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940 nm DIODE LASER ASSISTED COAGULATION AFTER TOOTH EXTRACTION IN DIABETES PATIENTS

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ABSTRACT
The aim of this work was to study the effect of 940 nm continuous diode laser in achieving faster clotting, prevention of dry socket and enhancing bone formation after tooth extraction for diabetes patients. Methods: Blood samples from 11 diabetes patients were divided into two groups control and test group which exposed to 3W diode laser for 10 s then clotting time (CT) was calculated for both groups and temperature changes due to laser exposure were measured too. The dose of 103.44 J/cm² was used on dental sockets of diabetes patients after tooth extraction. The patients were followed up at 3, 10 and 21 days after extraction. Clot was formed by laser in test group of blood samples, on patients, diode laser stopped bleeding within few seconds after extraction, clinically no dry socket observed, X- ray showed that bone was formed in dental socket after 21 days of extraction. Diode laser is safe and effective as hemostatic agent; it also stimulates soft tissue healing clinically and bone formation radiologically.

KEY WORD: Diabetes, Diode laser, dry socket, extraction.

INTRODUCTION

Diabetes mellitus is a systemic disease that characterized by defects in the metabolism of carbohydrates, fats and proteins because of insulin lack or resistance, it classified into cl I which is called insulin dependent this type occurs due to absolute insulin deficiency, cl II is non-insulin dependent, it occurs due to insulin resistance or secretory defect, and gestational diabetes which occurs in pregnant women (Wilson et al., 2010). The patient is considered to be diabetic when the fasting glucose level in blood is ≥ 126 mg/ dl, random glucose level is ≥ 200mg/dl and the glycosylated hemoglobin is ≥ 6.5% (Àlamo et al., 2011).

Diabetes is mainly accompanied by organs destruction, vascular diseases, and hemostasis alteration, hyperglycaemia can cause glycalation of blood proteins such as hemoglobin, prothrombin, and fibrinogen, the alteration of clotting protein causes hemostasis disturbance and coagulation defects therefore increase either the possibility of bleeding or vascular thrombosis (Ismail et al., 2015). Effects of diabetes extend to the oral cavity and cause many manifestations including periodontal diseases, xerostomia, burning mouth syndrome, test alteration, delayed wounds healing, increase the susceptibility of dental caries, plaque accumulation, and oral infections such as candidiasis (Matthews, 2002; Shrimail et al., 2011;Thayumanavan et al., 2015). Some complications during dental procedure can occur such as hypoglycemia which is a marked reduction in the level of blood glucose (Lalla and D'ambrosio, 2001). Post dental extraction complications such as abnormal bleeding, postoperative pain, infections such as dry socket and swelling are more prominent in diabetes than in non-diabetes groups (Karbassi et al., 2015). Lasers were used in dentistry since the 1st half of the past century, they provided hemostasis, reduction of bacteria, fastening of wounds healing and decreasing the postoperative side effects, their outcomes are superior to those of conventional methods (Pang et al., 2012). Blood components absorb lasers in visible and near infrared region of spectrum (Kraitl et al., 2005), therefore diode lasers are hemostatic tools that can coagulate a large area and depth of wounds in oral soft tissue (Vitruc and Levine, 2016).

MATERIALS & METHODS

This work included pilot study for clot formation and temperature changes, clotting time (CT) calculation for control and test groups, dental extraction, and clinical and radiographical evaluations.

Laser device (Epic 10 diode laser 940 nm Biolase, USA), this is a laser diode (active medium is InGaAsP) with maximum power =10Watt (W) which can be operated in continuous and gated pulsed mode. Laser wavelength = 940 ±10 nm, aiming beam 625-670 nm, laser classification: 4 and class 2 for aiming beam, fiber optic delivery system with a disposable tip (Biolase E3-7, 7 millimeter (mm) in length and 300µ in diameter). In this study continuous mode was selected to be used.

Samples preparation

From diabetes patients blood samples of 10 milliliter (ml) were collected and stored at room temperature in EDTA tubes for 5 minutes, samples were inverted upside down twice each 2 minutes, then they were distributed equally in eppendrof tubes (0.5 ml for each tube).

Pilot study

Pilot study was made to choose the least power that can form a firm, stable and fixed area covering clot with minimum temperature elevation. Blood samples of 10ml in volume

were taken from 12 diabetes patients, these samples were prepared as mentioned above, then they were divided on 240 eppendroff tubes as 0.5 ml in each tube. Twenty eppendroff tubes were obtained for each patient then they were divided to 4 sets each set consisted of 5 samples, each sample in the set exposed to different laser power, but the same distance between laser tip and blood surface. Laser tip was perpendicular on the blood samples surfaces, powers of 1, 2, 3, 4 and 6 W were used for 10 seconds for each set as a one power for each eppendroff sample and at different distances between laser tip and blood surface between each set, first set, the tip- surface distance was 3 mm, the second set which obtained from the same patient exposed to the same power but tip surface distance was 6 mm, 9 mm for the third set and 12 mm for the fourth. The selected parameters were: power =3 W, spot area = 0.29 cm^2, power density = 10.344 W/cm^2, energy density = 103.44 J/cm^2, session duration = 10 seconds, frequency or number of treatment was one, and the session number was one therefore the accumulative dose = 103.44 J/cm^2.

At these parameters clot was firm and covered the sample surface area when the distance was 12 mm between laser fiber tip and the blood surface. Temperature was measured at two points in each sample (4 and 13 mm deep to the surface) before, during and after laser exposure by a digital thermometer (AMPROBE TMD®-56, Everett, WA, USA), (that connected to computer and the data were recorded and stored by specific software.

Spot size was measured and laser dose was calculated, also blood clots were isolated and their volume was measured by mathematical equations.

Clotting time

Samples of equal volume were grouped into two groups: control G1, this group didn't expose to laser or any extrinsic factor, and test group G2 this group exposed to the laser selected dose then CT for both groups was recorded then the results were statistically analyzed by SPSS ver. 20.

For control group conventional CT test was performed, samples were clotted without any interactions, for test group, laser tip was 12 mm away from the blood surface with a power of 3 W each sample exposed to laser radiation for time ranged from 5 to 14 seconds (one interval for each sample) and the least time that produced the thickest blood clot was recorded, this method was repeated for all patients samples.

Patient's methods

Eleven diabetic patients with age ranged between (44-55 years) and a previous post extraction complications history had teeth extractions, Before the procedure many investigations were done to each patient these investigations included: random blood sugar (RBS), hemoglobin level (Hb), Hemoglobin A1C test, bleeding time, clotting time tests and Packed Cell Volume (PCV). Also blood pressure, medical, dental history and patient's medications were recorded. Local anesthesia Mepivacaine 3%, two carpules were used for each patient, laser was applied immediately after tooth removal, Follow up was after 3, 10 and 21 days after operation to examine the extraction sites clinically and radiological investigations were held in day 21, notes were recorded by operator and patient in a questionnaire paper.

RESULTS

Mean temperature elevation in pilot study was 1.55 °C at depth of 4mm and the mean at 13 mm depth was 1.23 °C.

Shapiro- Wilk test was done and showed that data were normally distributed.

Clotting time

Clotting time of control G1 and test group G2 is demonstrated in Table 1, descriptive statistics of Clotting time for control and test groups are shown in Table 2. Independent t-test was made to compare between clotting time for control and test groups as shown in Table 3.

TABLE 1. clotting time of control and test groups

Groups	Clotting time in s											
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
Control	240	210	150	210	180	180	210	210	210	180	240	210
Test	9	10	8	8	7	7	6	9	6	9	9	8

TABLE 2. Descriptive statistics for clotting time of control and test groups

Groups	N	Mean	Min s	Max s	Std Deviation	Std Error Mean
Control	12	202.5	150	240	25.98076	7.50000
Test	12	8	6	10	1.27920	0.36927

TABLE 3. Independent t-test for clotting time between control and test groups

t-test	df	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P	Sig
				Lower	Upper		
25. 902	11.053	195.5000	7.50909	177.98234	211.01766	0.00	HS

Patients' results

For laser assisted coagulation extraction sites, firm clot was formed and covered the extraction area, no bleeding, swelling, abnormal pain during the 24 hours after extraction. No dry socket or swelling was seen in the extraction site patients had no pain or discomfort in days 3 and 10 post extraction.

On day 21 the patients were examined clinically and radiographically, clinical examination showed closer of the wounds and x- ray showed bone formation in the extraction sockets, fig. 1 and fig. 2 showed two cases of teeth extractions from diabetes patients. According to patient questionnaire, all of the patients in this work preferred laser assisted coagulation after tooth extraction rather than conventional methods.

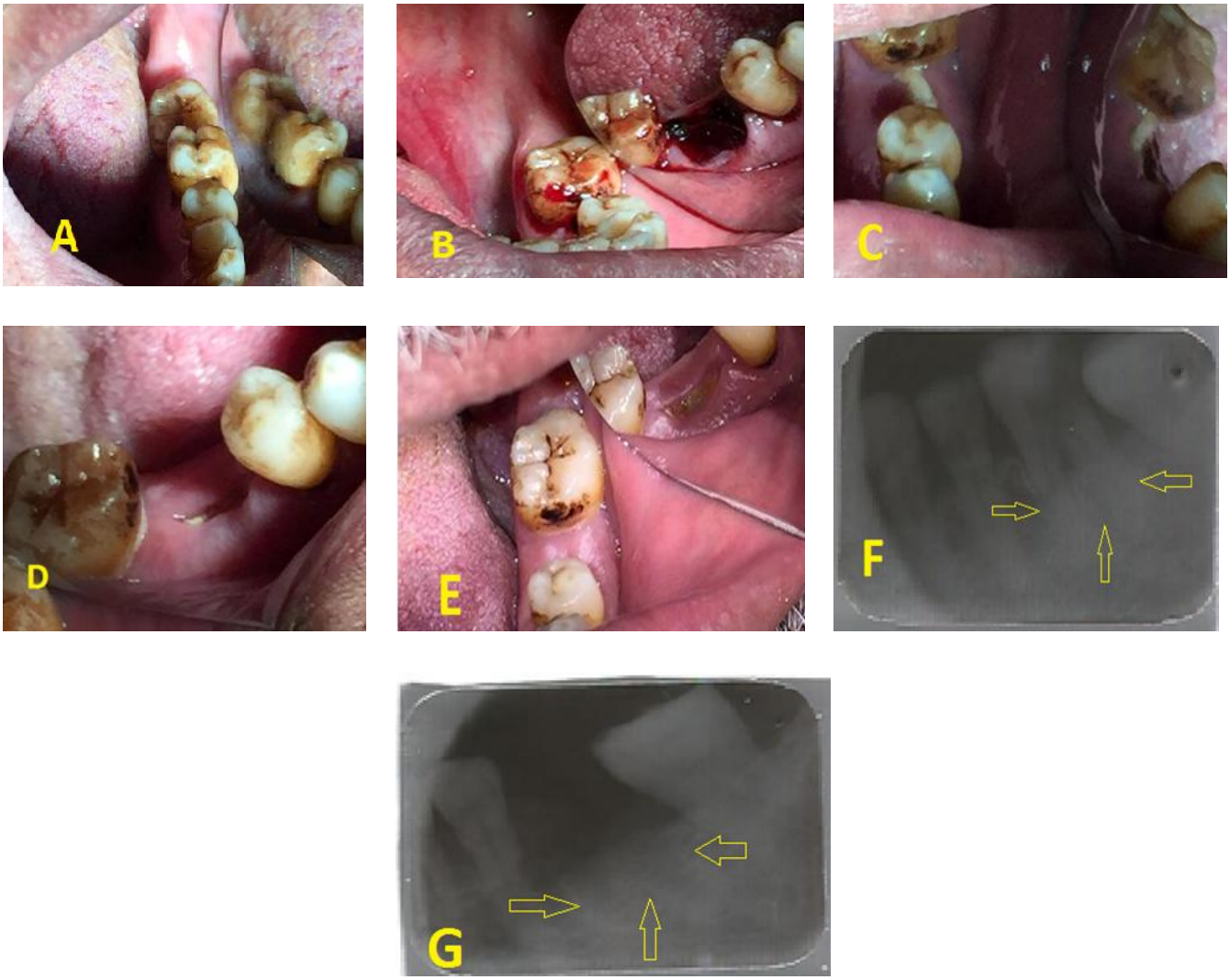

FIGURE 1. laser assisted coagulation after mandibular left 1st molar extraction for a male patient (dental photography mirror was used). (A) Before extraction, (B) After extraction immediately post laser application, (C) 3rd day after extraction, (D) 10th day after extraction, (E) 21st day after extraction, (F) radiographic image of the tooth before extraction, (G) radiographic image of the tooth 21st day after extraction.

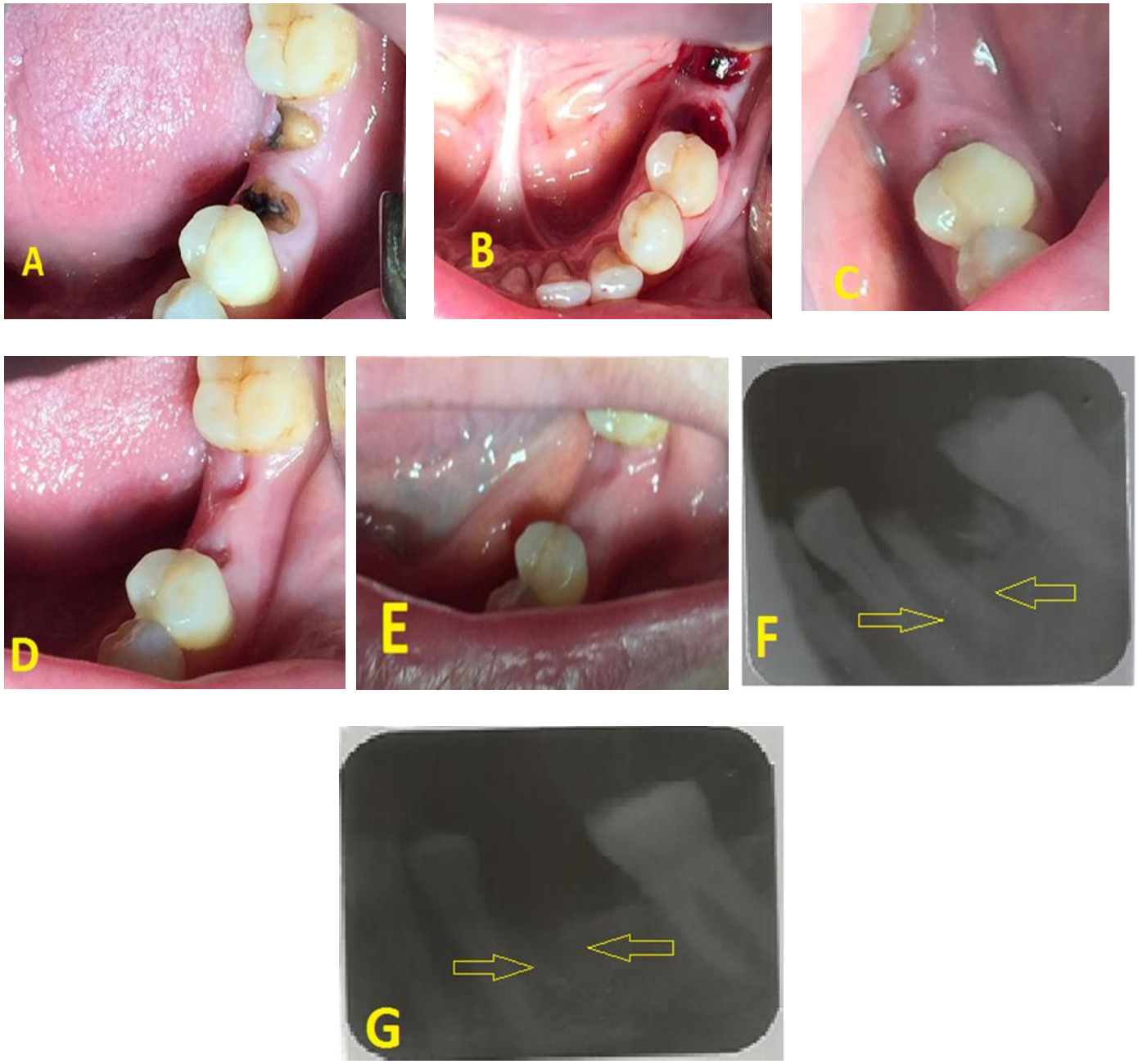

FIGURE 2: laser assisted coagulation after mandibular left 1st molar extraction for a female patient. (A) Before extraction, (B) After extraction immediately post laser application, (C) 3rd day after extraction, (D) 10th day after extraction, (E) 21st day after extraction, (F) radiographic image of the tooth before extraction, (G) radiographic image of the tooth 21st day.

DISCUSSION

Temperature elevation of periodontium by 10°C for one minute causes tissue destruction (Ribeiro *et al*., 2007), in the current work temperature elevation due to laser radiation is much lower than this temperature.

Clot formation is the initial stage of bone healing after tooth extraction (Khulaar and Datta, 2012), Blood clot over the extraction socket which formed after laser radiation was firm and covered the extraction wounds, laser reduced CT of the blood samples, P value in the statistical analysis between CT of control and test groups was 0.00 this means that the difference between CT of control and test group means was highly significant. The mean CT of control group= 202.5 s while for test group= 8 s. Patients were comfortable and satisfied by laser assisted coagulation, no abnormal pain, bleeding or infection, no swelling observed post operatively in the extraction sites.

CONCLUSION

The dose of 103.4 J/cm² of 940 nm diode laser (3W for 10s and 0.29 cm² surface areas) can reduce blood clotting time very significantly, and produced acceptable elevation in socket temperature which was harmless to the periodontium. Laser assisted coagulation after teeth extraction produced relatively no complications in compare to conventional method. Also patients in this study preferred coagulation by

laser rather than conventional extraction. The limitations of using lasers in dental clinics are their higher cost in compare

with conventional method and poor knowledge of the lasers benefits by the patients.

RECOMMENDATION

Future study with larger numbers of patients is needed to get more standard results, and different types of lasers for comparative study.

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Metric system:

Milliliter= ml,
Watt= W
Square centimeter= cm^2,
Millimeter= mm.