On implant integration in irradiated bone:
Clinical and experimental studies

av

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Abstract

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Radiation has an impact on the processes involved in bone- healing, regeneration and remodeling. The mechanisms that cause impaired bone healing of dental implants are not fully understood. Adjunctive treatments to revers radiation effects are limited. Dental implant surgery can be a risk in irradiated jaws and the risk for osteoradionecrosis is of concern. There is no consensus when to install implant after completed radiation therapy or what radiation dosage might cause impaired bone healing. The overall aim of the studies was to investigate bone tissue reactions adjacent to implants after irradiation.

I. A clinically long-term follow-up study was performed to assess the outcome of 18 dental implants inserted in five patients with and without irradiated fibula-reconstructed mandibles. Bone tissue reactions adjacent to 14 micro-implants were histologically evaluated. In the clinical follow-up, 15 implants were in function, with an overall success rate of 83%. The histomorphometric analyses demonstrated an impaired osseointegration with reduced bone-to-implant contact (BIC) and bone area (BA), in irradiated sides.

II. In an experimental animal study the aim was to find a critical level for a given single external radiation dosages causing impaired implant osseointegration. 9 rats received a single radiation dose of 2, 5, 10, 20 and 30 Gy, respectively to one hind-leg while the other served as a control. Three days post radiation two implants were inserted in each hind-leg and after a period of 5 weeks the implants (n=36) were harvested for histological examination. BIC and BA were lower for irradiated samples for dosages of 20 Gy and higher.

III. The aim was to investigate the effects of HBO on osseointegration of titanium implants in irradiated bone. 15 rats received an external single radiation dose of 20 Gy to one hind-leg. 3-days post-irradiation 2 implants were inserted in each hind-leg (n=60). The rats were divided in to 2 groups and one group received hyperbaric oxygen treatment (HBOT) 3 days post-implant insertion (n=8). After 5 weeks the distal implants were harvested for histological examination (n=30) and the proximal implants were used for removal torque tests (n=30). BIC obtained significant higher values for non-irradiated side, independent of HBO or not. BA obtained significant higher values for irradiated sides in the non-HBO group.

IV. The aim was to investigate gene expression in irradiate bone after implant insertion for bone formation, resorption and remodelling. 8 rats, received a single radiation dose of 20 Gy to one hind-leg and two implants inserted in each hind-leg 8 weeks after completed radiation therapy. After 5 weeks bone samples with implants were collected for gene expression analysis. ALP, OC (formation) and RANKL/OPG (remodelling) were down regulated in irradiated samples.

Conclusion: Bone-anchored dental bridges can be used in selected oro-mandibular reconstructed patients. Bone quality disturbances with impaired osseointegration for dosages of 20 Gy and more were demonstrated in an animal study model. HBO did not enhance osseointegration of implants placed in rat bone during a five-week follow-up period. Irradiation significant reduces bone formation and remodeling under influence of pro-inflammatory and growth factor cytokines.

Keywords: dental implant, osseointegration, radiation therapy, bone remodeling, histomorphometry, hyperbaric oxygen therapy, gene expression and in vivo.

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