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Implant geometry, micromotion (secondary stability) and bone to implant contact (%BIC). Are they correlated?

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Background: Implants osseointegration is defined as a direct and functional connection between titanium surface and the surrounding bone. The osseointegration development requires an implant initial mechanical fixation into the bone at the time of the surgery (the primary stability). Torque-in value, implant geometry and bone density are factors involved in implants primary stability, but it is still unknown what influence they could have in the secondary stability. The phase of new bone apposition on titanium surface leads to a certain implant immobility, but no one has directly measure the amount of implant micromotion (secondary implant stability) after bone healing. Some instruments, especially developed to evaluate implant stability, measure surrogate parameters of micromotion such as resonance frequency. The bone to implant contact percentage is often used as a value of the osseointegration amount, but it was not clarified how much this value is correlated to secondary implant stability.

Aim/Hypothesis: The aim of the present study was to evaluate the correlation between implant geometry, secondary micromotion and bone to implant contact percentage (%BIC) after implants osseointegration. The objective was also to compare the secondary stability of two different implant geometries and the influence of bone density on the implant micromotion.

Material and methods: Five implant sites were prepared in each (left and right) side of the iliac crest and mandible in four female sheep. In the left side of each animal, cutting and aggressive thread design implants were inserted (Dynamix, Cortex, Shlomi, Israel). In the right side of each animal, branemark type implants were used (Classix, Cortex, Shlomi, Israel). Implants were clustered in four group of 20 implants each: group 1 (Dynamix implants in low density bone), group 2 (Dynamix implants in high density bone), group 3 (Classix implants in low density bone) and group 4 (Classix implants in high density bone). Torque-in values ranged between 35 and 70 N/cm in the iliac crest and between 85 and 120 N/cm in the mandible. The sheep were sacrificed 2 months after implantation. Before performing the histological studies, each implant was fitted with a one-piece fixed straight abutment 11 mm in length and the bone blocks were fixed on a customized loading device for a direct micromotion evaluation. Horizontal forces of 25 N/cm were tested on each implant, and the lateral movement of the abutment was measured by the digital micrometer at 10 mm above the crest. Correlations between %BIC values and micromotion for each group and between different groups were tested statistically. Unpaired t-test was applied to verify the statistical differences in BIC percentage and micromotion amount between the different groups.

Results: No statistical correlation was found between the %BIC values and the implant secondary stability (micromotion) in both bone densities and for all implant geometries. Although the mean %BIC value in implants inserted in the iliac crest was higher than implants inserted in the mandible, the micromotion was lower in the second one. No statistical differences were found in %BIC between the two different implant geometries. The %BIC represents implant surface directly contacted by the mineralized bone matrix but an higher %BIC was not related to a superior implant immobility. An aggressive implant design with cutting threads allows to achieve higher peaks of insertion torque and better secondary stability both in soft and hard bone densities than branemark classical thread design.

Conclusion and clinical implications: Data from the present study strongly suggest that the bone density is the key factor in implant stability. The bone density is the more important to achieve an higher secondary stability than the %BIC. High torque-in value did not to have any negative effects on implant osseointegration. Aggressive thread design showed higher secondary stability levels than classical one in each bone density.