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Investigation of the Effect of Low-Level Laser Therapy on Tooth Extension in Wistar Rats: A Preliminary Study

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Abstract: A total of 12 male Wistar strain rats at 6 weeks old were used randomly for the study. Twelve rats were divided into 2 groups of 6 rats each to form the laser therapy and nonirradiation groups. To measure the amount of tooth extension, two points were identified in front of the right lower incisor in all rats. The measurements were performed between the gingival edge and the edge of the cutted incisal part of the tooth with a caliper. The tooth was cutted approximately until, the half. For the low-level laser source, a GaAlAs laser was used. The first dose of laser irradiation was performed just after the preparation of the teeth and then successive applications were realized at same time following two next days. In the laser application group, the averages of the teeth length were 3.1, 4.0, 5.2 and 7.08 at 0-3 days, respectively. In nonirradiation group these values were 3.11, 3.86, 4.65 and 5.7 at 0-3 days, respectively. To compare the differences of the measurements in each group the Wilcoxon signed ranks test was performed. The hypothesis is that LLLT may enhance tooth extension in rats. For this reason, in the presented study, the effect of LLLT was evaluated quantitatively.

Key words: GaAlAs laser, gingival edge, low-level laser, tooth extension, dentistry, rat

INTRODUCTION

Therapeutic laser treatment also referred to as Low-Level Laser Therapy (LLLT), offers numerous benefits. Along with the primary benefit of being nonsurgical, it promotes tissue healing and reduces edema, inflammation and pain (Azevedo *et al*., 2005; Sun and Tuner, 2004). For >30 years, LLLT has been an interesting, but not well-defined field among the medical, dental, physiotherapy and veterinary professions (Sun and Tuner, 2004). LLLT is being applied extensively in medicine and dentistry to treat both hard-and soft-tissue injuries (Garavello-Freitas *et al*., 2003; Pugliese *et al*., 2003). The following are some suggested treatment dosages: 2-3 J cm^{-2} 2 or 3 times a week on gingival tissues, 4-6 J cm^{-2} 2 or 3 times a week on muscles, 6-10 J cm^{-2} once or twice a week on a temporomandibular joint and 2-4 J cm^{-2} directly on the tooth or indirectly above the apex or osseous structure (Sun and Tuner, 2004). With respect to bone, LLLT has been shown to modulate inflammation (Corona *et al*., 2003), accelerate cell proliferation Ueda and Shimizu (2003) and enhance healing (Walsh, 1997).

In the study, there are many studies include the effect of LLLT on different tissue. But, none of them mention the effect of LLLT on the tooth extension in animals. The lower incisor tooth of the rat has a great potential rate of extension. The teeth of rodents and (rat, rabbit, etc.) are different then those of dogs, cats and people in that grove continually throughout the animals life. If the teeth are not aligned properly, they will not wear down at the correct rate, resulting in weight loss due to problems eating. This is not just a problem of the front incisors, as the back molars can overgrowth as well. The teeth of the rat continue to grow throughout life. If incisors overgrow, they can actually grow into the nasal cavity (Hillyer and Quesenbere, 1997).

In the present study, we investigated, the effects of low-level laser irradiation on tooth extension during natural tooth elongation. The effects of laser therapy were evaluated quantitatively by measuring the amount of tooth extension between the gingival edge and the incisal corner.

MATERIALS AND METHODS

A total of 12 male Wistar strain rats at 6 weeks old (165±10 g) were used randomly for the study. Twelve rats were divided into two groups of 6 rats each to form the laser therapy and nonirradiation groups. The animals

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were kept in the animal center of Gulhane Military Medical Academy at Ankara, in separate cages, in a 12 h light/dark environment at a constant temperature of 23°C.

All operations were carried out under general anesthesia by using intramuscular injection of ketamine (Alfamine 100 mg kg^{-1}, Alfasan, Turkey) (60 mg kg^{-1} body weight). For premedication xylazine hydrochlorur (Alfazyne 20 mg kg^{-1}, Alfasan, Turkey) was used intramuscular 4 mg kg^{-1} body weight. To measure the amount of tooth extension two points were identified in front of the right lower incisor in all rats. The measurements were performed between the gingival edge and the edge of the cutted incisal part of the tooth with a caliper. The tooth was cutted approximately until the half.

For the low-level laser source, a GaAlAs laser (BTL 2000 Powerlaser, Medic Tinedic, Denmark) was used. The wavelength was 830 nm and the output power was 25 mW, variable. The laser beam was delivered by a 1.8 mm-diameter optical fiber, by placing the end of the optical fiber tip in 10 mm away from the apex of the tooth. Irradiation was performed for 2.5 min once a day on 0-3 days (total 3 times). Total energy corresponding to a 2.5 min day^{-1} exposure was 9 J. The first dose of laser irradiation was performed just after the preparation of the teeth and then successive applications were realized at same time following 2 next days.

During the procedures of the measurements, the rats were premedicated with 4% isoflorane and the anesthesia maintenance was performed by lowering the initial dose to 1%.

For the statistical analysis Wilcoxon signed ranks test and the independent-samples t-test was performed to evaluate the significant or insignificant differences between the values in 2 groups. A value of $p<0.05$ was considered to indicate a significant difference.

RESULTS AND DISCUSSION

The values of the measurements of two groups are shown in Table 1. In the laser application group the averages of the teeth length were 3.1, 4.0, 5.2 and 7.08 at 0-3 days, respectively. In nonirradiation group these values were 3.11, 3.86, 4.65 and 5.7 at 0-3 days, respectively. To compare the differences of the measurements in each group the Wilcoxon signed ranks test was performed. The differences were realized between the averages of the measurements at day 0-3. According to these results there were statistically significant differences between the all measurements at each day in two groups. Although, the amount of tooth extension was statistically significant in both groups, but in the laser application group compared with the nonirradiation group was more quickly (Fig. 1). The increase of the teeth length averages in laser application group were greater between the 2 and 3 days compared to the other group. The independent-samples t-test was applied to reveal the differences between the values of the groups at 2 and 3 days and the p value was 0.02 ($p<0.05$). This result is explained that there was a statistically significant difference between the two groups at 2 and 3 days and it's concluded that the laser application was effective to tooth extension in rats.

The rats are the animals, which have a potential of extension in all tooth, but the incisive are being more influenced by this feature. The mechanism of the extension may describe as the cellular activation in the apex region of the teeth. This cellular activation may increase the odontoblastic activity; depending on an elongation in tooth length may produce. This circumstance provides a great advantage in animals and the fractured tooth attain the original length and carry on its function.

The mechanisms underlying stimulation of bone healing are not well understood, but may be multifactorial and include promotion of angiogenesis, collagen production, osteogenic cell proliferation and differentiation, mitochondrial respiration and ATP synthesis (Khadra *et al*., 2004). LLLT may also increase local blood flow, enhancing the supply of circulating cells, nutrition, oxygen and inorganic salts to the bone defect (Chen and Zhou, 1989).

During the early stages of wound healing, the energy requirements of the cells are increased. For this purpose, the appropriate dose for application of LLLT would be the one, which enhances growth factors such as TGF-β_1 production by osteoblasts (Khadra *et al*., 2005).

The dose (3 J cm^{-2}) used in this study was similar to those in several previous studies, which indicated that 1-5 J cm^{-2} is effective for inducing positive effects (Kucerova *et al*., 2000). Several laser systems are currently being applied for stimulation of tissue regeneration.

Table 1: The data of the measurements values of the teeth lengths at 0-3 days in laser application and nonirradiated group

	Laser therapy group (n = 6)							Nonirradiated group (n = 6)						
Day	1	2	3	4	5	6	Avg.	1	2	3	4	5	6	Avg.
0	3.1	3.0	4.0	3.0	2.8	3.1	3.1	3.9	3.0	3.0	4.0	3.0	3.0	3.3
1	4.0	3.9	5.1	3.6	3.5	4.0	4.0	4.5	3.5	3.6	4.5	3.4	3.7	3.8
2	5.2	5.0	6.5	4.8	4.6	5.1	5.2	5.3	4.2	4.4	5.2	4.3	4.5	4.6
3	7.2	7.1	6.9	7.3	6.8	7.2	7.0	6.4	5.3	5.5	6.4	5.2	5.4	5.7

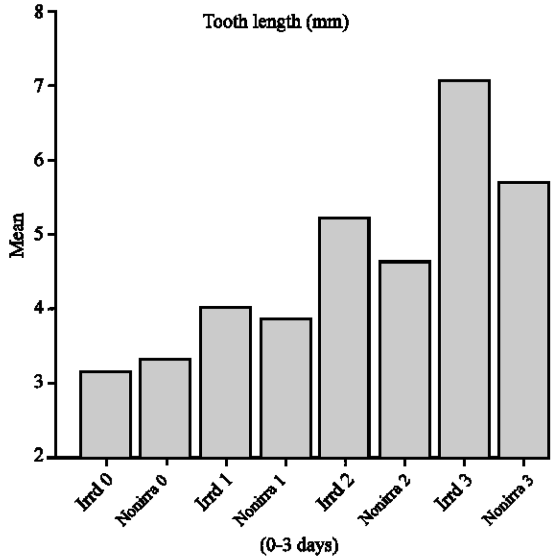

Fig. 1: Schematic comparison of the effect of laser therapy on teeth extension in both group

In selecting optimal laser therapy for experimental or clinical application, it is important that the properties of each device are carefully evaluated (Abelow, 1993). The present results have demonstrated that LLLT using a GaAlAs diode laser has a positive biostimulatory effect on osteoblast-like cells and does not cause cell damage.

The hypothesis is that LLLT may enhance tooth extension in rats. For this reason in this presented study, the effect of LLLT was evaluated quantitatively. To the knowledge, no such studies have been previously reported.

CONCLUSION

The results of this quantitative study demonstrated that the GaAlAs laser application cause an increase in tooth extension in rats. In the future, we desire to investigate the effects of this type of laser on the cellular activation with histomorphometrical parameters.

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