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. Unfortunately this condition is difficult to be prevented moreover large number of patients receive unnecessary medication like local and systemic antibiotics.

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. Regional lymphadenopathy may present in the affected side, and fever is infrequent. Dry socket is commonly observed in 40 to 45 years old patients, in an incidence of 1–4% after teeth extraction, with an incidence for lower teeth 10 times greater than that for upper teeth reaching 45% for mandibular third molars.

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 osteoclasts.

The application of 980 nm wavelength diode laser was approved to be useful in blood coagulation and biostimulation of bone healing. The laser emits at 980 nm wavelength. The laser was set to emit 76W/cm² power density in continuous mode of operation during the experiments. The laser used was a VELAS 60, China manufactured diode laser that emits at 980 nm wavelength. The 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.

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Results

The rabbit blood spectra indicated a value for the absorbance of 3.6 at 980 nm wavelength Figure 2.
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 straightforward due to the rabbit’s 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 severe 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.

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).

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).

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.
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 21, inflammation is less, and the bone is more regular with the presence of myxoid changes Figure (11).

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.

For day 14 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 21, 15s exposure time the bone alignment is more regular with less myxoid changes Figure (13) E, F, G and H.

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 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 dissolved 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 chromophores 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. 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. 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**