Osteogenesis gene expression of nano-HA covered implant in rats submitted to cigarette smoke inhalation

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Abstract

The habit of smoking is a challenging situation, negatively affecting the osseointegration process¹. Nicotin reduces osteogenic activity and may contribute to impaired bone repair and increased risk of loosing implants². The microstructure and surface characteristics of dental implants have a direct influence on bone response³. Previous studies have shown that nanostructures applied to titanium surfaces may contribute to a higher bone to implant contact, therefore accelerating bone healing⁴.

Methods and Materials

Thirty six rats were submitted to the inhalation of the smoke of 10 cigarettes, 3 times by day, during 60 days. On the thirtieth day of the experiment, mini implants (1.4 mm in diameter and 2.7 mm in length) with 3 types of surface (machined = MAC, double acid etched = DAE and with the addition of nano-hydroxyapatite = NHA; 12 implants of each type) were installed in the tibias of the animals. The rats were divided into three experimental groups (n=12 each): G1, MAC implants installed; G2, DAE implants installed; G3, NHA implants installed. The animals were euthanized 7 and 30 days (7d and 30d, 6 animals from each group) after implant placement, and bone biopsies around implants were collected and processed. Alkaline phosphatase (ALP), Osteopontin (OP), Runt related 2 transction factor (RUNX 2), and Osteocalcin (OC) values were determined by quantitative real-time PCR evaluation. Inter-groups differences were assessed using One-way Analysis of Variance + Tukey tests ($p < 0.05$).

Figure 1: Implant installation. A) Incision measuring approximately 1,5 cm parallel to the long axis of the tibia. B) Flap released. C and D) Surgery to implant placement under constant irrigation with saline solution. E) Implant installed. F) Flap sutured.

Results

Different letters indicate a statistically significant difference in the intergroup analysis. Equal letters of different sizes indicate a statistically significant difference in the intragroup analysis.

Conclusion

The nano-hydroxyapatite implant surface promoted an up-regulation in the osteogenesis gene expression when compared to machined or double acid etched surfaces, mainly in late (30 days after implant insertion) healing period, in in rats submitted to cigarette smoke inhalation, as a model of deficient bone repair. These results suggest that this implant surface should be tested in humans, in trials evaluating challenging clinical situations.

References

- Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Kuchler I. Smoking interferes with the prognosis of dental implant treatment: a systematic review and meta-analysis. *Journal of clinical periodontology*. 2007;34(6):523-44.
- Baig MR, Rajan M. Effects of smoking on the outcome of implant treatment: a literature review. *Indian journal of dental research : official publication of Indian Society for Dental Research*. 2007;18(4):190-5.
- Mendonça G, Mendonça DB, Simoes LG, Araujo AL, Leite ER, Duarte WR, et al. The effects of implant surface nanoscale features on osteoblast-specific gene expression. *Biomaterials*. 2009;30(25):4053-62.
- Bai L, Liu Y, Du Z, Weng Z, Yao W, Zhang X, Huang X, Yao X, Crawford R, Huang R, Huang D, Tang B, Xiao Y. Differential effect of hydroxyapatite nano-particle versus nano-rod decorated titanium micro-surface on osseointegration. *Acta Biomaterialia*. 2018(76):344-58.