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Effects of Continuous Electro-Magnetic Pulse (EMP) wave on Transverse Strength and Hardness of Self-Cured Acrylic Resin Denture Base Materials

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Abstract: This research investigate the influence of continuous Electro-magnetic pulse (EMP) on transverse strength and hardness of self-cured resin dentine base and estimated degree of changes happened on characteristic build up for cold cure resin. The results showed that hardness of self-cured acrylic samples increased more than that for control samples, also in the present study, transverse strength of samples exposed to (EMP) wave show variation in response with different degree of toughness for clear and plink acrylic than that of control samples, it is also found that (EMP) wave alter some polymer physical properties.

Keywords: (EMP) wave, Transverse strength, Hardness, Continuous wave.

Introduction

Physical Properties of Self-Cured Acrylic Resin

Many researches in recent years have been devoted to establish the fundamental properties of acrylic resin denture base materials, as well as structural characteristics made with the materials [(1)]. Acrylic resin used in dentistry consists of powder (polymer) and liquid (monomer), powder consist of small spheres called beads or pearls, while monomer is highly volatile [(2)].

Acrylic resin generally are low in strength, soft to certain degree beside and have a high resistance to failure in fatigue (1.2 million Flexures before failure at stress of 17 MPa, beside existence of inorganic pigments like ferric oxide (brown) show some changes in electrical properties and alter degree of their conductivity. Micro hardness measurement and transverse strength measurement allows a profile of that transition zone to be plotted, and allows to compare such an effects and degree of fall of material which is between 10 and 20% [(3)].

The loss of plasticizer can alter the bonding surfaces or the viscoelastic properties of such materials. Resulting in brittle material and transfers strength with tensile strength increased with leaching out of plasticizer, which resulted in stiffness[(4)].

Electro-dynamic and Electro-Magnetic Pulse Interaction

Organic and hybrid material are now under investigation for field of nano-a magnetism, they act as innovated material with different attractive properties in electron and in synthetic and characteristic nature [(5)]. Electromagnetic pulse was basically deal with electron flow, this flow is controlled by electron force which is one of the five fundamental forces in nature and this force can created a charge distribution because protons are fixed whereas electrons are free to move, so this create a conditions called electrical potential energy and this condition is prior to complete magnetism and EMP pulse spread [(6)].

So, depending on the inter action occur between dental material and the electrical potential energy, materials can be divided into two groups:

- 1st group show a shortening in the (EMP) wave response as in Argil, Agutos.
- 2nd group show an elongation in the (EMP) wave response as in Hytac, Ariston. [(7)].

Magnetism

Magnetism is a field effect associated with certain types of material said to be magnetic. The magnetic field is similar in many ways to the electrical field, but its manifestation is different. [4]. The smallest region of magnetism is called magnetic domain, and these domains randomly oriented and therefore show and exhibit no magnetism. Some material however have their magnetic domains aligned and therefore become magnetic, the electron configuration determined the three types of magnetism : ferromagnetism, parmagnetism, and diamagnetism, and because of the limited gradient strength available on human scanners clinical application of diffusion – weighted magnetic resonance imaging (DW-IURI) is recommended.

Permanent magnets do not use an applied electric current, instead the magnetic fields produced from mutual alignment of the very small magnetic fields produced by each of the atoms in the magnet. The following equation shows the line of magnetic fields which is generated from the coil.

$$\mathbf{B} = uo \frac{N \times I}{L} \quad \ldots\ldots\ldots \quad (8)$$

Where:

B = magnetic field, measured in teslas.
uo = Magnetic constant with exact value of $(4\ T * 10^{-7})\ M/A^2$
(Newton per ampere squared or in henrys per meter).
N = total No. of rolls in coil.
I = current in wire
L = length of the coil.

Magnetic fields and Dental Material

Self-Cured Acrylic Resin Polymer and MRI Wave Later-Action

Acrylic based resin consists of polymeric material based on poly methyl methacrylate, these dental material are the results of free radicals polymerization reaction and in case of cold cure acrylic resin by the time of mixing of material, a reaction will start and this type of acrylic is daily used in dental practice and it consist of pre-polymerized poly methacrylate with initiate and pigment, which mixed with monomer and cross – linking agents[9]. Dimensional instability and inaccurate results are one of most common disadvantages of these material used in **prosthetic** dentistry and making of different appliances, so by the use of (MRI) we can investigate and study environment of liquid in a mixture and visualized dimensional changes. [10].

Continuous Electromagnetic Pulse Wave and an (MRI) Wave Differences

Continuous (EMP) wave deals with resting electrical change radiates an electric field. When the change is in motion so when this motion is decrease, a photon of electromagnetic radiation is emitted; known as bremsstrahlung Rays and a photon of RF is emit. While, (MRI) wave deals with RF wave initiated by signals originated from the nuclei of atoms resonating in a patient in the presence of magnetic field, so it deals with behaviors of very small objects like proton, electron, and neutron[11].

Continuous (EMP) wave uses in Prosthodontics Field

Synthesis of organic/inorganic. Nano polymer has got much effort, because of small size of the particles, these nanoparticles offers unique properties of magnetic nanoparticles (MNP) based on different oxide composition that exists in the combination. So such a material must be able of being functionalized with one or more molecules, they must retain their magnetic properties under observatory by use of continuous (EMP) wave for reasonable period of time in aqueous media with vary in pH[12]. Uses of self or cold-cure acrylic resin polymer in dental field is very common, and the use of this smart polymer require adequate investigation of it is properties, since they got critical temperature. Close to the physiological value phenomena known as a lower critical solution temperature (LCST). [13].

Continuous (EMP) wave have shown an increase interest the study of the aqueous solution like (sodium alginate) because of the biocompatibility of such material and the use of such material as fundamental bases for tissues engineering and in dental impression technique. [14]. One of most recent application of continuous (EMP) wave in the development and improving of the quality of the algal biomass by expose culture – growth of demococcus olivaceous

and improving culture-growth about 40% after expose to continuous (EMP) by reducing carbohydrate and protein levels and increasing lipid level about 16% after exposure to pulse (EMP) wave [15].

Some of Mechanical Tests Used in This Study

Transverse Strength

Transverse strength stay in usually investigate ultimate the strength and determine resistance of material and it is capability to with stand a growing force applied on it up to lead to appoint where material undergo permanent deformation and the result will be fracture of the material under continuous force [16]. Since self-cured acrylic resin is the material under study, it is based on polymethyl-methacrylate (PMMA). The loss of plasticizer can alter the bonding surface on the visco elastic properties of resilient materials, which become brittle, and changing their properties [17].

The present of high-percentage of cross-linking, agates in liquid, can clinically alter-mechanical properties and reduce the dimensional change, and increase dimensional stability and this results in increase resistance to permanent deformation, and this clearly notice in heat-cured acrylic resin in compare with cold-cure acrylic resin [18].

Surface Hardness

Surface hardness is the measurement of the resistance of the material to the indentation and depends on the size of the indentation area, we can determined degree of the hardness of the material depending on the size of the deformation, and it is regarded as valid tool for evaluation of the hardness of rigid polymers under specific load [19]. The amount of residual monomer exists play significant role in the hardness of self-cured acrylic resin due to inter-chain forces, so that a high possibility of deformation will, occur easily under different degree of load [20]. The purpose and aims of such study is to evaluate the effects of continuous (EMP) wave pass through coils on acrylic resin and how this effect take part and interface with mechanical properties like transverse strength and hardness strength of self-cured acrylic resin and degree of this effects and action.

Experimental Work

Materials

*** (EMP) Wave Device**
A device throughout a redirect of the wave is happened through a coil designed to expose samples under test to a precise dose of wave, and study the expected results.

*** Cold "Self" Cure Acrylic Resin**
Materials under investigation, pink and white self cured acrylic resin were used to study and evaluate the effects of (EMP) wave on it, and undergo physical tests.

*** Plaster of Pairs**
Materials throughout molding of the sample were done by the use of the flask and preparation a mold for pouring of acrylic-resin samples.

*** Water**
Water is needed for chemical process "hydration" in which the plaster powder sets into solid mass, drinking water from Mosul water supply used throughout this research.

Sample Preparation

According to ADA specification for acrylic resin polymers, the dimension of studied sample for the hardness measurement will be

(30× 15 × 3)± 0.02mm. (Length, width and thickness) respectively for testing in hardness device Shore A (Fig.1).
The dimensions for samples of second experiment (Transverse strength) will be respectively (90 × 15 × 3)mm. length, width and thickness [21] (Fig. 2).

The plaster mix with water and then poured into flask to prepare a mold to prepare a samples by use of thin wax-pattern prepared on size of the samples dimensions, follow that deflasking and washing of wax-remnant with preserving surface landmarks. Following that, mixing powder and liquid of self-cured acrylic resin according to manufacture instruction in a glass-jar at room temperature and directly packed, then open, finished and polished to be tested.

Sample Testing

After complete finishing and polishing of samples are performed, samples were tested by placing special coil to redirect (EMP) wave toward samples under test, for extended period of time.

Fig (1) : Samples Testing for hardness strength

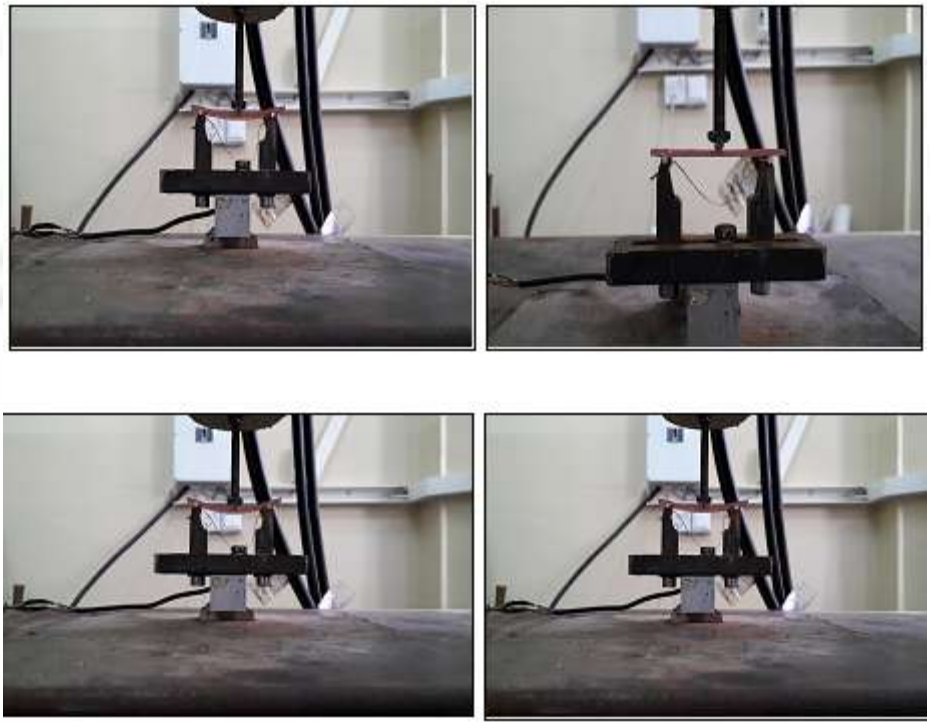

Fig (2) : Samples Testing for transverse strength

RESULTS

Table (1) : Statistic analysis of surface hardness test results:

One-Way Analysis of Variance

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	469.00	156.33	123.42	0.000
Error	10	12.67	1.27		
Total	13	481.66			

				Individual 95% CIs For Mean Based on Pooled StDev
Level	N	Mean	StDev	--------+---------+---------+--------
C1	3	80.833	0.764	(--*-)
C2	3	90.200	2.007	(-*--)
C3	4	93.600	0.770	(-*-)
C4	4	96.700	0.744	(-*-)
				--------+---------+---------+--------
Pooled StDev =		1.125		84.0 90.0 96.0

C1: Control Pink, C2: Control White, C3: Exposed pink sample to wave, C4: Exposed white sample to wave.

Table (2): Statistic analysis of transverse strength test results:

One-Way Analysis of Variance

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	5900.11	1966.70	622.42	0.000
Error	12	37.92	3.16		
Total	15	5938.02			

				Individual 95% CIs For Mean Based on Pooled StDev
Level	N	Mean	StDev	--------+---------+---------+--------
C5	4	48.500	0.744	(*-)
C6	4	70.050	1.895	(-*)
C7	4	86.175	0.854	(*-)
C8	4	36.400	2.787	(*-)
				--------+---------+---------+--------
Pooled StDev =		1.778		45 60 75

C5: Control Pink, C6: Control White, C7: Exposed pink sample to wave, C8: Exposed white sample to wave.

Discussion

* (EMP) wave applied to self-cured acrylic resin for extended period of time shown an increasing hardness of clear-acrylic compare with pink acrylic and this result agree to some degree with finding of Al-Khyeets et al. (2015), depending on differences in chemical composition.

* (EMP) wave applied to self-cured acrylic resin can be result in differences is transverse strength value. For different types of acrylic resin "pink, clear" with high value. For pink-acrylic resin compare with that for clear-acrylic resin, and this results can agree to some degree with Al-Khyeets et al. (2015) depending on elements exists, since this elements vary in their wave interaction and wave transmission in every spot across the specimen under study ,this result in wave recycle so many times and creates an area of weakness and deflection ,so., any force with certain magnitude fracture specimen at the point of energy failed to find away to distribute correctly .

Conclusions

Samples exposed to (EMP) wave show variation in response with different degree of toughness for clear and plink acrylic than that of control samples, it is also found that (EMP) wave alter some polymer physical properties.

References

[1]. Karaguchi T. Iassila L.V., Vallittn P.K., Takahash V. (2011): Mechanical properties of denture base resin cross linked with methacylated dendrites. Dent. Mat. J. ; (27) : 755-761.
[2]. Graig R.G., Power J.M., and Wataha J.C. (2013). Dental Material : prosperities and manipulation ; Mosby Com. PP. 270-275.
[3]. Chudek J.A., Hunter G., Mackay R.L., (2012). The application of magnetic resonance microimaging to the visible light curing of dental resins. Dent. Mat. J., (17): 177-185.
[4]. Garcia R.C., Cury A.D., Oliveira V.M. ; and Ieon B.L. (2003). Effect of a denture cleanser on weight, surface roughness and tensile bond strength of two resilient denture liners. J. Prosthet. Dent., (89): 489-94.
[5]. Gervais G., Laurencia D., Bonhomme C., (2014). Pregress in Nuclear Magnetic Resonance Spectroscopy. J. Science Direct., (77): 1-48.

[6]. Bushong C.T. (2003). Magnetic resonance imaging physical and biological principles 3rd. edition. CV Mosby Company.
[7]. Buchardt D.V., Lewick A.M.B., (2013): Disturbing effect of different dental materials on the MRI results. Preliminary study. Acta of Bioenerening and biomechnics. Vol.15, No.4. 22. abb.
[8]. Kim K. ; Sun C.T. ; Ko J.H ; Kwon C.I. ; cha E.J. (2011). Development of MRI/NIRF 'activatable' multimodal imaging probe based on iron oxide nano particles: Journal of Controlled Released. Vol (755): No. 152-158.
[9]. Bettencourt A.F., Neves B.C., Oliveiva A.S., Castro F.M. (2010). Biodegragation of acrylic based resins. J. Dent. Mat. (28): 177-180.
[10]. Thomas C.A., Fellous C.M. (2009). Determination of bound and unbound water in dental alginate irreversible hydrocolloid by nuclear magnetic resonance spectroscopy J. Dent. Mat. (25): 486-493.
[11]. Miller J., Mungas D., Harvey D., Decarli C., Reed B. (2012). MRI predictors of cognitive change in adiverse and carefully characterization elderly population. J. Nemabiology of Agirg. (33): 83-90.
[12]. Fessi H., Elaissan A., Sanntos J. (2011). Stimuli-responsive magnetic particles for biomedical application. Inter. J. of Pharmac. ; (403) 133-167.
[13]. Dimitrov I., Trzebicka B., Müller A.H., Dwork A., Isretanor C.B. (2007) Thermosensitive water-soluble copolymers with doubly responsive reversibly interacting entites. Prog. Polym. Sci. (32). 1275-1343.
[14]. Lin H.R., Yeh Y.L. (2009). Porous alginate / hydroxyl-apatite composite scaffolds for bone tissue engineering preparation characterization and in vitro study. J. Bio. Med. Mater. Res. (773) ; 52-65.
[15]. Zhi Y., Guoy S., Li L., (2007). Effects of electromagnetic field on the batch cultivation and nujtritional composition of spirulina platensis in an air lift photobioreactor. J. Bioresorce. Technol. (98); 700-705.
[16]. Vivane M.B., Oliveiva DB., Cury DB. (2003). Effect of denture cleanser on weight surface roughness and tensile bond strength of two resilient denture lines. J. Phosthet. Dent. (89): 489-94.
[17]. Graham BS., Jones DW., Sutow EJ. (2011). An in vivo and in vitro study of the loss **of** plasticizer from soft polymer-gel materials**.** J. Dent. 16 ; 239-46.
[18]. Al-Rifaiy M.Q. (2012). Bond strength of light polymerization hard reline resin and denture base resin subjected to long-term water immersion. Saudi Dent. J. ; 1241: 23-27.
[19]. Machado C., Gabosa C.M., Somar F.M.; Margarete J.M., (2009). Influence of mechanical and chemical polishing in the solubility of acrylic resins polymerized by microwave in vadiation and conversia, water bath. J. Dent. Mat., (20): 565-569.
[20]. Neppelenbroek K.H., Giampaolo E.T., Vegani C.E., (2005). Hardness of heats-polymerized acrylic resins after disinfection and long term water immersion. J. Prosthe. Dent. ; (92): 766-6.
[21]. Hatim N.A., Taqa A.A., Hasan R.H. (2004). Evaluation the effect of curing techniques on color property of acrylic resins. Al-Rafidin Dent. J. ; 4(7): 28-33.
[22]. Al-Khyeets S., Saead F., Kameal S., Foad H., (2015): Reability of MRI evaluation and EMP wave continuation on geometric accuracy of magnetic wave and distortion. Birjournal s. cont.org. (54); 65-67.