Comparison of zirconia and titanium implants after a short healing period. 
A pilot study in minipigs

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The aim of this animal study was to investigate and compare the osseointegration of zirconia and titanium dental implants. 14 one-piece zirconia implants and 7 titanium implants were inserted into the mandibles of 7 minipigs. The zirconia implants were alternately placed submerged and non-submerged. To enable submerged healing, the subperidental part was removed, using a diamond saw. The titanium implants were all placed submerged. After a healing period of 4 weeks, a histological analysis of the soft and hard tissue and a histomorphometric analysis of the bone–implant contact (BIC) and relative peri-implant bone-volume density (rBVD; relation to bone-volume density of the host bone) was performed. Two zirconia implants were found to be loose. All other implants were available for evaluation. For submerged zirconia and titanium implants, the implant surface showed an intimate connection to the neighbouring bone, with both types achieving a BIC of 53%. For the non-submerged zirconia implants, some crestal epithelial downgrowth could be detected, with a resultant BIC of 48%. Highest rBVD values were found for submerged zirconia (80%), followed by titanium (74%) and non-submerged zirconia (63%). The results suggest that uncoated zirconia and titanium implants osseointegrate comparably, within the healing period studied.

Method and Materials

The study was performed on 7 one-year-old miniature pigs. Two types of implants were studied: zirconia and titanium. Zirconia implants (diameter 4 mm, length 10 mm) were manufactured from yttria-stabilized tetragonal zirconia polycrystalline (whiteSKY, Bredent, Germany). The surface was sandblasted. According to the producers, the physical surface roughness parameters were: Ra 1.0 mm and Rz 7.2 mm. Titanium implants (Xive, Dentsply, Friadent, Germany) had a sandblasted, acid-etched surface, Ra 2.75 mm and Rz 16.30 mm.

Surgical procedure

Three surgical interventions were performed; all under general anaesthesia (midazolam 1 mg/kg i.m., ketamine 10 mg/kg i.m., atropine 0.05 mg/kg i.m.). Carprofen (2–4 mg/kg s.c.) was administered postsurgery. The animals received a soft diet and water ad libitum. In the first operation, the primary premolar teeth were extracted. The remaining areas were cleaned and the implant sites were prepared. After 2–3 weeks, the primary premolar teeth were reinserted. A week later, the implants were inserted. The animals were killed 4 weeks after the generation of the implant sites.

Histology

4 weeks after implant placement, the animals were killed. Mandibular en bloc resections were retrieved for analysis. The samples were fixed in formaldehyde and dehydrated in a graded series of ethanol. The implants and surrounding bone were embedded in methylmethacrylate (Technovit 9100, Heraeus Kulzer, Wehrheim, Germany). 100 μm thick sections along the axis of each implant were cut in an orofacial direction using a diamond microtome (Exakt-Apparatebau, Norderstedt, Germany). These sections were rehydrated and reduced to 30 mm thickness using grinding techniques on a roll grinder containing diamond-coated sandpaper. About three middle sections could be obtained per implant. A Masson–Goldner stain was carried out. The sections were imaged and analyzed using light microscopy (Olympus BX 61, Hamburg, Germany) and polarized light analysis. Multiple image alignment was performed using an automated scanning table (Ma¨rzha¨user, Wetzlar, Germany).

Histomorphometry

Histomorphometric analysis was measured BIC on the implant surface. For each histological section, the length of implant surface in contact with bone tissue was calculated and compared with the total implant surface length. The percentage of bone within the implant grooves was measured and compared with the percentage of bone within a neighbouring region of reference (RoRef) within the host bone, defining the relative bone-volume density (rBVD). The area within the implant grooves was defined by placing a borderline at the tips of the grooves, parallel to the implant length axis. The neighboring RoRef had a rectangular shape and was selected from an area distant to the implant, within the host bone. This RoRef had the depth of an implant groove and the length of three grooves (Fig. 2).

Statistics

Data were described by means. Means were supplemented with their 95% confidence intervals. One-wayANOVA was applied to test for differences between means of the three implant groups. Test results were considered significant for P-values below 0.05. All statistical analyses were performed using SPSS version 15.0 software (SPSS, Chicago, IL, USA).

Results

In conclusion, this animal experiment showed satisfactory osseointegration and good soft and hard tissue biocompatibility of zirconia implants after a 4-week healing period. This applied to submerged and non-submerged healing and could be the basis for an investigation of further healing periods with a higher number of implants.

References

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