ORIGINAL RESEARCH PAPER

VOLUME-6 | ISSUE-7 | JULY-2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A 980 NM DIODE LASER CLOT FORMATION OF THE RABBIT'S DENTAL SOCKETS AFTER TOOTH EXTRACTION

Dental Science

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ABSTRACT

The aim of this research work is to evaluate the use of 980 nm diode laser in clotting the blood in the bone socket after tooth extraction. The objective is to prevent possible clot dislodgement which is a defect that may lead to possible infection.

Material and methods: A number of rabbits were irradiated using 980 nm CW mode diode laser, 0.86W power output for 9s and 15s exposure time. The irradiated groups were studied histopathologically in comparison with a control group.

Results: showed that laser photothermal coagulation was of benefit in minimizing the possibility of the incidence of postoperative complications. The formation of the clot reduces the possibility of bleeding and infection.

KEYWORDS:

980nm wavelength laser, Dry socket, clotting.

Introduction

One of the most common causes of pain after 3-4 days after tooth extraction is dry socket (alveolitis simplex). Symptoms develop 10 to 40 days after tooth extraction. Dry socket may be defined as a postoperative pain surrounding the alveolus that increases in severity for some period from 1 to 3 days after extraction; partial or total clot loss in the interior of the alveolus, with or without halitosis follows that [1, 2]. Unfortunately this condition is difficult to be prevented moreover large number of patients receive unnecessary medication like local and systemic antibiotics[3]

Microscopically, dry socket is characterized by the presence of inflammatory cellular infiltrate, including numerous phagocytes and giant cells in the remaining blood clot, associated with the presence of bacteria and necrosis of the lamina dura [4]. Regional lymphadenopathy may present in the affected side, and fever is infrequent. Dry socket is commonly observed in 40 to 45 years old patients [5, 6,] in an incidence of 1- 4% after teeth extraction, with an incidence for lower teeth 10 times greater than that for upper teeth7 reaching 45% for mandibular third molars [8-12].

Blood clot formation is a fundamental step for the subsequent phases of tissue repair. The fibrin network allows invasion by fibroblasts, endothelial cells and macrophages, which are present in the remaining periodontal ligament. New fibroblasts are usually a characteristic of the granulation tissue. The macrophages are essential for clot remissions this tissue undergoes maturation with the progressive apposition of collagen and production of bone matrix by osteo blasts[13,14].

The application of 980 nm wavelength diode laser was approved to be useful in blood coagulation and biostimulation of bone healing[15,16]. 600 nm to 980 nm diode lasers have energy per photon that is very poorly absorbed by hemoglobin, water, and other body pigments (Figure 1),this type of laser energy relies on multiple pigment effect to produce a general tissue interaction. The depth of penetration of 980 nm diode laser is comparable to but less than Nd:YAG laser. Moreover 980 nm wavelengths penetration depth is much less than 980 nm in tissue[17,18].

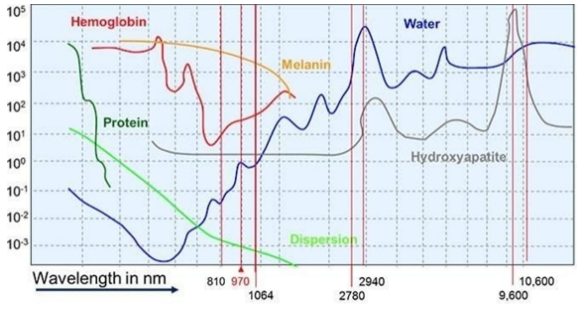

Fig. (1): Absorption and Scattering coefficients of blood relative to wavelength.(http://www.sirolaser.com/)

The present work involves a trial to obtain suitable laser parameters that can provide an immediate blood clot in the dental socket after extraction, without exposing the underneath bone to infection and delayed healing.

Material and Method

Fifteen rabbits 4 months to 6 months of age were used as samples for this experiment. Each rabbit was anaesthetized using an intramuscular injection of (5 mg/kg) Zylazine in combination with (35 mg/kg) Ketamine[19]. The extraction of the lower left central incisor was done for each sample, the rabbits were divided into three groups; a control group; where the coagulation was done by pressing on the wound site with a cotton pellet for 20min. (the conventional method), a second group; the socket was irradiated after tooth extraction for 9s exposure time, and a third group; the socket was irradiated after tooth extraction for 15s exposure time. The bone sockets of the second and third groups were exposed to the diode laser light while in the control group the coagulation was left to be formed. Samples were sacrificed according to the healing process schedule 24hour, 3 days, 10days, 14 day and 21 day after laser irradiation. Laser dose parameters as power density and exposure time were deduced out of a pilot study to coagulate rabbit blood in Dirham tubes.

Spectroscopic analysis for the blood sample of the rabbit was performed before the selection of the suitable wavelength to coagulate the blood in the socket after tooth extraction.

The laser used was a VELAS 60, China manufactured diode laser that emits at 980 nm wavelength. The laser was set to emit 76W/cm2 power density in continuous mode of operation during the experiments. The serial histopathological sections were stained with hematoxylin and eosin using standard procedures, and then examined by light microscope (Olympus).

Results

The rabbit blood spectra indicated a value for the absorbance of 3.6 at 980 nm wavelength Figure 2.

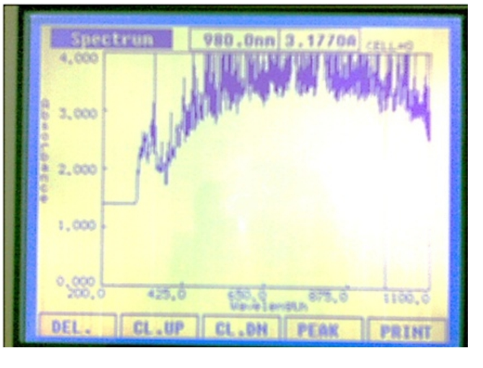

Fig. (2): Absorption spectra of the rabbit's blood for 980 nm wavelength

Immediately after laser irradiation clotting of the blood in the socket was obvious. There was no sign of charring or bleaching at the peripheral border of the socket where the vital tissue present.

Most of the extractions were not straight forward due to the rabbits lower jaw anatomy and the long cylindrical shape lower incisor.

The results of the present study showed comparable (almost relative) histopathological features.

In control group the histopathological lesion on the first day was characterized by sever inflammation. There was an infiltration of inflammatory cells (neutrophils and macrophages) in addition to the blood coagulum which was extended cervically to fill the socket space. The coagulum was composed of densely aggregated red blood cells, platelets extended with presence of scavenger cells Figure 3

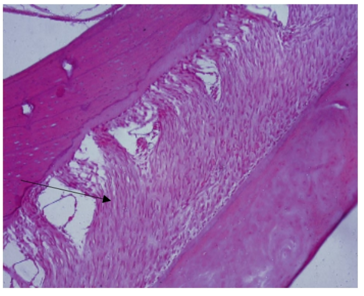

Fig (3): Hisopathological section of the tooth socket for a rabbit (control) first day showing severe hemorrhage(→), (H&E stain X4).

On the third day there was a proliferation of granulation tissue consisting of congested blood capillaries with immature fibroblasts and infiltration of inflammatory cells (Figure 4). While on the 10th day there was infiltration of inflammatory cells at the periphery of the woven bone (Figure 5).

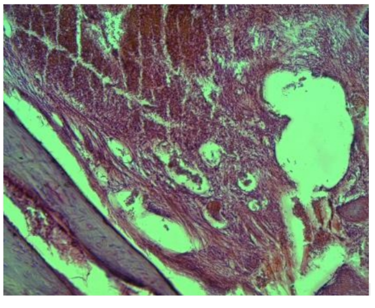

Fig (4): Histopathological section of tooth socket for rabbit (control) 3rd day showing angiogenesis with infiltration of inflammatory cell. (H&E stain X10).

Fig. (5): Histopathological section of the tooth socket for a rabbit (control) 10th day showing infiltration inflammatory cells
(⤷) (H&E stain X4).

Even for day 14th the control group shows infiltration of inflammatory cell myxoid changes, irregular bone alignment with the presence of focal area of hemorrhage in addition to the presence of fibrin network in some sections (Figure 6).

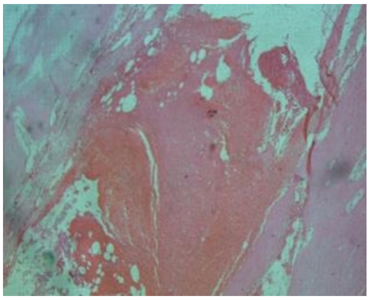

Fig. (6): Histopathological section of the tooth socket for a rabbit (control) 14th day showing irregular bone alignment with infiltration inflammatory cells.(H&E stain X4).

Similarly for day 21st control group the features of inflammation is mild to moderate degree. There are signs of healing; the inflammatory cell infiltration were obvious, the presence of woven bone trying to form regular bone, fibroblast and fiber formation. Angiogenesis is in the normal limit, osteoblast are present at the site of healing with the presence of myxoid changes Figure 7.

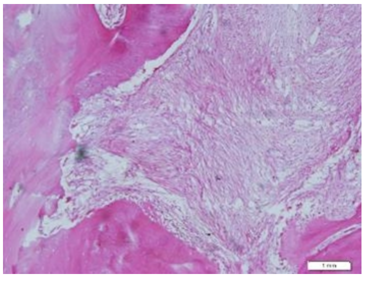

Fig. (7): Histopathological section of the tooth socket for a rabbit (control) 21th day showing irregular bone alignment with infiltration inflammatory cells.(H&E stain X10)

For the **9s exposure time group**, histopathological changes started with inflammation and hemorrhage on the first day Figure 8. The granulation tissue proliferation was seen on third day Figure 9, while the organization of the mature bone appeared at day ten Figure 10.

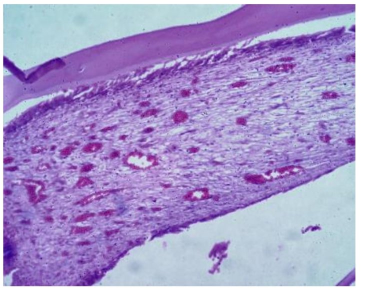

Fig. (8): Histopathological section of the tooth socket for a rabbit (9s exposure time) for 1st day (H&E stain X4)showing angiogesis heamorrahage infltration of inflammatory cell.

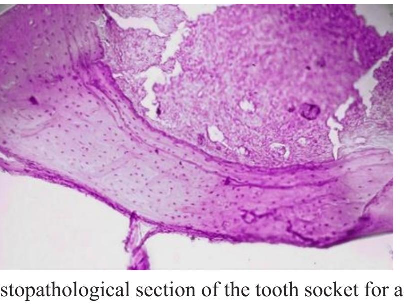

Fig. (9): Histopathological section of the tooth socket for a rabbit (9s exposure time) for 3rd day showing proliferation of granulation tissue (H&E stain X4).

Histology of day14 post-operative revealed inflammatory cell infiltration which is a sign of normal healing, bone alignment is more regular in comparison with the control group, fiber network with fibroblast which is part of secondary healing. More islands of woven bone were obvious in the center of the socket at day 21st, inflammation is less, and the bone is more regular with the presence of myxoid changes Figure (11).

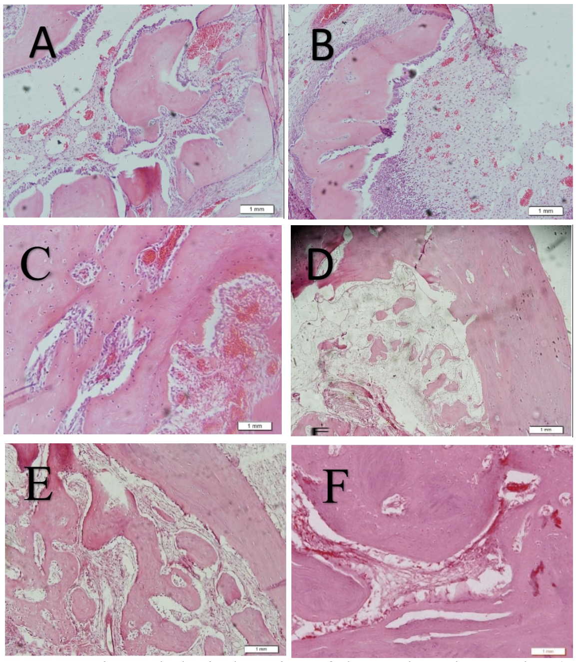

Fig. (11): Histopathological section of the tooth socket 14 day (9s exposure time) post operatively where the infiltration of inflammatory cells and bone shows regular alignment (A. @ 4X, B @10X, C.@ 20X). The tooth socket @day21st postoperatively better healing and bone formation with less fibrin network(D.4X ,E 10X and F 20X) (H&E stain).

The histopathological picture of the 15s exposure time on the first day showed a variety of responses, the inflammation was noticed with granulation tissue (fibrous connective tissue). The organization of hemorrhage site was obvious as indicated in Figure (12C) on the third day, mature bone appeared which was characterized by trabiculae, lacunae in addition to osteocytes; which were evident at the tenth day as shown in Figure 12D.

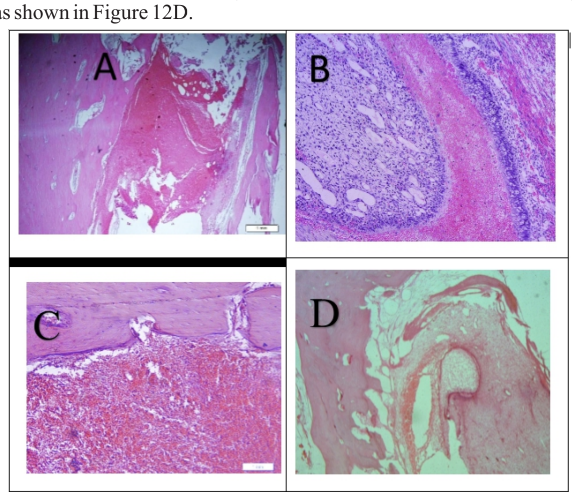

Fig. (12) : Histopathological section of the tooth socket 1st day (15s exposure time) infiltration of inflammatory cells and angiogensis(A. @ 4X, B @10X). The tooth socket at day 3 (15s exposure time) healing evidence with the presence of fibrin network (C.10X). Day 10(15s exposure time) (H&E X400)

For day 14th post operatively for the 15s exposure time shows more advanced features of bone healing less hemorrhage, less inflammation, the bone is covering most of the slide section and the bone alignment is better than that of the 9s exposure time group Figure (13) A , B,C and D. For day 21st, 15s exposure time the bone alignment is more regular with less myxoid changes Figure (13) E, F ,G and H.

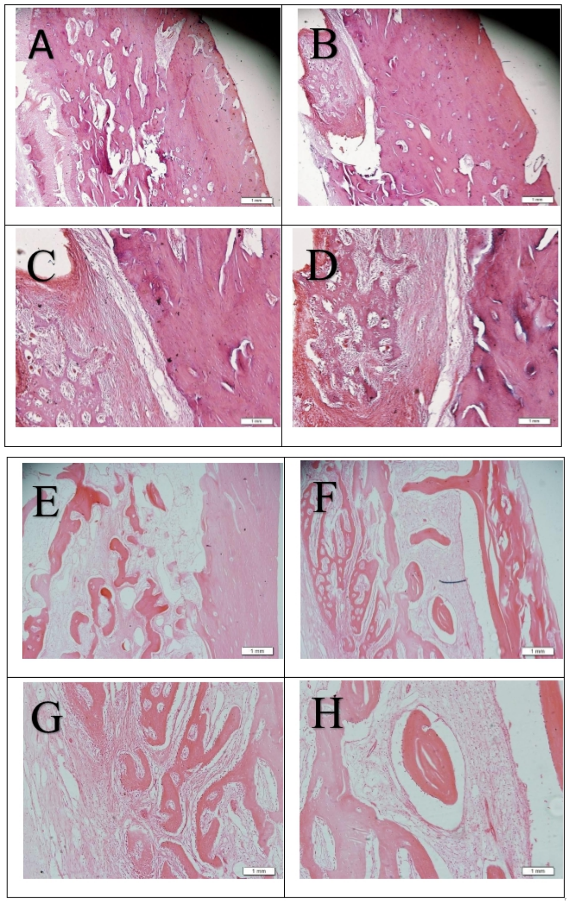

Fig. (13) : Histopathological section of the tooth socket 14 day (15s exposure time) infiltration of inflammatory cells and bone with regular alignment (A. and B. @ 4X magnification, C. and D. @10X magnification). The tooth socket at 21day (15s exposure time) shows better healing and bone formation with less fibrin network (E. and F. 4X magnification @10X1,G and H.) (H&E X400).

The histopathology features at 21st post operatively in control group shows more fibrosis which a sign of bad healing with heavy infiltration of inflammatory cell neutrophil and lymphocyte in comparison with laser irradiated groups. For the laser irradiated group the 15second exposure time shows better angiogenesis, less fibrosis, regular bone alignment less intensity of inflammatory cell and better healing than 9second exposure time.

Discussion

Different regions of the socket wall may experience different responses, depending on the trauma of the extraction .The bone health of the patient and to what degree the blood clot is retained. Independent of what is happening to the socket wall, if normal healing occurs, the fibrin clot will convert into granulation tissue and get organized into a collagen plug during the first month. This collagen plug will increase in density until it is gradually replaced from the apex and periphery by bone deposition.

A localized fibrinolysis results from conversion of plasminogen to plasmin, which dissolves fibrin crosslinks. The transformation of plasminogen to plasmin, where the latter acts as a dissolver of fibrin cross link. This will lead to localized fibrinolysis which is subsequently lead to clot loss within the tooth socket. It is believed to underlie the pathogenesis of alveolar osteitis[20].

Bone resorption was not noticed in the histopathology of the socket in control group and irradiated group. The sequel of the healing process of the bone socket was normal for the control group, 9s and 15s group in accordance to Boyne 1966 [21].

In the case of the 15s exposure time group there was a progress in the organization of granulation tissue and an early appearance of the bone trabiculae in all biological tissue is a complex amalgam of connective tissue and cells. It contains light-absorbing elements known as chromophores, each of which absorbs light in a specific part of the electromagnetic spectrum. Examples of naturally occurring chromo phores include melanin, hemoglobin, carotenoids, proteins, and water .A photon passing through the tissue generates no tissue effects until it is absorbed via rotation, vibration or electronic transition between energy levels by a wavelength specific chromophore. This process results in molecular excitation of the chromophore to a higher energy state. De-excitation of the chromophore releases this energy back into the tissue, causing tissue change through either photochemical or photothermal mechanisms[22]. As light passes into matter, the direction of the incident rays is changed by the molecules present. Scattering plays an important role in the spatial distribution of the absorbed energy; it broadens the incident beam and eventually the deposited energy in the target area gets decreased.

Due to fluctuations in the refractive index of these media, the propagation of light into the tissue is modified and the scattering affects where the absorption will occur, usually reduce the penetration of light into the tissue. Heating decreases with tissue depth, as absorption and scattering attenuate the incident beam. At 940nm-980nm wavelength, scattering coefficient is 0.6-0.64mm-^{1} and absorption coefficient 0.25-0.28mm-^{1} in blood gives out an optical extinction coefficient of 0.82-0.86mm-^{1} [23].

Those numbers prove that clotting was achieved in this research work due to absorption. Scattering was the factor that limits the laser photothermal effect to be conserved on the clot formation only, leaving the normal surrounding bone unaffected but instead its healing may be stimulated by the remaining scattered light from the incident laser

Conclusion

Using 15s exposure time with an output power of 0.86W (76W/cm2) in CW mode of operation stimulate and facilitate bone healing process, in addition to the980nm effect to coagulate the blood to provide dressing to the wound side. The use of laser for clotting blood in dental socket after tooth extraction gives encouraging results in particular is the absent thermal trauma to the underlying bone or any sign of delayed healing.

REFERENCES

1 Blum IR. Contemporary views on dry socket (alveolar osteitis): a clinical appraisal of standardization, aetiopathogenesis and management: a critical review. International journal of oral and maxillofacial surgery. 2002 Jun 1;31(3):309-17.

2 Torres-Lagares D, Serrera-Figallo MA, Romero-Ruiz MM, Infante-Cossío P, García-Calderón M, Gutiérrez-Pérez JL. Update on dry socket: a review of the literature. Medicina Oral, Patologia Oral y Cirugia Bucal. 2004 Dec;10(1):81-5.

3 Bowe DD. The management of dry socket alveolar osteitis. Journal of Irish Dental Association. 2011 Dec 1.(13):32-5

4 Faillo PS. Proteolytic enzyme treatment for the necrotic alveolar socket (dry socket). Oral Surgery, Oral Medicine, Oral Pathology. 1948 Jul 1;1(7):608-13.

5 Rud J. Removal of impacted lower third molars with acute pericoronitis and necrotising gingivitis. British journal of oral surgery. 1969 Jan 1;7(3):153-60.

6 Rood JP, Danford M. Metronidazole in the treatment of "dry socket". International journal of oral surgery. 1981 Oct 1;10(5):345-7.

7 Alling RD, Alling III CC. Mandibular third molars. Part I. Buccal-occlusal approaches. Alling, CC, IIIIII, Helfrick, JF, Alling, RD (Eds.),. In: Impacted Teeth. WB Saunders, Philadelphia. 1993:149-202.

8 Buller DP, Sweet JB. Effect of lavage on the incidence of localized osteitis in mandibular third molar extraction sites. Oral Surgery, Oral Medicine, Oral Pathology. 1977 Jul 1;44(1):14-20.

9 Al-Khateeb TL, El-Marsafi AI, Butler NP. The relationship between the indications for the surgical removal of impacted third molars and the incidence of alveolar osteitis. Journal of oral and maxillofacial surgery. 1991 Feb 1;49(2):141-5.

10 Faillo PS. Proteolytic enzyme treatment for the necrotic alveolar socket (dry socket). Oral Surgery, Oral Medicine, Oral Pathology. 1948 Jul 1;1(7):608-13.

11 Trieger N, Schlagel GD. Preventing dry socket. A simple procedure that works. Journal of the American Dental Association (1939). 1991 Feb;122(2):67.

12 Noroozi AR, Philbert RF. Modern concepts in understanding and management of the "dry socket" syndrome: comprehensive review of the literature. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Jan 31;107(1):30-5.

13 Okamoto T, Okamoto R, Alves RM, Gabrielli MF. Interference of the blood clot on granulation tissue formation after tooth extraction. Histomorphological study in rats. Brazilian dental journal. 1993 Dec;5(2):85-92.

14 Dvivedi S, Tiwari SM, Sharma A. Effect of ibuprofen and diclofenac sodium on experimental would healing. Indian journal of experimental biology.1997 Nov;35(11):1243-5.

15 Gibson KD, Ferris BL, Pepper D. Endovenous laser treatment of varicose veins. Surgical Clinics of North America. 2007 Oct 31;87(5):1253-65.

16 Fornaini C, Rocca JP, Bertrand MF, Merigo E, Nammour S, Vescovi P. Nd: YAG and diode laser in the surgical management of soft tissues related to orthodontic treatment. Photomedicine and laser surgery. 2007 Oct 1;25(5):381-92.

17 Berger NA, Eeg PH. Veterinary laser surgery: a practical guide. Fundementals of laser tissue intraction: John Wiley & Sons; 2008:41 and 112.

18 Hudson DE, Hudson DO, Wininger JM, Richardson BD. Penetration of laser light at 808 and 980 nm in bovine tissue samples. Photomedicine and laser surgery. 2013 Apr 1;31(4):163-8.

19 Plumb Donald, C. "Veterinary Drug Hand book." Blackwell publication; 1993: 804.

20 Birn H. Etiology and pathogenesis of fibrinolytic alveolitis ("dry socket"). International journal of oral surgery. 1973 Jan 1;2(5):211-63.

21 Boyne PJ. Osseous repair of the postextraction alveolus in man. Oral Surgery, Oral Medicine, Oral Pathology. 1966 Jun 1;21(6):805-13.

22 Niemz MH. Laser-tissue interactions: fundamentals and applications. Springer Science & Business Media; 2013 Mar 14.

23 Vuylsteke M, Van Dorpe J, Roelens J, De Bo T, Mordon S. Endovenous laser treatment: a morphological study in an animal model. Phlebology. 2009 Aug;24(4):166-75.