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

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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 periods 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

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 fields are not equal electrons (5).

Iron atoms are ferromagnetic material, which are easily 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 defining 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 specimens 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:

\[
\text{Tensile strength} = \frac{F \times M}{A (\text{MM})^2}
\]
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Samples used for indentation (Rock Well) hardness test prepared with dimension of \(30 \times 15 \pm 0.03\) 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 inform of round steel ball of 1/4 inch in diameter with a load of 60 kg/MM² and with time up to (15-20) second.

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Figure (2): Tensile testing sample dimensions

Figure (3): Gunt universal testing machine

Figure (4): Gunt universal testing machine

Figure (5): Indentation Hardness testing sample dimensions
Statistical test used include one way analysis of variance (ANOVA), Student’s (t-test) and Descriptive statistics 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 (ANOVA) 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≤0.05 a significant differences at P≤0.05 in tensile 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 |
|--------------|-------------|-------|----|------|------------|---------|
|              | Between Groups | 0.297 | 3  | 0.099| 482.626    | 0.000*  |
| Pink         | 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 other 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≤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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Paired sample T-test for both Pink and Clear acrylic group comparing means of hardness at four different periods of time as in Table (4) a significant differences in hardness mean at four period.

**DISCUSSION**

The purpose of this study to evaluate 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 ferromagnetic 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 composition of two types of acrylic (Pink, Clear)\(^{(16)}\) surface hardness (Rock Well) test is test of material resistance to indentation, 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 although clinical use, denture base acrylic resin material im-mersed in saliva water, aqueous cleans-ing lead to increase in hardness, with high value for (Heat cured) acrylic resin\(^{(19,20)}\) and result obtain in Figure (2 A-B) agreed with conclusion as with the increase of magnetic resonance, the’” precession or lambor frequency” is directly proportion-al to strength\(^{(21)}\) and results shown in Table

| 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.

| 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).
which show a significant differences at four periods of time is explain by Geometric distortion, which arise from Variaty of factors, a part of it from chemical and susceptibility differences.

CONCLUSION
Exposure to (MRI) at different periods 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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