WILEY CLINICAL ORAL IMPLANTS RESEARCH

Thermal evaluation by infrared measurement of osteotomies performed with Er:YAG laser, piezosurgery–an animal study

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Background: Bone drilling is a common step of an everyday procedure in dental implantology. Frictional heat from these osteotomies may result in thermal necrosis of bone. Bone temperature must be below the temperature of 47°C during drilling to avoid thermal osteonecrosis. Many factors (drill design, drilling parameters, coolant delivery) contribute to heat generation during osteotomy. Consequently, superior methods of bone tissue surgery, which would enable reduced collateral tissue thermal trauma, force and friction, has been developed including erbium laser ablation and piezoelectric surgery.

Aim/Hypothesis: The purpose of the present experimental study was to determine the thermal changes of the bone tissue following osteotomies performed by piezoelectric surgery, and Er:YAG laser ablation used in contact and non-contact modes using infrared thermographic camera.

Material and Methods: A total number of 24 Wistar rats were used in this study, randomly divided into 4 groups, based on the post-operative duration of survival of the animals. Osteotomies on both rat's tibiae were performed under general anaesthesia by an intraperitoneal injection of thiopental sodium. Four osteotomies were performed always in the same sequence: digitally controlled non-contact Er:YAG laser (X-Runner™, Fotona, Slovenia), piezosurgery (Piezomed, W&H Dentalwerk Burmoos GmbH, Austria) and contact Er:YAG laser (LightWalker®, Fotona, Ljubljana, Slovenia). The osteotomies were 5 mm away from each other and 2 mm deep, with a same diameter. Temperature measurements during each osteotomy were done using an infrared thermographic camera (FLIR T335, FLIR Systems Pty Ltd, Australia) with a detection range of −20°C to +650°C, a thermal sensitivity of <50 mK, and IR resolution of 320 × 240 pixels. The camera was set up on a tripod at a fixed distance (30 cm from the rat's tibia), and the settings were always the same. Analysis of the recorded data was performed using the FLIR Tools software (FLIR Systems, Inc., North Billerica, MA, USA).

Results: For each measurement temperature before the osteotomy (Tbaseline) and maximal temperature measured during osteotomy (Tmax) were determined. Mean temperature (ΔT) values were calculated for each osteotomy technique. Results were presented as a histograms. Mean baseline temperature for each group of osteotomies was 29.96°C for non-contact laser, 27.98°C for contact laser and 29.39°C for piezosurgery. Mean Tmax for contact laser was 29.92 °C (ΔT = 1.94 °C), for non-contact laser was 79.11°C (ΔT = 49.15 °C) and 29.15 °C (ΔT = −0.24 °C), for piezosurgery. There was statistically significant reduction of heat generation after contact Er:YAG laser and piezosurgery when compared to non-contact Er:YAG laser osteotomy.

Conclusions and Clinical Implications: The present study showed beneficial effects of the piezosurgery and Er:YAG laser used in contact mode of working on heat generation of bone tissue during osteotomy, reducing potential overheating of the bone as registered by means of thermography. Digitally controlled non-contact Er:YAG laser results in the production of temperature that is higher than the allowed border for bone tissue during osteotomy.