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Effect of Er, Cr: YSGG Laser on Intra Pulp Temperature during Cavity Preparation

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Abstract

Aim: Evaluate the intrapulpal temperature(temp.) during cavity preparation (CP) by used Er,Cr:YSGG laser.

Materials and Method: Forty five sound permanent premolars teeth were prepared at occlusal aspect and thermocouple was inserted into pulp chamber (PC). ClassV cavity prepared at buccal surface using Er,Cr:YSGG laser at following parameters: power (250mj, 300mj, and 350mj), frequency (10Hz,15Hz and 20Hz) with 50 % water flow and 80% air. Total time of irradiation(30 sec.). Two- way ANOVA was used to test .

Result: Cavities prepared by the energy (350 mJ) and frequency (20 Hz) shows the value of temp. (3.96±0.96°C), while the energy setting of (250mJ and 10Hz) shows the lowest temp value (0.80±0.20°C).

Conclusion: CP with an Er, Cr: YSGG laser at different energies and frequencies influence the intrapulpal temp..

Keyword: Er,Cr:YSGG Laser, Intrapulp temp., Cavity preparation.

Introduction

In order to develop effective mean for remove dental caries pioneering investi-gations of the interactions between the energy of laser with tooth structure. Erbium laser was better adjusted to the clinical needs for CP without deleterious effects on the pulp led to further investigations.(1) The laser has been widely used in dentistry and several wavelengths have been investigated as a substitute for high speed handpiece.TheCPis traditionally done by cutting or abrasion of tooth structure, using rotary instruments with side effect like pain, need for anesthesia and noise. However, the laser ablation of enamel and dentine for the cavity preparation has attracted many researchers, since it is considered safe, reduces pain, noise, vibration and comfort in the patients treatment.Thus,theErbium:yttriumaluminum-garnet (Er:YAG) (2.94mm) and Erbium, Chromium: yttriumscandium galliumgarnet (Er, Cr:YSGG, 2.78 mm) lasers have been widely studied due to the interest of its use in dental tissues.(2)The Er,Cr:YSGG laser emits photons at a wavelength of 2.78 mm and is strongly absorbed by water and hydroxyapatite the main components of the tooth structure.(3)The absorbed energy cause rapid water vaporization and make microexplosions in hard tissue.(4)Microexplosions of irradiation tissues associated with high temp. production which might affect pulpal tissue vitality . In order arrange such effect water spraye was commonly used with laser devices during preparation when the dentine is irradiated by Er,Cr:YSGG laser with water spray not only the temp. is suppressed but also cutting efficiency increases.(5)Thermal changes of the pulp can be examined invivo using histological studies, microscopy and laser doppler flowmetry. Invitro studies are performed on extracted teeth using a thermocouple penetrated the tooth structure into the PC.(6,7) Proper cavity clinician may need to change the parameters of the irradiation depending on the response of tooth. Limited information available regarding the effect of different energy and frequency parameter on the pulp temp..The present invitro study to examine the temp. inside the extracted PC of human teeth during CP using Er,Cr:YSGG laser at a different energy and frequencies. The laser energy mean "measure of the ability of body for produce achange, expressed usually in Joules", while frequency "is the pulses number of arepeating signal in specific time unit normally measured in pulses per second".

Materials and Methods

Forty five extracted human mandibular premolars were stored at room temp. in distilled water until use, teeth were scaled for removal of any calculus deposits and polished for removal of any stain when present.(8)Teeth divided into three groups according to laser energy. Each group was subdivided according to frequency into three subgroups (n=5).For all teeth thickness of dentin at the buccal surface was measured before preparation using radiographs which varied from (2.5 to 3mm) measure by vernia ruler.(9) The occlusal surface was perforated at the top surface of the PC using high speed hand piece(turbine) with dental round bur until reach the chamber room. The thermo-couple (Digital Ki and BNT model: ST-1, China) was inserted into the PC through occlusal surface. Inside the PC, the thermocouple was fixed by red wax inside the PC for covered the PC and prevented the water used for cooling from influencing temp. measurements.ClassV cavities were prepared on buccal surfaces one mm above the cemento-enamel junction using Er,Cr:YSGG laser (Waterlaseiplus, BIOLASE Technology, USA) (Figure1). Three different energy settings were used(250,300and 350 mJ). Each energy level was combined with three different frequencies(10,15 and 20 Hz). Laser irradiation was performed perpen-dicular to the buccal surface in noncontact mode with fixed at distance of 2mm away from the laser tip, to ensure consistent energy density, spot size, distance, and the handpiece of laser was attached to a modified surveyor(Figure2). The total period of irradiation for each was 30 sec and the diameter of fiber tip was 6mm(MZ6-Zip Tip).(10, 11) Cooling during the CP was done with rate of water spray 50% and 80% air.Throughout the CP it was notified that the elevation in the intropulpal temp. start to rise since the beging of the irradiation and continues for a few seconds after irradiation ends.Maximum intrapulpal temp. increases were observed and recorded within 30sec. during cavity preparation. Two- wayANOVA was used to test the differences in temp. value between the parameters of (energy and frequency). The Pairwise comparisons test was used to determine differences between groups. All statistic tests were conducted at 95% level confidence.

Figure 1: Er Cr: YSGG laser

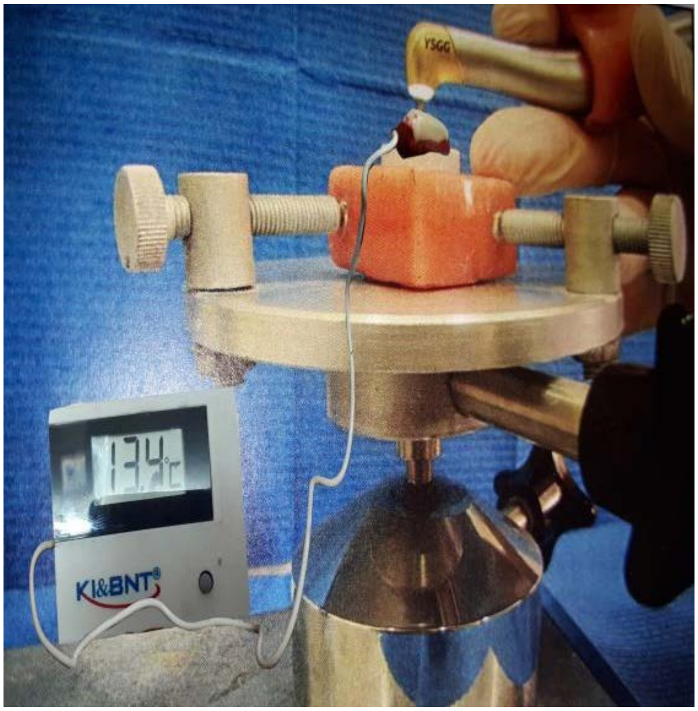

Figure 2 modified surveyor

Results

Mean and SD of maximum temp-erature values with each parameter (energy and frequency) are shown in (Table1). CP with laser irradiation by the highest energy level (350 mJ) and frequency (20 Hz) result the highest rise in temp.(3.96±0.96°C), while the energy setting of(250 mJ) and frequency(10 Hz) caused the lowest increase(0.80±0.20°C).Pairwise comparisons of different frequency at each energy the result shows significant differences in temp.s between frequency at (10Hz and 20Hz) but no significant difference between (15Hz and 20Hz) are presented ($p<0.05$) in (Table2 and Figure3).Pairwise comparisons of different energy at each frequency the result shows significant differences ($p<0.05$)in temp-eratures between energy at (250mJ) and (300mJ and 350mJ). No significant differ-ence between 300mJ and 350mJ are presented in (Table3 and Figure3).Two-way analysis showed that the influence of energy level on the temp. increase was stronger than that of frequency (Table 4and Figure3).

Table 1: Means and SD for Intrapulp Temp. after Cavity Preparation

energy	frequncy	Mean	Std. Deviation	N
250mj	10hz	.8000	.20000	5
	15hz	1.3200	.47645	5
	20hz	1.9400	.92898	5
300mj	10hz	1.7200	.52154	5
	15hz	3.1000	.43012	5
	20hz	3.7200	1.14978	5
350mj	10hz	1.9600	.74364	5
	15hz	3.5800	.94446	5
	20hz	3.9600	.96592	5

Table 2: Pairwise Comparisons Between frequency at each level of irradiation energy

Energy	(I) Frequncy	(J) Frequncy	Mean Difference (I-J)	Std. Error	Sig.[a]
250mj	10Hz	15Hz	-.520-	.485	.291
		20Hz	-1.140-*	.485	.024
	15Hz	20Hz	-.620-	.485	.209
300mj	10Hz	15Hz	-1.380-*	.485	.007
		20Hz	-2.000-*	.485	.000
	15Hz	20Hz	-.620-	.485	.209
350mj	10Hz	15Hz	-1.620-*	.485	.002
		20Hz	-2.000-*	.485	.000
	15Hz	20Hz	-.380-	.485	.438

Table 3: Pairwise Comparisons Between Frequency and Energy of Laser Irradiation.

Fregunсy	(I) Energy	(J) Energy	Mean Difference (I-J)	Std. Error	Sig.[a]
10Hz	250mj	300mj	-.920-	.485	.066
		350mj	-1.160-*	.485	.022
	300mj	350mj	-.240-	.485	.624
15Hz	250mj	300mj	-1.780-*	.485	.001
		350mj	-2.260-*	.485	.000
	300mj	350mj	-.480-	.485	.329
20 Hz	250mj	300mj	-1.780-*	.485	.001
		350mj	-2.020-*	.485	.000
	300mj	350mj	-.240-	.485	.624

Table 4 : Two Way ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	53.123	8	6.640	11.304	.000
Intercept	271.339	1	271.339	461.897	.000
Fregunсy	23.019	2	11.510	19.593	.000
Energy	28.103	2	14.052	23.920	.000
Fregunсy * Energy	2.001	4	.500	.852	.502
Error	21.148	36	.587		
Total	345.610	45			
Corrected Total	74.271	44			

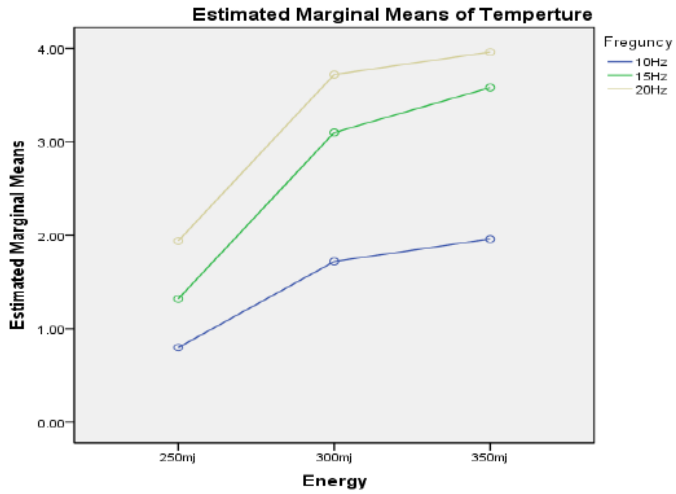

Figure 3: Two-way analysis for intrapulp temp.

Discussion

Possible dentin surfaces exposure to laser energy may cause damage to the pulp if temp.s rise sufficiently high. Zach and Cohen 1965 reported that pulp temp. rises of 5.6°C caused loss of pulpal vitality in (15% of teeth tested). The highest temp. increase(3.9°C) seen in the PC was achieved in samples treated with laser parameters of(350 mJ and 20 Hz). All other parameters tested showed smaller temp. increases. While a decrease in temp. seen because the cooling effect of the water spray these results are within the safety limits determined by Zach and Cohen.(12)Relation between the energy(mJ), frequency(Hz) and the variation of the intrapulpal temp. from the data of this study can be observed in the samples irradiated with 250 mJ, 300 and 350 mJ, with cooling, where the same numbers of pulses were applied. The intrapulpal temp. is higher when 20Hz is used, following 15 and 10 Hz. The same results were found by Vinicius R. Geraldo-Martins et.al,(13) who stated that the repetition rate was the most important parameter determ-ining the accumulated heat. Our ablation regimens were defined (the relationship of the laser pulse duration and the laser pulse energy) the result of the study demonstrated that. At high levels energy the speed of ablation was faster than the diffusions of heat into the tissue.This kind of ablation is called(cold ablation) "meaning that there is no heating of the surrounding tissue" therefor it is wise to understand the fact that when clinician plane to achieve cold ablation the pulse duration should be shorter than the tissue relaxation time.(14) It is a fact that the temp.s are higher for enamel ablation than for dentin removal, but the distance to the PC is less in dentin, pulp vitality is in greater danger from the overheating of dentin.(15) The temp. in the pulp rise during invivo laser cavity preparations will be lower than in hard tissues because of the pulp tissue nature itself which includes blood circulation causing heat dissipation, and the higher water content of the vital tooth structures.(16) Rizoiu et al documented there are no apparent adverse thermal effects of Er;Cr:YSGG CP on the pulp drop in temp. occurred, which was considered to be secondary to the cooling effects of the water vapor.(17)The importance of the remaining dentin thickness in the thermal changes seen in pulp tissue. Although in this study we did not measure remaining dentin thickness, in the study by Tamara S. Al-Qaradaghi et al.,(18)decreasing remaining dentin thickness resulted in higher intra-pulpal temp..The shorter irradiation period reach the high ablation threshold of hard dental tissues faster, and consequently less energy is transformed into heat. In our investigation minimal thermal effects were seen on dental tissues, confirming that irradiation time(30 sec.) produced thermal effects (0.80°C -3.96°C).Other lasers used in dentistry such as the CO_2 and Nd:YAG lasers caused considerably higher temp. increases in the pulp than did the Er,Cr:YSGG laser. Türkmen et al.(19) study (30sec) of irradiation time of dentine with a CO_2 laser caused temp. increases of 37°C in the PC and Nd:YAG lasing increased the intrapulp temp. 28°C it can be concluded that irradiation of Er,Cr:YSGG laser at subablative parameters for CP led to an acceptable temp. Increase in the PC without exceeding 3.9ºC.

Conclusion

The effectiveness of the Er Cr: YSGG laser for remove of caries indicate for CP and caries removal at different energy and frequency that does not cause a harmful temp in the PC with shorter irradiation period.

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