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Radiological Effect of Low Level Laser Therapy on Fracture Healing in the Distal Third of Radius in Dogs

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ABSTRACT

The aim of this study was to investigate the radiological effects of low-level laser therapy (LLLT) diode laser on the fracture healing in the distal third of radius in dogs, 18 male adult street dogs were used, and Transverse fracture induced in the distal third of the radius under general anesthesia using the combination of ketamine hydrochloride (15 mg/Kg.B.W) and xylazine (5 mg/Kg.B.W), then fixed by (Gypson), with window to facilitate direct irradiation of the laser therapy. The animals were divided into two equal groups each contain 9 dogs. Control group left without laser irradiation, treated groups which received daily single dose of LLLT (850 nm, for 5 minutes at 72 hours interval for 14th days). The radiological findings were represents early new bone formation in the treated group at end of the 1st wk, compare with the control group. This new bone formation became more dense in the end of the 3rd wk in the treated group with slightly disappear of the fracture line and signs of bridge formation at the fracture sites ,compare with the control group which appear slight new bone formation in the same period. At the end of the 6th wk complete radiological union in the treated group, while in the control group at the same period the fracture line still visible with no radiological union. The conclusion is the LLLT accelerated fracture healing in the distal third of radius in dogs.

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Introduction

Bone fracture is a medical condition in which there is a break in the continuity of the bone and can be resulted from high force impact, stress, or trauma that weaken the bones(1). Fourteen percent of long bone fractures are involved the distal 1/3 of the radius and ulna. This represents the most common site of radial fracture in the dog and it accounted for 85% of the radial fractures(2). These fractures are associated with a higher incidence of delayed or nonunion (3 and 4).

The goal of fracture healing is to regenerate mineralized tissue, and to restore mechanical strength and integrity of the injured bone to normalize the functionality of the repaired tissue(5). Several studies and trials were done for the discovering best methods for treatment or fixation of bone fracture, and a number of biophysical and biochemical results have been investigated in an attempt to minimize the time for bone consolidation and to decrease the chance of possible complications which may be originated from abnormal regeneration process (6). Chemical agents like prostaglandin E2 or PGF2& were used for enhance fracture healing and remodeling phase(7 and 8). Physical stimulation therapies like laser was used to promote and enhance fracture healing (9 and 10). The most common way of fracture treatment of both intramembranous and endochondral ossification with callus development is improved by micro movement which inhibited by firm fixation (11and 12).

LLLT has been used to improve bone healing, and decreasing inflammation in various circumstances, such as by dental extraction, or bone fractures, speeding up soft tissue treatment and exciting the growth of new blood vessels. Also accelerates the treatment of bone injuries and enhances callus

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growth, by speed up bone cells growth and improving osteoblastic action. laser device could enhance callus growth in the initial phase of the procedure of recovery, with doubtful improvement in biomechanical qualities of the treatment bone cells(13-16) .Also, it may activate osseointegration and enhance bone cells ingrowths and functional recovery(17 - 21). Due to the good outcomes on bone cells metabolic rate and on bone fracture consolidation the use of LLLT has been encouraged in clinical practice. (22) revealed a significant enhance in the growth of osteoblasts laser device irradiation. Laser device seems to speed up the procedure of bone fracture fixation and cause an enhance callus volume and bone cells mineral solidity(23). The aim of this study is to investigate the radiological effect of LLLT on the fracture healing in the distal third of radius in adult dogs.

Materials and methods

Eighteen adult male street dogs, aged and weighing 17-20 kg body weight were used. They divided into two equal groups, housed in standard cages with the same condition. The animals were fasted 24 hrs from food and 2 hrs from water prior the operations. Anesthesia was achieved by administrated atropine sulphat,0.04mg/Kg.B.W as а premedication followed by intramuscular injection of a mixture of 15mg/kg B.w ketamine hydrochloride, and 5mg/kg 2% xylazine. Ander aseptic condition, 10 cm length of the skin Incision was done in the distal third at the anterior surface of the radius bone, the subcutaneous tissue dissected. Elevate and retract the extensor tendons laterally as needed for fracture visualization(24), induced transverse fracture by using electrical saw and continues applied locally normal saline to avoid thermal reaction .

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Suturing the subcutaneous tissue using 2/0 chromic catgut and closed skin by interrupted suture pattern using 0 silk, then fixed the fractured bone by (Gypson) with induced window to facilitate direct irradiated dose of laser in the treated group, while the control group left without irradiation.

Penicillin –streptomycin was injected intramuscular for 5 days post operation .The treated group was irradiated a single daily dose of Laser source (Diod laser. Continuous Frequency, Energy density: 148.4 J/cm2, 850nm) for 5 minutes at interval 72^{th} hours for 14^{th} days post operation. The control group left without any treatment. Plain radiographic image was taken at the end of the 1^{st} , 3rd, and 6^{th} wks. Post operation with medolateral view the exposure factors were,Kv=53-58, mAs = 2.2-3, F.F.D = 30-60 inches

The results

• End of the 1st wks P.O. A. Control group: The fracture line was still visible with turbid coloration of the fracture gap, smooth end of the fragments bone, no periosteal reaction (Fig.1.A).B. Treatment group: Good alignments of the two fragments, with smooth ends, the fracture line still visible with turbid coloration in the fracture site, visible new bone formation at the fracture line at the point, of the laser device irradiated (Fig.1.B) red head.

• End of the 3rd wk. P.O. A. Control group: the fracture line visible, with periosteal reaction at the fracture site, callus formation around fracture line. (Fig.2.A).b. Treatment group: the fracture line slightly disappeared with new bone development for bridge formation to union bones fragments (Fig.2.B).

• End of the 6thwk. P.O. A. Control group: fracture line still visible, the callus formation in attempt to bridge and joins the two bone fragments. (Fig.3.A). B. Treatment group: radiological union, complete disappear of fracture line with callus production and bridge formation at the irradiated point of the radius (Fig.3.B).



Fig 1. Radiography of end of 1st wk post operation A. Control groups no periosteal reaction. B.treatment group the red head () new bone formation.



Fig 2.radiography of end 3rdweek post operation A. control group visible fracture line, B.treatment group , bridge formation, slightly disappear of fracture line.



Fig 3. Radiographic of end of 6thweek post operation. A. control group the fracture line still obvious. B.treatment group the fracture line disappears.

Discussion

The LLLT which was used in this study in the dose and duration has been improve the process of fracture healing in the distal third of the radius in dogs, and that was evident by the new bone formation which formed early in the treatment group at the end of the first week and was noticeable radiographically and this is due to the effect of laser device irradiation ,which stimulate the fracture repair, and this statement is agree with (13 and 16), as they mentioned that the LLLT had a several mechanisms which speeds up the therapy of bone injuries and increases callus development, by increasing osteoblastic activity. On other hand these real effect of laser device within week with regardless of the wave length is by clear visual density in the bone fracture sites in initial phase of bone repair due to the bio modulator impact of this laser device therapy(25 - 26).

The newly bone formation which later became more dense within the end of the 3rd and 6th weeks post operation during the healing stages which was demonstrated radiographically, due to the beneficial effect of LLLT on bone cells metabolism and cells activity which enhance callus development in the bone fracture union as reported by (22,23) and that was because of the laser activity to enhance callus development in the early stage of the healing process, with improvement in structural qualities of the healing bone and this agree with the results of (23). The new bone formation which occurs at the fracture line in the end of the 3rd week especially at the treatment group which lead gradually to disappear of the fracture line and shows clear signs of radiological union at the end of the 6th wk in the treatment group may be due to the aggressive mineralization, when compare to the control group at the same period which the fracture line still visible in the end of the 3rd and 6th weeks post operation.

The action of laser during this phase related to its ability of promote proliferation of endothelial cells which leads to the formation of a newly riched vascular net work which is essential for repair process, also stimulate fibroblast cells for collagen synthesis and bone growth(26). Many authors referred that laser stimulate osteoprogenitor, osteoblasts and osteoclasts cells which contributing to bone remodeling. The low dose of the laser which employed in this study leads to some best results and that was evident from the radiological signs especially at the end of the first week by the newly bone formation and that agree with(27), Who indicated that the low amount of LLLT tends to work better than the same wave length delivered at high levels. LLLT is a biophysical way of intervention in the fracture repair procedure, which, through several mechanisms, accelerates the treatment of bone injuries and enhances callus growth.

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The impact of laser device on bone fracture treatment is controversial. Some writers affirm that LLLT can speed up bone cells growth by improving osteoblastic action, laser device could enhance callus growth in the initial phase of the procedure of recovery, with doubtful improvement in biomechanical qualities of the treatment bone cells(16)

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