RESEARCH ARTICLE

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Evaluation of the Effects of Laser Phototherapy on the Tretament of Skin Wounds with Tissue-Loss in Cats and Dogs

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Abstract
The treatment of skin wounds with tissue-loss is one of the most important issues in the field of veterinary medicine. Many studies have been conducted aiming to facilitate faster wound healing without contamination of the wound site with a significant loss tissue area. In this study, laser phototherapy was evaluated by means of its effect on wound healing. This study was carried out on 20 cats and 20 dogs of different ages, races, and genders, which were brought to the surgery clinic of Animal Hospital at Kirikkale University. These patients were divided into 4 groups, two of which were include in the study groups and two of which were included in the control group. In the study group, 10 cats and 10 dogs were subjected to laser phototherapy, and the rest, control animals, received routine treatment. The subjects were followed by laboratory work and clinical observation, and the results on treated animals with laser phototherapy were compared to those of the routine treatment protocol. During the study, the physiological parameters, wound size, and wound healing characteristics were recorded. The treatment was applied under general anesthesia or sedation. The wound sites were examined daily. For 21 days, wound sizes were drawn on transparency film and then the then wound area were measured. Based on measured area and clinical observation, infection control as well as wound closure rates were faster in the study groups compared to those of the control groups ($P<0.05$). In conclusion, the low-intensity laser phototherapy is useful and a valuable treatment option in skin wound treatment, especially those with infection and tissue-loss in cats and dogs. The laser phototherapy can also be considered as an adjunct to routine treatment modalities.

Keywords: Cat, Dog, Laser, Phototherapy, Wound healing.

INTRODUCTION

Wound is a common name given to lesions characterized by disruption of normal continuity of body structures. Injury may occur in the skin damaging the superficial as well as underlying structures. In addition to systemic treatments, local wound care also alleviates wound related unfavorable conditions and promotes wound healing (Arun et al. 2009).

Tissue healing is a complex process involving local and systemic entities. Laser treatment has been shown to be effective in wound healing by modulating both local and systemic responses (Karu, 1999). In the human body, there are more than 75 trillion cells each of which needs electrons to communicate with each other. The laser light emits these necessary electrons directly to the cells and improves their ability to produce ATP and, thus, energy. In addition, low-level laser therapy induces the release enzymes necessary for healing with an optimal functionality (Markolf, 2003; Baxter et al. 2004).

Laser applications have been used in the field of Veterinary Medicine over the recent years for different purposes. In addition to laser surgery, treatment of diseases such as myositis and atrophy as well as skin wounds with tissue loss are some examples of the conditions in which low-intensity laser phototherapy has been used (Basford, 1989;, Arun et al. 2009). However, Veterinary practitioners still question whether laser therapy is feasible by means of cost vs effectiveness as well as indications. Thus, further data are needed to evaluate the effect of laser therapy. Thus, the aim of this study was to investigate the effect of laser treatment on wound healing in cats and dogs.

MATERIALS AND METHODS

This study was conducted upon approval by the Kirikkale University Local Ethics Committee for Animal Experiments with a decision number of 2016/05. In this study, 20 cats and 20 dogs with complaints of skin injury characterized by tissue loss submitted to the surgical clinic composed the animal material of the study.

The animals in the study (10 cats and 10 dogs) received laser phototherapy while the animals in the control group (10 cats and 10 dogs) received routine treatment protocol.

For laser phototherapy application, the device namely Intelectvet® Chattanooga (USA) and its accessories (1 diode, 1x100mW/1cm^2 and 13 diode cluster, 3x850nm 200mW/3cm^2 laser, 7x670nm 10mW LED, 3x950nm 15mW LED) were used (Figure 1). Acetate papers and millimetric paper were used for measuring wound sizes.

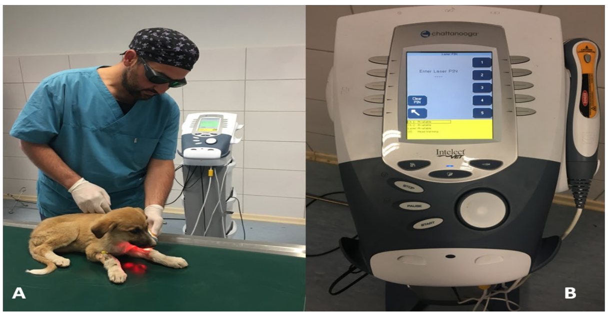

Figure 1. A: Application of laser phototerapy, B: Laser phototerapy device.

During the study, a patient follow-up form was used to record data on physiological and blood parameters of the animals, wound sizes, and clinical observation. Upon obtaining the informed consent from the animal owner, routine sedation or anesthesia protocol was applied to the animals with aggressive behavior. The wound sizes were drawn on an acetate paper daily. Then, the drawn area in the paper was measured using a millimetric paper (Figures 2, 3).

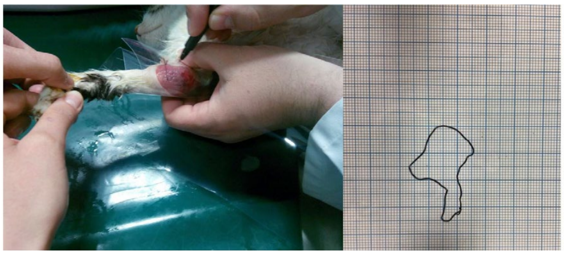

Figure 2. Wound area calculation in a cat.

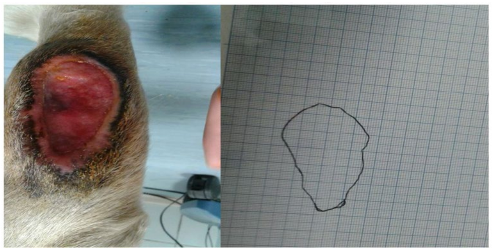

Figure 3. Wound area calculation in a dog.

The laser dose was adjusted from 4 to 20 J / cm^2 based on the wound area calculated and the wound condition. In infected wound with tissue loss, laser treatment began at a dose of 20 J / cm^2. After granulation tissue formation at the wound sites as well as observation of possible bleeding or tendency to bleed after irradiation, the laser dose was gradually reduced. The laser dose at the beginning of the study, 20 J / cm^2, was reduced to 15 J / cm^2 in case of the disappearance of infection symptoms. The dose was then reduced to 10 J / cm^2 in case of healing and progression of granulation tissue. When irritation and petechial bleeding symptoms were observed, the laser application continued at a dose of 4 J / cm^2.

Statistical Analysis

In statistical evaluation, the data obtained on the 1st, 4th, 7th, 10th, 14th and 21st days obtained cats and dogs of the study and control groups. Data were not normally distributed. Differences between cats of control and study groups and between dogs of the study and control groups were determined using a nonparametric test, Kruskal-Wallis. Statistical significance were evaluated by the Mann-Whitney test. The Pearson Correlation analysis was performed to determine the relationship between wound size and wound closure rate. For evaluation of wound closure rates, a p value of ≤ 0.01 was accepted as level of significance. Independent variables t-test was used to determine the relationship between infection and wound closure. SPSS 21.0 statistical package program was used for statistical evaluations. A p value of <0.05 was accepted as level of significance.

RESULTS

Wound closure rates were faster in the laser group than the control group not only in dogs but also in cats (P <0.01) In each group, the wound closure time and additional suturing, if presence, were recorded. The wound closure time was recorded based on the formation of the crust and the wound size became down to less than 1cm^2 (Figures 4,5). In wounds with a high tissue loss, if the wound size decreased below 50% and the signs of infection disappeared with the presence of granulation tissue formations, these wound sites were sutured. Surgical suture was applied to the wound in 3 cats and 2 dogs in the study group.

Although statistically insignificant, infection-related blood parameters were decreased during the study (p>0.05) The wound closure rate was statistically significantly better in both cats and dogs of the study group compared to the

Table 1. Wound closure rates in % (Mean ± SD).

Group	1st day	4th day	7th day	10th day	14th day	21st day	P value
Laser dog	0	10.05±4.26*	8.46±2.57*	5.32±3.79*	2.97±1.52	0	0.01
Control dog	0	1.24±0.89	0.87±0.1	1.05±0.6	0.64±0.3	4.16±2.11	
Laser cat	0	18.87±11.83*	11,4±8,08*	3,54±1,49*	1,36±0,09	4,16±2,11	0.01
Control cat	0	4.24±3.21	1.8±0.8	4.41±2.15	2.45±1.35	7.51±4.23	

Data are expressed as mean ± SD (n= 10).

*Indicates significant differences. When compared to the differences between the study groups and the control groups.

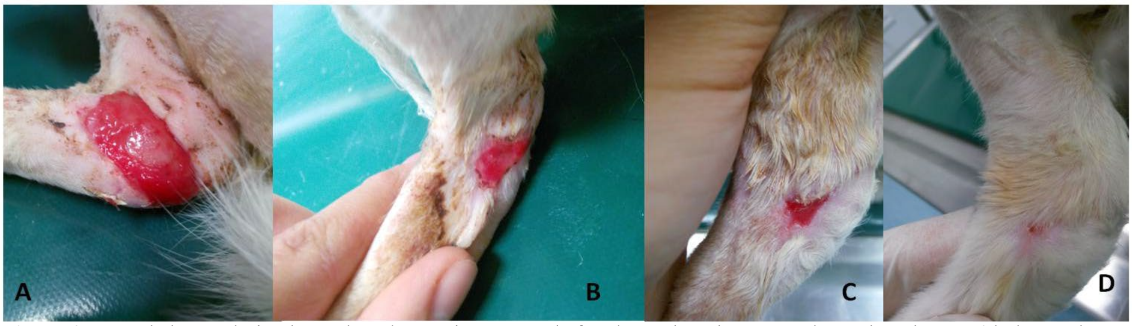

Figure 4. Wound closure during laser phototherapy in a cat. A: before laser phototherapy, B: laser phototherapy 4th day, C: laser phototherapy 7th day, D: laser phototherapy 10th day.

Figure 5. Wound closure during laser phototherapy in a dog. A: Before laser phototherapy, (more than 10 days made rivanol wet compress), B: laser phototherapy 4th day, C: laser phototherapy 10th day.

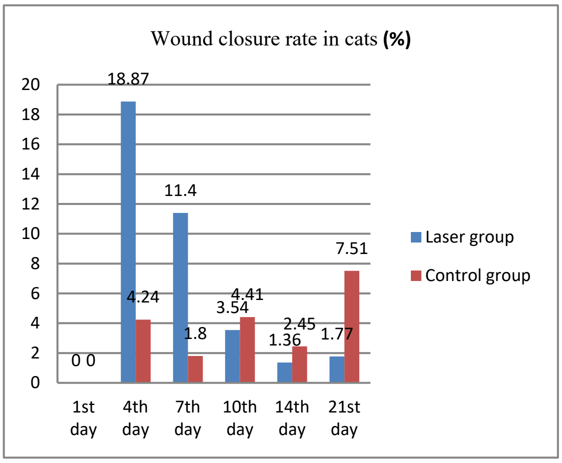

Figure 6. Comparison of wound closure rates in cats.

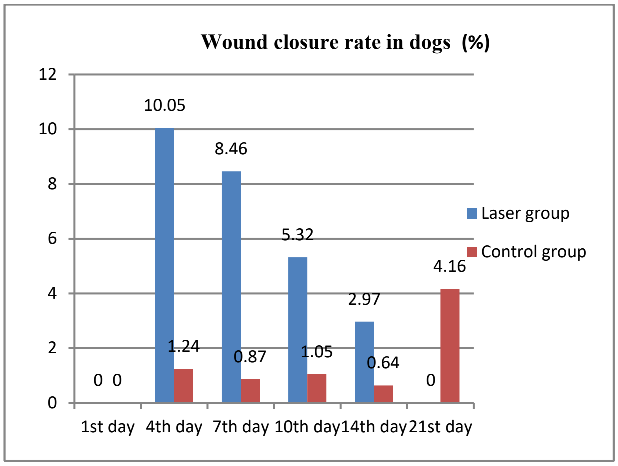

Figure 7. Comparison of wound closure rates in dogs.

control group (p≤0.01) (Table 1). In addition, time period to suturing was also significantly shorter in thes study group compared to control group (Figure 6 and Figure 7).

In the control group, the wound closure rate was significantly lower in both cats and dogs in the presence of infection ($p < 0.05$). Although there was a higher wound closure rate in dogs treated with antibiotics, there was no significant difference between the study group and control ($p > 0.05$). However, in the control group, wound closure rates were significantly higher in animals treated with antibiotics than those without antibiotics.

DISCUSSION

Laser applications have been used in the veterinary field for different purposes. Laser surgery and treatments of skin wounds, atrophy and myositis are among subjects for veterinary clinics have recently begun to use low-intensity laser phototherapy. Studies were underwent to reveal the mechanism of action as well as to determine appropriate dose and exposure time. A there is a limited number of studies (Lucroy et al. 1999; Theoret, 2004; Ilman, 2005), additional studies should be conducted as the present study.

The wound, characterized by an interruption in the continuity of body tissue, can result from any type of physical, chemical and mechanical trauma, or may be triggered by a medical condition (Chaves et al. 2014). Among many methods used in wound healing is the method of laser applicat ion. The benefits of laser light in the treatment of wounds have been known since the 1960s (Yeh et al. 2010; Chaves et al. 2014). Many studies have reported that laser therapy is an effective approach to tissue repair as it minimizes factors that delay or hinder the healing process (Guo et al. 2010). In wounds with tissue loss, the laser application promoted healing as it happened in a short time compared to the control animals. Similarly, the wound with a significant tissue loss became appropriate for suturing in a shorter period of time. Over all, suturing and primary healing were achieved significantly better and shorter time period. This study found that the use of laser phototherapy method contributed to wound healing when used in an appropriate dose and time. At continuous application of the laser dose of 20 J, the wound sites have tendency to bleed upon formation of granulation tissue. However, if the laser application continued at a dose of 20 J / cm^2, animals exhibited signs of anxiety and restlessness during application of laser phototherapy. Consequently, the working dose was adjusted, ranging between 4 J / cm^2 and 20 J / cm^2.

This study was planned to study the efficacy of laser phototherapy in the treatment of the most common tissue loss skin injuries in animals. As cited, laser phototherapy may accelerate cell regeneration by increasing mitochondrial activities, regulating the oxygen mechanism of the cell (Watanabe, 1996a; Watanabe, 1996b). In support to this notion, this study found that laser phototherapy is beneficial as it significantly accelerated wound healing in cats and dogs. There are also data suggesting that laser phototherapy promotes angiogenesis (Watanabe, 1996a; Petermann 2008). In the present study, clinical data indicate that angiogenesis is evident as the newly formed granulation tissue, which is faster in animals with laser phototherapy, showed greater tendency to bleed.

In animals with laser phototherapy, local infection could be easily controlled even without antibiotics treatment. Local infection symptoms disappeared in a period of 3-4 days and the wound sites exhibited signs of healing. In both cats and dogs of the study group, the wound closure in animals with application of laser phototherapy became apparent within the first 4-days while there were no signs of wound closure in control animals (Table 3.1.). Thus, it seems that the positive effect of laser phototherapy on wound healing is the highest during the proliferation stage of the wound healing. In this stage, the wound sites with laser application were characterized by rapid wound closure and regression in the severity of infection in the wound sites. Alleviation in infected wounds without use of antibiotics also suggests that the laser phototherapy may possibly activate cellular defense mechanisms. Such a theory should be investigated by further studies.

The use of LED and LPL has been reported to stimulate collagen production, fibroblast proliferation, and local micro vascularization (Conlan et al. 1996; Pinheiro et al. 2004; Person et al. 2005; Silveira et al. 2007). Lucroy et al. (1999) also reported that the use of low intensity laser beam in chronic wound treatment in dogs contributes positively to wound healing. It is thought to promote these contributions by increasing cell proliferation, collagen synthesis, growth factor release, and DNA synthesis. As also found in the present study, it is clinically evident that the application of laser phototherapy increases granulation formation and angiogenesis at the wound sites. The formation of granulation tissue and the increase in wound contraction rate and shrinkage of the wound area were evident that supported the previous literature given above.

Moura et al. (2014) examined the effects of ultrasound and low-level laser application on tendon healing in rats with tendinitis. Based on histomorphological examination, they concluded that low-level laser application increased type I and Type III collagen formation and thus contributed higher to healing process compared to ultrasound application. Although histomorphologic examination was not conducted in the present study, it was clinically so evident that laser phototherapy contributed to wound healing and granulation at wound sites.

The results of previous studies concluded that laser phototherapy application contributes to cell repair process by stimulating cellular metabolism and increasing energy. Thus, it is effective in controlling pain and reducing healing time (Karu et al. 1995; Silveira et al. 2009). In support to these, this study also found that laser phototherapy application significantly accelerated wound healing process in cats and dogs.

In conclusion, low-intensity laser phototherapy promotes wound healing by accelerating wound closure and formation of granulation tissue in cats and dogs. Thus, laser phototherapy is valuable treatment option for skin wound. The laser dose should be carefully selected to avoid unwanted effects such as bleeding. Further studies should be conducted in different kinds of wounds and to reveal how laser phototherapy modules the healing mechanism.

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