

**Clinical Comparison of The Use of Er,Cr:YSGG and Diode Lasers In  
Second Stage Implant Surgery**

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## Study protocol

A total of 265 osseointegrated implants in 75 patients were evaluated in detail for the application of second-stage surgical procedures. Conventional methods were preferred for the second-stage implant surgeries of 164 osseointegrated implants in 35 patients and they were excluded from the study because of the lack of adequate keratinized gingiva in the implant site or the fact that localization of the implant is not known due to the thickness of the gingiva. Patients who needed tissue transposition techniques (Roll flap, Palacci technique, etc.) were also not included in the study. Periapical radiographs of the implants were obtained for all patients. Implants which showed signs of probable bone growth on the closure screw were not included in the study for standardization between groups.

40 patients were found to be eligible for the second-stage surgical operation with dental lasers. The study group consisted of healthy individuals aged 18-70 years. These patients had no risk for second-stage surgery. The patients were divided into two groups by randomization procedure (<http://graphpad.com/quickcalcs/randomize1.cfm>). The systemic illness, smoking status and toothbrushing habits of all patients included in the study were recorded.

The second-stage implant surgeries of the patients in the first group ( $n = 20$ ) were performed with 940 nm Ga-Al-As diode laser (Ezlase™, BIOLASE Technology Inc, USA) and the surgeries of the second group ( $n = 20$ ) were performed with 2780 nm Er,Cr:YSGG laser (Waterlase iPlus®, BIOLASE Technology, Inc, USA).

The second-stage implant surgery of both groups began without the use of local anesthesia (LA). Patients were informed that they will be treated with topical LA (Vemcaine Pump Spray 10% 50 ml; Vem, Ankara, Turkey) if they had any pain during treatment.

In the first group, the procedures were performed with a 940 nm wavelength diode laser (Ezlase 940; Biolase Technology, Inc., Irvine, CA) according to the guidelines recommended by the manufacturer. (surgical E4 300  $\mu$ m tip, 2.5 W power, average power: 1.25 W, pulse length CP2: 1.00 ms, pulse interval: 1.00 ms, duty cycle 50%, continuous wave).

In the second group, the procedure was performed in line with the recommended "implant recovery" setting of the Er,Cr:YSGG laser with a wavelength of 2780 nm (MZ5-6mm tip, 2.00 power, 100 Hz, H mode, 10% water and 10% air). The patients were instructed to use a mouthwash containing 0.2% chlorhexidine gluconate (Klorhex Gargara, 200 mL; Drogasan İlaç, Ankara, Turkey) three times a day.

To uncover the implant, laser-assisted incisions were expanded in a circular fashion, starting from the most likely position of the implant's closure screw in both groups.

Patients were recommended to use paracetamol (Parol 500 mg tablets, Atabay Ilac San, Istanbul) as a pain reliever in the postoperative period, only when needed. VAS (Visual Analogue Scale) values (0-10), intraoperative bleeding grades (intraoperative bleeding: 1: minimal, 1, 2, 2: normal, 3: excessive hemorrhage), the number of pain relievers used in the postoperative period and the duration of operation (min) were recorded. The total operation time was divided by the number of implants, and the operation time per implant was determined and recorded. Complications observed in the wound area during the control visits were scored and noted (soft tissue inflammation: 1, edema: 2, gingival bleeding: 3).

### **Statistical methods**

Characteristics of the study participants for the continuous variables were analyzed by t test after Shapiro Wilk normality test for comparisons between the diode and Er,Cr:YSGG laser groups. For the categorical variables were analyzed by Pearson chi squared test and likelihood ratio chi squared test, as appropriate, for comparisons between the diode and Er,Cr:YSGG laser groups.

Generalized linear mixed model (GLMM) was used for analysis of VAS outcomes. Fixed effects factors in GLMM were used laser groups, time (days), sex, and brush and as covariates operation durations and age. The results of GLMM was obtained according to residual subject specific pseudo likelihood method with ar(1) covariance structure and negative binomial distribution because of data possess an excessive of zeros. Holm-Tukey multiple comparison adjustment were used for the p-values and obtained confidence limits for the differences of LS-means. The analyses were performed using SAS version 9.4 statistical software (SAS Institute Inc, Cary, North Carolina, USA).