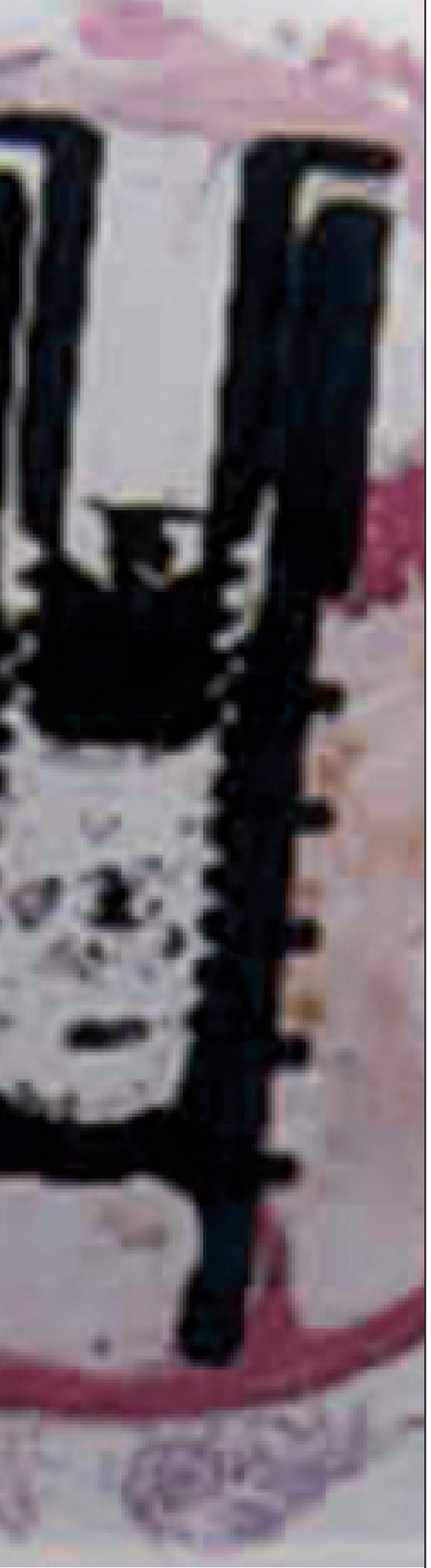

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(2832) BONE CONTACT IN RABBIT IN MACHINED AND TITANIUM PULL SPRAY SUPERFICIAL (TPSS) IMPLANTS

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Objective:
The aim of this study was to evaluate the differences of bone contact between machined implants (control implants) and implants where the surface roughness was increased through micromechanical removal of parts of the superficial metal layer with the use of aluminum oxide 0.5 microns micropoints (Titanium pull spray superficial TPSS) (test implants). Methods: Grade 3 3.8 x 10 mm c.p. titanium implants were used in this study. The surface roughness (Ra) of the machined implants was 0.30 microns, while the Ra of the TPSS implants was 2.74 microns. Twelve white New Zealand mature rabbits were used in the present investigation. Each rabbit received 2 implants, one machined and one TPSS, into the articular femoral knee joint. A total of 24 implants were inserted. Six animals each were killed at 15 and 60 days after implant placement. The specimens were processed to obtain thin ground sections with the Precise 1 Automated System (Assing, Rome, Italy). Results: In the 15 days specimens, the control implants showed a bone-implant contact (BIC) percentage of 21%, while in the test implants the BIC was 30%. After 8 weeks, in control implants the BIC was 52%, while in test implants it was 59%. The statistical significance was assessed by Fisher's PLSD test. The differences were statistically significant both at 15 days (p-value 0.043) and at 60 days (p-value 0.0197). Conclusion: The results of our study showed that the rougher TPSS surfaces have a greater bone-implant contact percentage at early and late healing phases.

Introduction:
Several studies have demonstrated the influence of different surface characteristics on bone-implant integration. Surface roughness has been shown to affect osteoblast proliferation and differentiation. In the last decade, techniques such as surface blasting, acid etching, plasma spray treatment, hydroxyapatite coating have been developed to roughen the dental implant titanium surface. All these procedures needed to respond to the main scientific criteria, which were biocompatibility, effectiveness and safety. The ideal degree of surface roughness still remains unknown, but, however, an average roughness (Ra) of about 1.5 microns seemed to be the best for the osteoblasts activities around titanium implants. Sandblasted implants may present alumina particles, not easily eliminated after ultrasonic cleaning. Even if these residual particles have been shown to have no negative effects on cell adhesion (Wennerberg et al., 1996), acid-treated surfaces have been introduced to clean and eliminate aluminum remnants. The aim of our study is the evaluation of the cellular events around a new implant surface, where the surface roughness was increased through micromechanical removal of parts of the superficial metal layer with the use of aluminum oxide 0.5 microns micropoints (Titanium pull spray superficial TPSS).

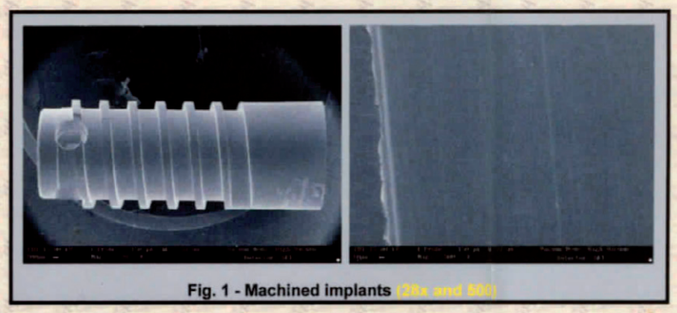

Fig. 1 - Machined implants (28x and 500)

Results:
Under SEM, control implants presented characteristic machining grooves produced during manufacturing. Test implants showed homogenous superficial irregularities and no remnants of any material. Surface roughness measurements were 0.30 microns for machined implants and 2.74 microns for TPSS implants.

Material and Methods:
Bioplant grade 3 titanium implants (Oralplant, Cordenons, Pordenone) 3.8 x 10 mm were used for this experimental study. The titanium pull spray superficial (TPSS) treatment has been used to produce implant roughness. It is a subtractive technique obtained by using high precision instruments that make round and regular micro-porous cavities on the titanium surface, without altering its properties. A total of 24 implants have been inserted in the tibial joints of 12 New Zealand rabbits. Each rabbit received 2 implants, one machined (Control) and one TPSS (Test). Six animals were killed at 15 days and 6 rabbits at 60 days after implants placement. Block sections were obtained, fixed in 10% buffered formalin and then processed for embedding in a glycolmethacrylate resin (Technovit 7200 VLC, Kulzer, Wehrheim, Germany). From the samples obtained semi-thin sections were produced using the Precise 1 Automated System (Assing, Rome, Italy) and then stained with toluidine blue and acid fuchsin. Histological evaluation at the different time intervals and histomorphometry were performed. Histomorphometry of percentage of bone contact (BIC) was carried out using a light microscope (Laborlux S, Leitz, Wetzlar, Germany) connected to a high-resolution video camera (3CCD, JVC KY-F55B) and interfaced to a monitor and PC (Intel Pentium III 1200 MMX). This optical system was associated with a digitizing pad and a histometry software package with image capturing capabilities (KS 100, Zeiss, Hallbergmoos, Germany). Qualitative surface analysis of the implants was conducted using a Leo 435 VP SEM (Leo, Cambridge, UK). Roughness average (Ra) measurements of the control and test surfaces were made with a Mitutoyo Profilometer (Mitutoyo Instruments, Tokyo, Japan). Three readings were carried out for each surface and the results were averaged. Statistical analysis has been performed using the Fisher's PLSD test.

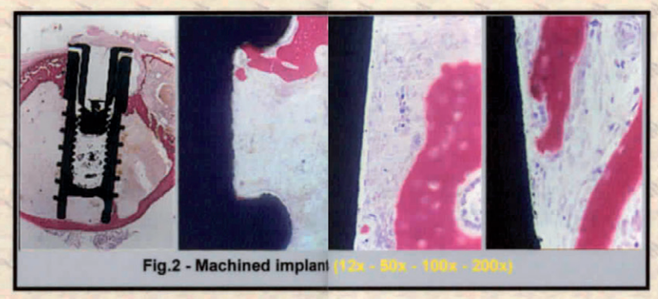

Fig.2 - Machined implant (12x - 50x - 100x - 200x)

Histological evaluation:
At 2 weeks, around control implants there were trabecular newly formed bone and the contact bone-implant was 21%. At this same time, test implants showed a greater osteogenic activity than the control ones and the bone-implant contact was 30%. In both samples no multinucleated or inflammatory cells were present.

After 8 weeks, around machined implants there were some regions with mature bone rich in haversian channels and an osteoid layer interposed between this compact bone and the implant. Few osteoblasts were present. The bone-implant contact was 52.3%. The bone around TPSS implants appeared mature and perfectly adapted to the surface irregularities. The osteoid, not mineralized layer zone was present only in few regions and there were no gaps at the bone-implant interface. The contact between bone and implant was 59.5%. There was no inflammatory reaction.

Statistical analysis:
The statistical evaluation of the data showed a difference statistically significant of the bone-implant contact percentage between control and test implants at 15 days (p-value = 0.0043) and at 60 days (p-value = 0.0197).

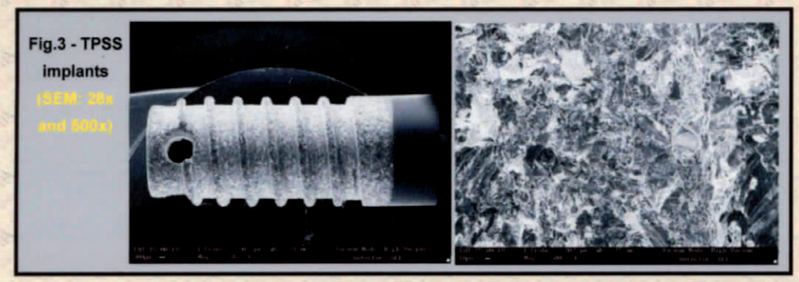

Fig.3 - TPSS implants (SEM: 28x and 500x)

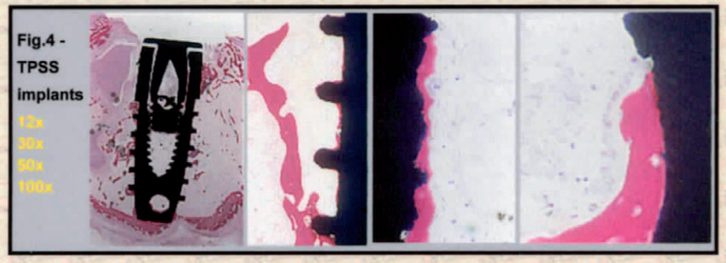

Fig.4 - TPSS implants 12x 20x 50x 100x

Conclusion:
The results suggest that both machined and TPSS implants are biocompatible and are osteointegrated in early (2 weeks) and late (8 weeks) stages of healing. Geometric surface properties seem to affect the quantitative and qualitative properties of newly formed bone around implant surface. Indeed, there was a greater bone-implant contact on TPSS implants than in the control ones. Moreover, test implants showed numerous active osteoblasts and little presence of non-mineralized osteoid substance. On the other hand, machined implants demonstrated little osteoblastic activity and a constant layer of osteoid interposed between titanium surface and newly- deposed osseous tissue. Therefore, the TPSS treatment is an effective and safe method, which roughens the titanium implant surface and increases bone formation around it, without producing untoward effects.