



Histologic evaluation of bone healing following low-energy laser irradiation (experimental study)

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Abstract

The application of laser is widely used in many branches of medicine and surgery. The high energy laser has coagulating, cauterizing and destructive effect, while the low energy laser has a bio- stimulating effect.

A hole was made using a surgical bur in zygomatic bone of four rabbits and a low energy laser was applied on zygomatic bone of experimental group and compared to control non- irradiated group.

This study showed that application of low-energy laser has a promoting effect and facilitate bone deposition in the bony defect of the experimental group when compared to control group.

It may be concluded that application of low-energy laser have promoting effect on acceleration of bone healing.

Key words: Low-energy laser, bone healing, experimental

Introduction

Application of lasers have gained increasing interest in the past few decades especially in the field of medicine and biology ,its applications ranges from mere surgical applications to the controversial photodynamic applications.

High energy lasers are useful in cutting biological materials and bone and in producing coagulation necrosis in the target tissue with subsequent reaction on surrounding tissue^{1,2,3}.

Therapeutic success of low-energy laser therapy (LLLT) in the treatment of wounds was first reported by Mester⁴. Photo biological effect of low-energy lasers have been studied by several authors^{5,6,7,8,9}.

The aim of the present study is to evaluate the effect of low –energy laser on zygomatic bone healing in rabbit

Materials and methods

Four adult male rabbits ,age eight months, average body weight 1.25 kg ,were used in this study They were fed a pelleted commercial diet.

Under general anesthesia by giving an intramuscular injection of Ketamine, 2ml. of 100 mg Ketamine base and an intramuscular injection of barbiturate base containing 100 mg barbiturate. The surgical field was prepared for operation and shaved carefully then sterilized by spirit and hibitane.

Aim of the study

An incision was made extending from the outer canthus of the eye to the preauricular area for exposure of zygomatic bone¹⁰. The incisions are bilateral, right and left sides. The zygomatic bones were exposed and by using a round surgical bur number zero a perforated hole was made in each zygoma. The right perforated zygoma was irradiated by low-energy laser (Ga-As) for five minutes then suture the flap, this side regarded as experimental side, while the left zygoma not irradiated by laser and suture the flap immediately after perforation of the bone, this side regarded as control side.

The animals were given long acting Benzathin Penicillin (400 000 IU) intramuscular injection as a single dose immediately after suturing the flap.

The laser equipment used in this study was Optodent unit, the laser energy was low-energy infra-red (Ga-As) laser, wave length 904 nm, using continuous beam of radiation, average power 5 mW, focal spot of 5.1 mm, and energy density 7 J/cm². The animals were sacrificed at zero, seven and fourteen days after surgery.

Results

The animals were inspected and examined regularly and found to be in a normal appearance, weight and activity.

First day:

Grossly at the time of surgery there were no differences between control side and experimental side, the drilled hole was filled by blood.

Seven days:

Light microscopic study of the zygomatic bone revealed that the bone cavity in the control side was filled by newly formed granulation tissue together with small, newly formed osteoid bone (fig.1, 2).

In the experimental side the bone formation was more evident and the granulation tissue was more fibrous in comparison to the cellular one in control side (fig.3, 4).

Fourteen days:

The control side showed bone trabeculae and fibrous connective tissue formation (fig.5,6), while in the experimental side the bone trabeculae was more abundant and thicker than in control side and completely filled the bony defect (fig.7,8).

Discussion

Several studies have shown that low energy laser irradiation improved soft tissue healing; it stimulates DNA-RNA-protein system and raises mitotic activity of cell. This occurs through modification of cellular homeostasis of the mitochondria promoting a cascade of events in the respiratory chain of some mediators that permit absorption of light leading to increase in mitochondrial content of ATP, and changes in ultra structure of organelles, these changes in mitochondria promote cell division^{3, 7, 9, 11, 12, 13, 14}.

It has been reported that infra-red laser irradiation stimulate the formation of collagen from fibroblast cells of the oral mucosa thus facilitating the healing process¹⁵, therefore, in the first and second phases of tissue repair, laser treatment may be more effective¹⁶, and also facilitate bone deposition in the tooth extraction socket in experimental animals (Takeda 1988), reduces incidence of dry socket¹⁷, and accelerate tooth movement accompanied with alveolar bone remodeling¹⁸.

The result of this study have clearly shown that low –energy laser has an influence on the bone deposition in healing process when compared to

control group ,this come in agreement with other studies on tibia bone¹⁹, and alveolar bone healing after tooth extraction^{12,17}.

Conclusion

It may be concluded that application of low-energy laser have promoting effect on acceleration of bone healing.

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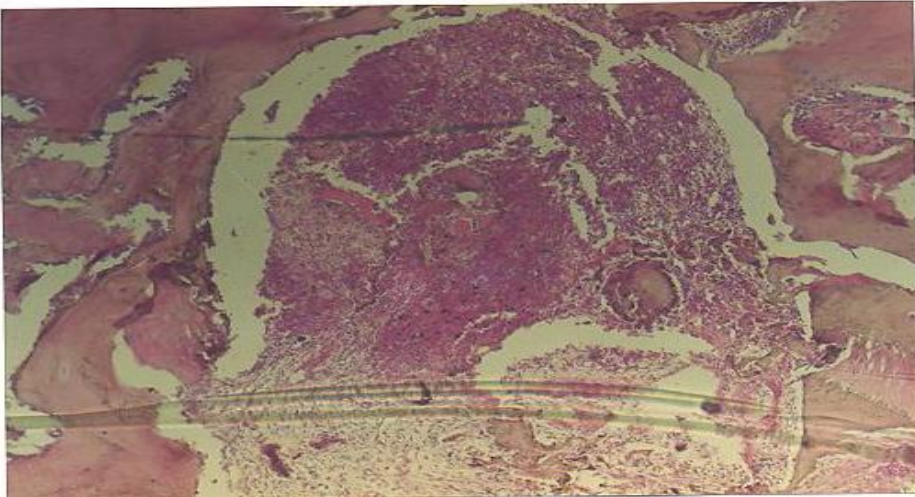


Fig. 1: Control group, 7 days after surgical operation 13.2X. Histology of rabbit zygomatic bone shows newly formed granulation tissue and newly formed bone.

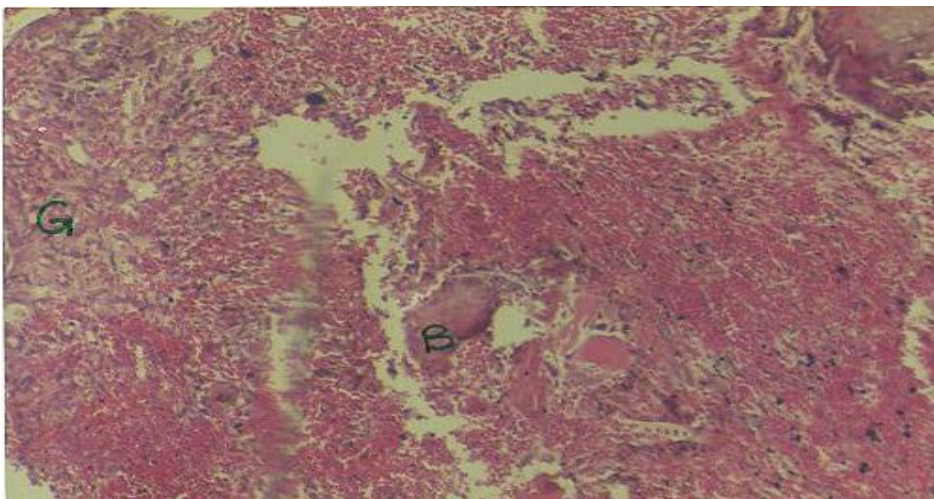


Fig.2: Control group, 7 days after surgical operation 33X. The bone is highly cellular granulation tissue (G) and newly formed osteoid bone (B).

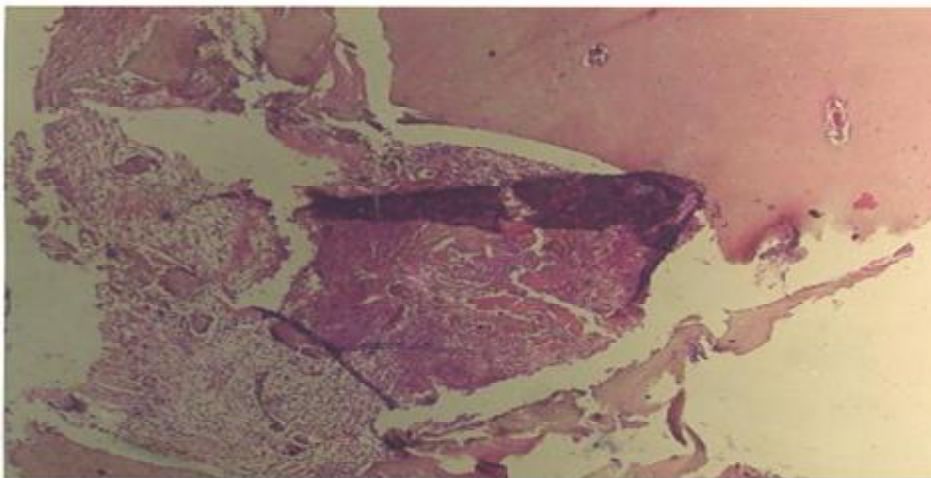


Fig.3: Laser irradiated group, 7 days after surgical operation 13.2X. The bone formation is more evident and the granulation tissue contains more fibers and less cells.

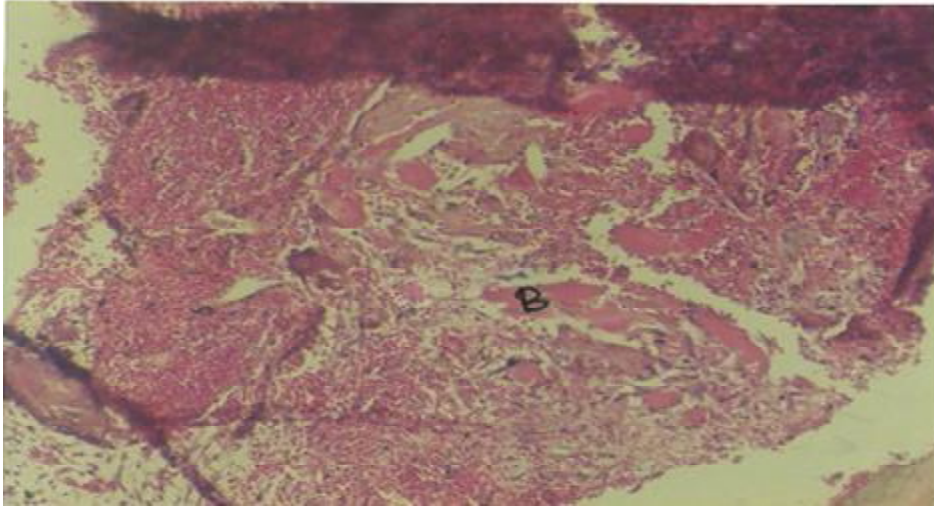


Fig.4: Laser irradiated group, 7 days after surgical operation 33X. The bone formation is quite evident (B) and the granulation tissue is more fibrous and less cellular.

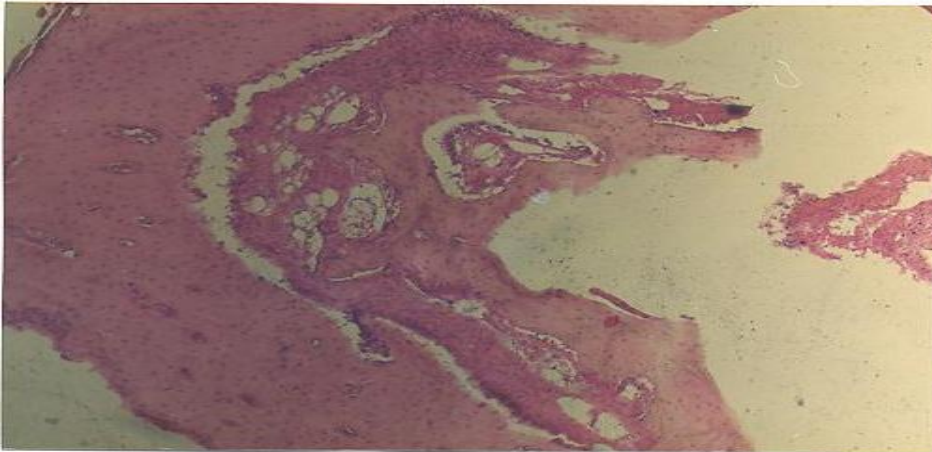


Fig.5: Control group, 14 days after surgical operation 13.2X. The slide shows bone trabeculae and fibrous connective tissue formation.

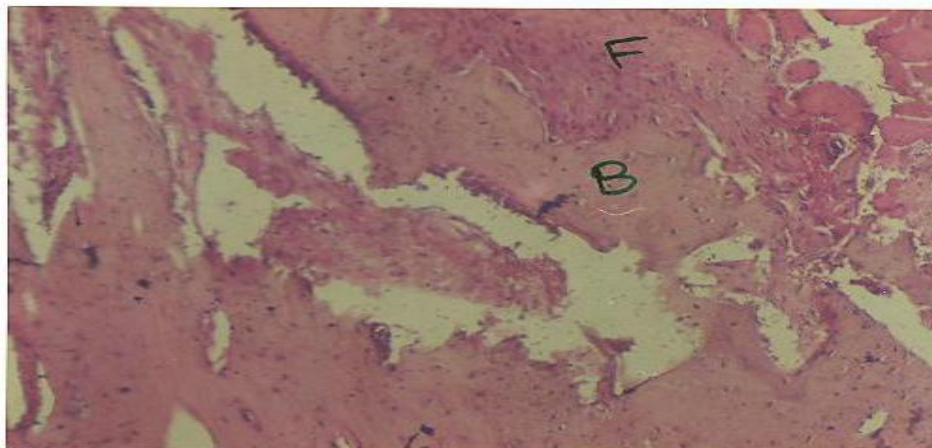


Fig.6: Control group, 14 days after surgical operation 33X. The bone trabeculae (B) and fibrous connective tissue (F).

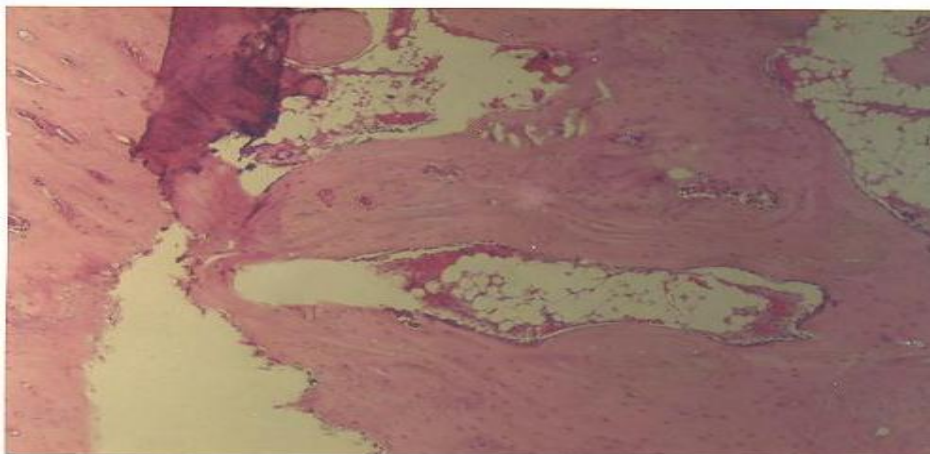


Fig.7: Laser irradiated group, 14 days after surgical operation13.2.X.
Photomicrograph shows abundant and thick bone trabeculae.

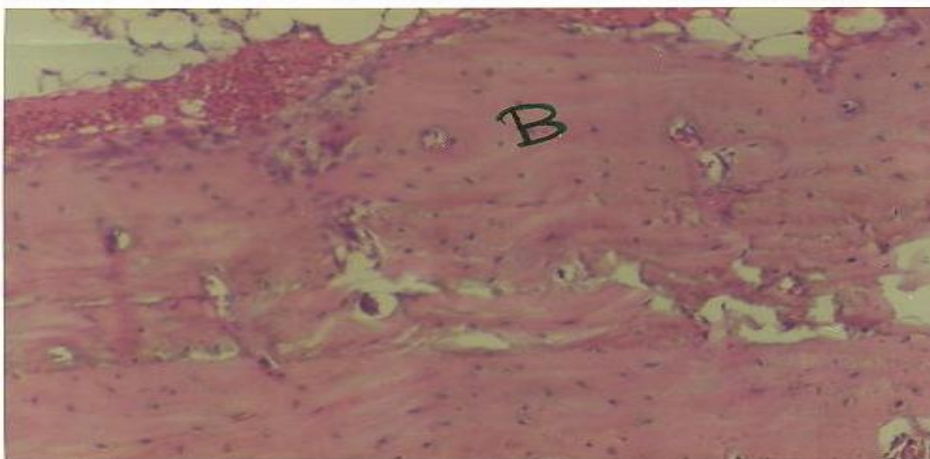


Fig.8: Laser irradiated group, 14 days after surgical operation132.X. Bone trabeculae formation (B).