The low-level intensity laser therapy (830 nm) improved the osseointegration in grafted areas

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Background and Aim

Background: Low intensity laser therapy (LLLT) has been shown to improve the bone healing due to stimuli on the differentiation and activation of osteoblasts. In fact, the LLLT stimulates the repair of long bone fractures and accelerates the process of osseointegration of implants placed in native bone. The enhance in the quality of bone healing promoted by LLLT indicates that therapy can improve the healing of grafted areas.

Aim: The objective of this study was to evaluate the effect of different LLLT protocols on osseointegration of implants placed in sites grafted by deproteinized bovine bone (DBB) and hydroxyapatite/ β -tricalcium phosphate (HA/TCP).

Materials and Methods

Figure 1: Groups and treatments

* LIB-Laser irradiation on the grafted area and on the implant; **LI-Laser irradiation only on the implants; ***DBB-deproteinized bovine bone ; ****HA/TCP- hydroxyapatite/ β -tricalcium phosphate.

Figure 2: Fluxogram of the experiment.

Figure 3: Analysis. The pattern of osseointegration and bone repair in the grafted area was evaluated by A) biomechanical, B) microtomographic and C) histometric analyzes. D) Additionally, it was evaluated the expression of BMP2, osteocalcin (OCN) and alkaline phosphatase (ALP) proteins by Immunohistochemistry by a score of labelling extension. (0) absent; (1) soft; (2) moderate; (3) strong.

Results

Figure 4: Biomechanical Analysis. A) DBB; B) HA/TCP. The DBB-LI group presented higher removal torque values than the other groups. # $p<0.05$; ## $p<0.01$ Intragroup differences-Mann-Whitney test; * $p<0.05$; ** $p<0.01$ - Higher removal torque than the no irradiation groups; $\delta p<0.05$; $\delta\delta p<0.001$ - Higher removal torque than the LIB groups- Kruskal-Wallis and Dunn tests.

Figure 5: Micro Ct Analysis. A) DBB; B) HA/TCP. It was observed higher values of mineralized tissue volume in the LI groups than the other groups. # $p<0.05$; ## $p<0.01$; ### $p<0.001$ Intragroup differences- Unpaired t -test; * $p<0.05$; ** $p<0.01$ Intergroup differences- One-way Anova and Tukey.

Figure 6: Representative images of the descalcified histological sections. The maturation of the bone tissue occurred earlier in the LIB groups as can be observe at 15 days sections. At 45 days, all of the grafted areas presented bone with mature aspect. A) DBB and DBB-LI at 15 days; B) DBB-LIB at 15 days; C) all DBB groups at 45 days; D) HA/TCP and HA/TCP-LI at 15 days; B) HA/TCP-LIB at 15 days; C) All the HA/TCP groups at 45 days. (HE-100x).

Figure 7: The LLLT applied on the implants placed in grafted areas improved the osseointegration compared with the no irradiations groups and than the LLLT applied in two moments (LIB). # $p<0.05$; ## $p<0.01$; ### $p<0.001$ -Intragroups differences-Unpaired t-tests. * $p<0.05$; ** $p<0.01$ -Groups with higher BIC or BBT than the no irradiated groups, $\delta p<0.05$; $\delta\delta p<0.01$ - Groups with higher BIC or BBT than the LIB groups - One-way Anova and Tukey tests (Stevel's blue and acid fucsin-100x).

Figure 8: Expression of OCN, ALP and BMP2. The expression of these proteins was higher when the LLLT was applied especially at 15 days. (HE-100x). Expression of the proteins on the no irradiation groups (A-C). A) OCN at 45 days; B) BMP2 at 15 days; C) ALP at 15 days. Expression of the proteins in the LLLT groups. (D-F). D) OCN at 45 days; E) BMP2 at 15 days; F) ALP at 15 days. * $p<0.05$ -Higher expression than the no irradiation groups.Kruskal-Wallis and Dunn tests (200x).

Conclusions

The LLLT performed on implants placed in grafted areas accelerates the process of osseointegration. The application of LLLT in two different moments (in the grafted area and subsequently in the implants) cause limited improvements on the osseointegration in grafted area.

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