Spectrophotometer, Pink Acrylic

Al-Khyeet AI, Al-Noori AK, Taqa AA, The Effects of Magnetic Resonance Imaging (MRI) On Tensile Strength And Indentation Hardness of Acrylic Resin Denture Base Materials. *Al-Rafidain Dent J.* 2015; 15(2): 399-404.

Received: 12/8/2012

Sent to Referees: 13/8/2012

Accepted for Publication: 9/10/2012

INTRODUCTION

Magnetic resonance imaging (MRI) is a non invasive medical test that helps physicians in diagnosis and treat medical condition and provide detailed pictures of organs soft tissue, bone and other body structure⁽¹⁾.

The hydrogen nuclei in the patient and protons behave like tiny moments since hydrogen makes up 80% of all atoms found in the human body and exhibiting a “magnetic moment”, under normal circumstances

and each has a north and south pole⁽²⁾.

Research carried out date suggests that there are no adverse effects caused by short term exposure of head to static magnetic field up to “2” tesla (T) (each T-10000 of earth gravity) whole body exposure should not exceed 4T, since most of medical research not exceed “2T”⁽³⁾.

Magnetic biological research deals with interaction of biological systems with neck static and/or on frequency ultra-low intensity

electromagnetic fields with and/or via possible phenomena⁽⁴⁾.

- crystallization of iron-bearing magnetic mono-particles in tissue of organism.
- Possible existence of long-lived rotational states of some molecules inside protein parts.
- Bending and releasing electrons up to new levels of energy states

Chemical changes measured via (NMR) and it is due to the electronic environment around nuclei, since magnetic field are not equal electron⁽⁵⁾.

Iron atoms are ferromagnetic material, which are easily to lined up under the action of external magnetic field due to strong interaction between atoms which was called "exchange forces"⁽⁶⁾.

(MRI) scanners is very useful for define identical changes in material in three orthogonal planes with no risk of any interaction in case of "human-material" experiment⁽⁷⁾.

Aims This study aims to evaluate the effect of (MRI) on physical, and mechanical properties of acrylic resin denture base materials.

MATERIALS AND METHODS

Data Collection:

In this study, we used two types of acrylic resin "Pink, Clear" both are heat cured acrylic resin, both types are important denture base material. The total number of specimens were one hundred and ten, the samples were divided into two groups each group contain two hundred twenty seven :

1. 1st. group samples were "Pink" heat cured acrylic resin.
2. 2nd. Group samples were "Clear" heat cured acrylic resin.

Then, the total no. of samples of these two main groups were divided into four

sub-groups, each sample were cured according to ADA specification " No.13, 2009", samples were cured for 90 minutes in 70°C follow by 30 minute in 100°C using thermostatically controlled curing unit, after that the samples have incubated into distilled water at 37±1°C for two days for conditioning before testing (ADA specification), follow that samples were exposed to magnetic resonance image (MRI) at three different time periods (5, 15, 30) minutes respectively, and at end of each period of time, samples were tested for "Indentation hardness, tensile strength"

The samples preparation started by preparing a mold by investing a hard elastic foil then water and stone mixed in a ratio of 100:23 "powder-water", with manual spatulation for (10-20) second, mixture placed in flask, the two halves were closed after good vibration, left for one hour for complete setting, wax elimination was done by immersing the metal flask in boiling water for (4) minutes⁽⁸⁾.

Each specimen after complete finishing and polishing well placed inside distilled water for condition before testing then, samples placed inside (MRI) device" Philips" (MRI) device and tested at different periods of time (5, 15, 30) min.

Samples used for tensile strength procedure will be at dimension of " 90*10*3±0.3" mm. according to ADA specification No.12 as seen in Figure (1), and the samples were tested by use of (Gunt universal testing machine) as seen in Figures (2),(3), as specimens were grasped by two arms of machine and pulling force will start at room temperature and result were recorded on computer, forces at failure was recorded in Newton (N) and by formula:

$$\text{Tensile strength} = F M/A \text{ (MM)}^2 - (9)$$

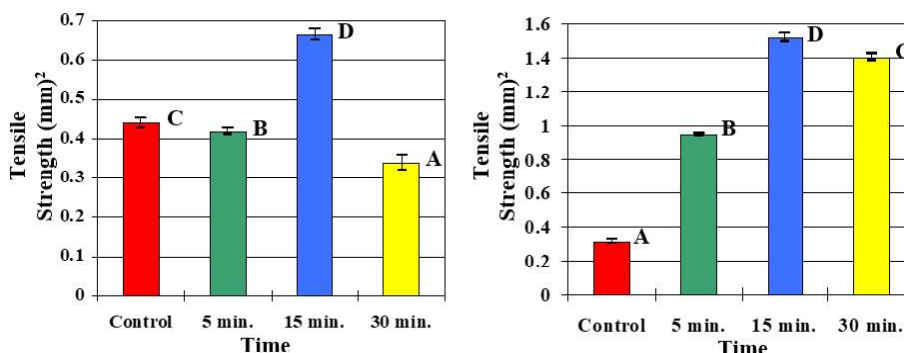


Figure (1): A-B: Descriptive statistics and Duncan's Multiple Range Test of tensile strength test



Figure (2): Tensile testing sample dimensions

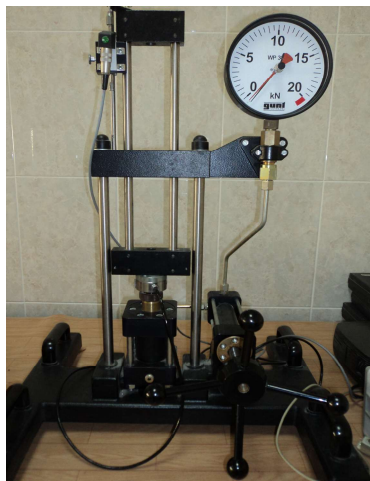


Figure (3): Gunt universal testing machine

Samples used for indentation (Rock Well) hardness test prepared with dimension of $(30*15*3\pm 0.03)$ as shown in Figure (4), random five reading were taken, and the means of this reading were taken. The

test was done by using “digital Rock Well hardness” tester Figure (5) and the indenter used in form of round steel ball of 1/4 inch in diameter with a load of 60 kg/MM^2 and with time up to (15-20) second.



Figure (4): Gunt universal testing machine

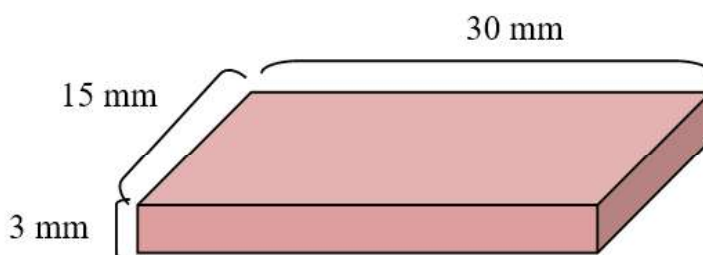


Figure (5): Indentation Hardness testing sample dimensions

Statistical test used include one way analysis of vari-ance (ANOVA), Student’s (t-test) and Descriptive statis-tics and Duncan’s multiple range test for both tensile strength and for indentation hardness test.

RESULTS

Tensile strength means and standard deviation for the tested groups at different period of time (5, 15, 30) min. respectively and control group for both “Pink, Clear”

acrylic resin as shown in Figure (1). One way(ANO-VA) analysis of variance shown in Table (1) and Duncan’s multiple range test as shown in Figure (1) for two types of acrylic demonstrated at $P \leq 0,05$ a significant differences at $P \leq 0,05$ in ten-sile strength for both type of acrylic “Pink, Clear” at different periods of time (5, 15, 30) minutes within control group.

Table (1) : Analysis of variance (ANOVA) : Tensile Strength

Acrylic Type	SOV	SS	df	MS	F-value	p-value
Pink	Between Groups	0.297	3	0.099	482.626	0.000*
	Within Groups	0.003	16	0.001		
	Total	0.300	19			
Clear	Between Groups	4.505	3	1.502	5177.977	0.000*
	Within Groups	0.005	16	0.001		
	Total	4.510	19			

* Significant difference existed at 5% level.

SOV: Source of Variance; SS: Sum of Squares; df: Degree of Freedom; MS: Mean Square.

since Figure (1-A) shown a higher means of tensile strength for (15) min. group while Figure (1-B) shown a higher means of (15 min.) group also than oth-er tested sub-groups, paired sample T-test for both Pink

and Clear acrylic comparing at four periods of time as in Table (2) show a significant differences at four periods of time between Pink, Clear acrylic.

Table (2) : Student’s t–test : Tensile Strength

Group	Acrylic	No.	Mean	+ SD	t-value	df	p-value
Control	Pink	5	0.440	0.012	16.837	8	0.000*
	Clear	5	0.314	0.011			
5 min.	Pink	5	0.418	0.008	-83.168	8	0.000*
	Clear	5	0.944	0.011			
15 min.	Pink	5	0.666	0.015	-69.892	8	0.000*
	Clear	5	1.522	0.023			
30 min.	Pink	5	0.338	0.019	-87.039	8	0.000*
	Clear	5	1.404	0.019			

* Significant difference existed at 5% level

Rockwell indentation hardness means, standard deviation for the tested group at (5, 15, 30) minutes respectively and control for Pink and Clear shown in Figure (2). One way (ANOVA) analysis of variance Table (3) and Duncan’s multiple range at $P \leq 0.05$

shown significant differences for both types of acrylic “Pink, Clear” Figure (2-A) show a high means for 30 min sub-group of “Pink” acrylic , while Figure (2-B) shown a higher means for (15) minutes group than other tested groups.

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Table (3) : Analysis of variance (ANOVA) : Hardness Value

Acrylic Type	SOV	SS	df	MS	F-value	p-value
Pink	Between Groups	442.212	3	147.404	230.139	0.000*
	Within Groups	10.248	16	0.641		
	Total	452.460	19			
Clear	Between Groups	186.690	3	62.230	46.182	0.000*
	Within Groups	21.560	16	1.348		
	Total	208.250	19			

* Significant difference existed at 5% level.

SOV: Source of Variance; SS: Sum of Squares; df: Degree of Freedom; MS: Mean Square.

Paired sample T-test for both Pink and Clear acrylic group comparing means of hardness at four different pe-riods of time

as in Table (4) a significant differences in hardness mean at four period.

Table (4) : Student's t-test : Rockwell Hardness Value

Group	Acrylic	No.	Mean	+ SD	t-value	df	p-value
Control	Pink	5	220.400	1.140	-20.115	8	0.000*
	Clear	5	244.200	2.387			
5 min.	Pink	5	219.200	1.304	119.546	8	0.000*
	Clear	5	126.600	1.140			
15 min.	Pink	5	254.400	1.140	25.200	8	0.000*
	Clear	5	229.200	1.924			
30 min.	Pink	5	229.600	1.140	26.163	8	0.000*
	Clear	5	207.400	1.517			

* Significant difference existed at 5% level SD (Standard Deviation).

DISCUSSION

The purpose of this study to evalu-ate the differences that expected to be happened in acrylic resin denture base material in patients who suspected to visit (MRI) unit diagnosis for cancer or other oro-facial problem and study the possible physical changes that might be happened on material due to exposure to (MRI).

In this study, tensile strength test usually investigate the ,ultimate strength and the resistance of material to catastrophic failure^(11,12), it has been found that increase the tensile strength and mechanical properties of heat cured denture base acrylic is improved by the use of new (dental polymer)⁽¹³⁾ to in-crease dimensional stability and fixation against "MRI" wave to change in poles direction and reduce magnetic effect⁽¹⁴⁾, and results shown and obtain in Figure (1) explained by existence of ferromag-netic substances increase magnetization for (Pink) acrylic

and for (Clear) acrylic explain by contain of more spaces in between polymer chain and reduction of magnetic fold to about million fold than applied field at low time exposure and high time exposure⁽¹⁵⁾, and results shown in Table (2) depend and explain basically by different composi-tion of two types of acrylic (Pink, Clear)⁽¹⁶⁾ surface hardness (Rock Well) test is test of material resistance to in-dentation, and small size indentation the harder the material⁽¹⁷⁾. And the use of ((Scale L)) is for plastic and semi-plastic material for evaluation of hardness of rigid substance⁽¹⁸⁾ although clinical use, den-ture base acrylic resin material im-mersed in saliva water, aqueous cleans-ing lead to increase in hard-ness, with high value for (Heat cured) acrylic res-in^(19,20) and result obtain in Figure (2 A-B) agreed with conclusion as with the increase of magnetic resonance, the" precession or lamor frequency" is directly proportion-al to strength⁽²¹⁾ and results shown in Table

(4) which show a significant differences at four periods of time is explain by Geometric distortion, which arise from Varity of factors, a part of it from chemical and susceptibility differences⁽²²⁾

CONCLUSION

Exposure to (MRI) at different peri-ods of time lead to change in physical properties of denture base material and this change happen at different levels and degree in addition to change in the order of arrangement of atoms within same molecules which result in increasing vibration of bands in between two at-oms with out alter main atom and no change chemically has happened.

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