CLINICAL ORAL IMPLANTS RESEARCH

PBR-115 Basic Research

Evaluation of bone healing following different types of osteotomy using SEM and 3D-SEM analyses – an animal study

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Background: Osteotomies are frequently performed procedures in dental implantology and are generally performed with traditional instruments. Despite the fact that they are considered a golden standard for bone osteotomies, these instruments present some disadvantages caused by the pressure and friction arising during their contact with the bone tissue which can delay, or even, jeopardise the bone healing process. Consequently, the requirement for superior methods of bone tissue surgery, which would enable less invasive, precise osteotomies unrelated to the geometry of the mechanical instrument, with limited collateral tissue trauma and reduced force and friction, has promoted the development of new osteotomy techniques including erbium laser ablation and piezoelectric surgery.

Aim/Hypothesis: The purpose of the present experimental study was to determine the dynamics of the bone healing process following osteotomies performed by standard steel bur, piezoelectric surgery, and Er:YAG laser ablation used in contact and non-contact modes using SEM and 3D-SEM analysis. The null hypothesis tested was that there were no differences between the tested surgical techniques with respect to neoformation of bone in the artificially prepared osteotomies.

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: low speed surgical bur, 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. Animals from the first group were euthanised immediately after performing osteotomies, with an overdose of anaesthetic solution. The animals from the second group were sacrificed after 1 week, from the third group after 2 weeks and from the fourth group after 3 weeks, all with an anaesthetic overdose. Bone samples collected from the rat tibiae were cut transversely to contain the complete osteotomy sites. Electron images were obtained with a cold cathode field-emission gun scanning electron microscope (FEG-SEM Hitachi SU 8030, Tokyo, Japan). The three-dimensional (3D) stereo-photographs (anaglyphs) were created by taking two stereo-pair photographs with a separation of 7 degrees, the first at −3.5 degrees and the second with a + 3.5 degree tilt. The microphotographs were superimposed and visualized with 3D-anaglyphic glasses.

Results: Immediately after surgery, there were significant differences in the appearance of the bone defects, with the presence of bone fragments and debris after standard steel bur preparation, in comparison to the clean smooth walls and relatively sharp edges in all other groups. The initial bone formation in defects prepared by piezosurgery was observed to be the most rapid. After 3 weeks, all bone defects were completely restored; although, differences in the healing pattern were noted, with a modest initial delay in healing after laser preparation. The first stage of the bone healing process is delayed when contact and non-contact Er:YAG laser modes are used, principally due to the haemostatic effect, and accelerated by piezosurgery. However, the results after 3 weeks demonstrate similar restitution of defects in all of the tested groups.

Conclusions and Clinical Implications: The initial healing process of the defects prepared by piezosurgery was observed to be the most rapid. Osteotomies prepared by contact and non-contact Er:YAG laser exhibited an initial delay in the bone healing, arising from the pronounced haemostatic effect. Results after 3 weeks demonstrated similar restitution of the defects in all tested groups. The results of presented study suggest that piezosurgery and Er:YAG laser ablation can be of a potential benefit in performing dental osteotomies.