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Evaluating Low Level Laser Therapy for Fracture Healing in Dogs

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Abtract

Twelve dogs having long bone fracture were randomly divided into two groups. Fractures of both groups were immobilized by intramedullary pinning. Group I was the treatment group with immobilization along with low level laser irradiation therapy. Group II acted as control. A lesser degree of inflammation, exudation and pain was observed in group that undergone low level laser therapy. None of the animals of both groups was able to bear weight on their fractured limb on two post-operative day. Weight bearing progressively increased in both group but it was more in group I. Radiographic evaluation revealed initiation of periosteal reaction as early as 7[th] post-operative day, marked callus was recorded on 21[st] post-operative day and commencement of remodeling from 42[nd] post-operative day in laser treated group.

Keywords: Fracture; intramedullary pinning; laser therapy; weight bearing

Introduction

Bone healing is a complex physiological process and involves numerous mechanisms at tissue and cellular level. This phenomenon differs from that of soft tissue because of its morphology and composition. Healing of bone is a slow process as a result of which there is chance of failure of implant if due attention is not provided. Whenever, an implant is used the surgeon is often worried about the implant migration, since the animals cannot be kept confined at a place for longer duration of time and avoids its running and jumping. Orthopedician often implies various methods so as to limit the incidence of implant failure, in this regard they often think of mechanisms that can increase the bone-implant-contact often referred as BIC. A thorough review of literature reveals that the low level laser therapy increases the bone–implant-contact (Pereira *et al.,* 2009). Literature suggests that low level laser therapy have photochemical rather than thermal effect because low irradiation level used which does not cause appreciable temperature rise (Kitchen and Partridge, 1991). The photochemical theory which is not yet universally accepted, postulates that absorbed light interacts with chromatophores (organic molecules) which in turn modulate cellular activities (Beckerman *et al.*, 1992). The effect of low level laser therapy on bone healing is still an untouched field. Various bio-stimulatory effects have been reported in wound healing and collagen synthesis *in vivo* and *in vitro*. Low level laser therapy is assumed to cause alleviation of pain proliferation of angioblast and fibroblast and increase healing rate. Moreover, it is often reported that low level laser therapy acts as catalyst for transformation of non-differentiated mesenchymal cells into osteoblast which further changes rapidly to osteocytes (Pinheiro *et al.*, 1997).

Materials and Methods

Twelve dogs brought for treatment of fracture of long bones were selected for present study. The animals were randomly divided into two groups having six animals each. Fractures of both the group were immobilized by intramedullary pin. Group I was the treatment group and in this immobilization along with irradiation of low level laser therapy of 10 H_z (Hertz) for 10 minutes divided into two durations of 5 minutes each with rest for five minutes in between was given. Group II acted as control and in this group only immobilization was performed. In both the groups, antibiotic Amoxicillin-Clavulanic acid at 15 mg/kg b. wt. I/M (Intramuscular) was given for 5 post-operative days and Meloxicam (Melonex[a]) at 0 .4 mg/kg b. wt. I/M were administered for next two days. Fracture healing was evaluated on the basis of inflammation, exudation, pain at fracture site, weight bearing, implant failure and radiographic findings at different time intervals.

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Table 1: Inflammation, exudation and weight bearing at different time intervals

Days	Inflammation		Exudation		Pain		Weight bearing	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
2nd	+++	+++	+++	+++	+++	+++	-	-
4th	+ to ++	+++	+ to ++	+++	++	+++	to + -	-
6th	- to +	++	-to +	+	- to +	++ to +++	++	- to +
8th	-	+	-	- to +	-	+	+++	+

Nil (-), mild (+), Moderate (++), Marked (+++)

Table 2: Radiographic evaluation at different time intervals

Day	Group I	Group II
0	-	-
7	-	-
14	++	-
21	+++	+
42	+++	++
84	-	++

Nil (-), mild (+), Moderate (++), Marked (+++)

Results and Discussion

Inflammation, Exudation and Pain

Inflammation, exudation and pain at the fracture site are shown in Table I. On 2nd post-operative day marked inflammation was observed in all animals in both groups. The degree of inflammation decreased progressively in both groups and on 4th post-operative day, it was mild to moderate in group I but marked in group II. 6th day data revealed nil to mild inflammation in group I and moderate inflammation in group II. Findings of 8th day revealed absence of inflammation in group I, however, it was still present in mild degree in group II.

Exudation at fracture site at different time interval is depicted in Table 1. The data of 2nd post-operative day indicated marked exudation in both the groups, however it became mild to moderate on 4th post-operative day in group I, but it was still marked in group II at this interval. Nil to mild exudation was observed in group I on 6th post-operative day, whereas in group II it was of mild degree. An absence of exudation was observed in group I on 8th post-operative day, whereas in group II it was still present in some dogs.

Evaluation of pain at the fracture site was too undertaken on 2nd, 4th, 6th and 8th post-operative day. Marked pain at fracture site was recorded in all animals irrespective of group on 2nd post-operative day, thereafter a decreasing trend in pain was observed. 4th day observation revealed moderate pain in animals of group I and marked pain in animals of group II. The animals of group I manifested nil to mild pain on 6th post-operative day, whereas it was moderate to marked in group I. There was no pain in any of the animal in group I on 8th post-operative day, however mild pain at the fracture site was observed in dogs of group II at this interval. These findings were similar to the findings of Mester *et al.* (1971) who studied the effect of laser on wound healing and found that it reduces pain, Young *et al.* (1989) who studied the macrophage responsiveness to light therapy and found that low level laser therapy reduces the inflammation 20-30 percent, Honmura *et al.* (1992) who studied the therapeutic effect of laser irradiation on experimentally induced inflammation in rats and concluded that it reduces inflammation and pain, Lizarelli *et al.* (1999) who studied the effect of low level laser therapy on healing of dental alveolus in rats and reported that low level laser therapy modulate inflammation at irradiation site, Turner and Hode (1999) who studied the effect of low level laser therapy and concluded that it reduces pain and Nazrul *et al.* (2011) who studied the effect of laser healing in human and reported that laser therapy showed better stable fracture and earlier alleviation of pain and inflammation.

Weight bearing

Weight bearing by animals at different time intervals is shown in Table 1. None of the animal of both group was able to bear weight on their fractured limb on 2nd post-operative day. Weight bearing progressively increased from mild on 4th to moderate on 6th and marked on 8th post-operative day in laser treated group. This might be due to alleviation of pain due to laser treatment. Contrary to this complete weight bearing was not observed till 8th day in any case in

Fig.1: Post-operative laser therapy of fracture site in animals of group-I

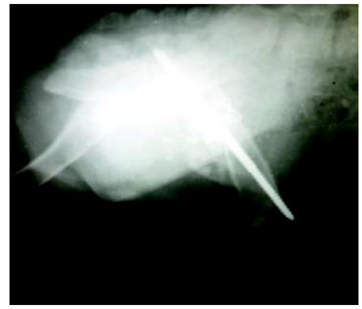

Fig. 2: 7th Post-operative day radiograph revealing periosteal reaction at fracture site in case I (group-I)

Fig. 3: 14th Post-operative day radiograph revealing moderate callus at fracture site in case I (group-I)

Fig. 4: 21st Post-operative day radiograph revealing marked callus at fracture site in case I (group-I)

Fig. 5: 84th Post-operative day radiograph revealing remodeled bone with patent bone marrow in case I (group-I)

Fig. 6: 21st Post-operative day radiograph revealing marked callus at fracture site in case II (group-I)

Fig. 7: 42nd Post-operative day radiograph revealing progression of remodeling phase in case I (group-I)

Fig. 8: Radiograph of 14th post- operative day with initiation of periosteal reaction at fracture site (group-II)

Fig. 9: Radiograph of 42nd post-operative day revealing marked callus at fracture site (group-II)

group II. Partial weight bearing from 7th to 10th day was too reported by Dubey *et al.* (1992), Raghunath and Singh (2003), Ganesh *et al.* (2004), Yuvraj *et al.* (2007), Gupta *et al.* (2008) and Singh (2015) in dogs treated with internal immobilization techniques.

Implant Failure

None of the animals in group I treated with laser therapy had any incidence of implant failure till the end of observation period, contrary to this in the group where no laser therapy was given an incidence of implant failure was observed in one of the case on 15th post-operative day. These findings were similar to Khadra *et al.* (2005) who studied the effect of low level laser therapy on bone implant interaction and concluded that low level laser therapy enhances the functional attachment of implant to bone and promotes bone healing and mineralization, Pereira *et al.* (2009) who observed that the low level laser therapy increases the bone-implant-contact and Petri *et al.* (2010) who investigated the effect of low level laser therapy on human osteoblastic cells grown on titanium and concluded that low level laser therapy might have possible benefit on implant osteo-integration despite a transient effect immediately after laser irradiation. Karaca *et al.* (2018) stated that low level laser therapy enhance bone healing around immediately loaded implant and increase implant stability.

Radiographic Evaluation

Radiographic evaluation of both the group is shown in Table 2. The radiographic evaluation of fracture site of animals treated with laser on 7th post-operative day revealed initiation of periosteal reaction in both the fracture segment in animals of group I (Fig. 2), contrary to this in none of the case of group II revealed any evidence of periosteal reaction on this day. On 14th post-operative day moderate callus formation was seen in group I (Fig. 3) however in group II none of the radiograph revealed any proof of callus formation. Though an initiation of periosteal reaction in the fractured segment was observed at far end of a segment in some of the cases. The callus became marked in animals treated with low level laser therapy on 21st post-operative day (Fig. 4), whereas; it was of mild degree in animals without having laser therapy. 42nd day radiograph revealed progression of re-absorption of excessive callus in some of the cases in group I (Fig. 7), which might be due to commencement of remodeling stage on this day. Radiographs of animals of group II at this interval showed marked callus at the fracture site. Finding on 84th day in group I revealed remodeled bone with patent bone marrow (Fig. 5), however in group II it was still marked.

These findings can be explained by findings of Pinheiro and Frame (1992), Luger *et al.* (1998) and Kucerova *et al.* (2000) who observed dense callus at the operative site and attributed it to the effect of laser on the undifferentiated mesenchymal cells. They opined that these undifferentiated mesenchymal cells might have been biomodulated positively to osteoblast that changes rapidly to osteocytes. Weber *et al.* (2006) also used low level laser therapy in conjunction with autogenous bone graft and barrier membrane for treatment of intra bony defects and found that quantity and quality of bone remodeling was more evident in irradiated animals than non-irradiated animals. A hastened remodeling was too observed by Ebrahimi *et al.* (2012).

Conclusions

From the above study, it can be concluded that low level laser therapy alleviates pain, inflammation and exudation at the fracture site. It favors early and extensive callus formation, increases bone implant contact and reduces the chance of implant failure. Use of this modality, the bone remodeling is too hastened and bone often regains its normal contour to some extent. This modality is economical since there are no recurring expenses on other medicinal therapy.

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