125

Impact of implant diameter on implant micromotion and insertion torque

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Topic: Basic research

Abstract

Objectives: Measuring impact of implant diameters on primary stability in relation to three different bone densities *in vitro* (Soft, Medium, Hard).

Materials and methods: A total of 64 TRI® dental implants were placed in fresh bovine bone samples. A loading device, consisting of a digital force gauge and a digital micrometer was used to measure the micromovements of the implant during the application of 25 N lateral forces.

Results: Data showed no statistically significant differences in micromotion between 4,1 diameter implants and 4,7 diameter. Implants with large diameter (4,7 mm) demonstrated higher mean values of insertion torque than implants with smaller diameter.

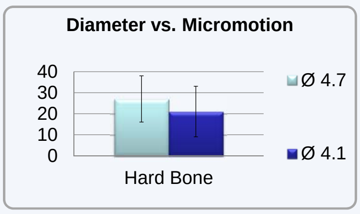
Conclusions: Increasing implant diameter from 4,1 mm to 4,7 mm does not influence significantly the primary stability in any type of bone density.

Background and Aim

The degree of primary stability depends on several factors: bone density, implant shape, design and surface characteristics and surgical technique[1]. It has also been suggested that the cause of failure of immediate load implants is due to the micromotion on the bone-implant interface induced by immediate loading[2]. The implant geometry and the host bone quality[3,4,5] are considered key factors in order to achieve the primary stability but there are no studies which evaluate the impact of implant diameter on implant micromotion immediately after placement.

The aim of the present study was to conduct an experimental *in vitro* test of implant micromotion of two different diameters.

Graph 2 – Comparison between implant diameter (mm) and average implant micromotion (µm) in Hard bone

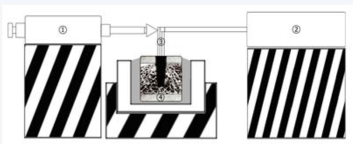


Methods and Materials

33 implants were 4,1x10 mm and 31 were 4,7x10 mm. Implants were inserted, according to the manufacturer's instructions, on 2cmx2cm samples of fresh humid bovine bone representative of the following quality categories as previously suggested[6]: soft, medium and hard.

Customized electronic equipment connected to a PC was used to register the peak and insertion torque data. Each implant was fitted with a one-piece fixed straight abutment 11mm in length to allow for the application of the lateral load. After implant placement, the bone blocks were fixed on a customized loading device for evaluation of micromovement[7].

Fig. 1 - Schematic drawing of the micromotion-testing tool: 1.micrometer, 2.digital force gauge, 3.long implant abutment, 4.bone specimen with the implant in place



This device (Fig.1) consisted of a digital force gauge and, on the opposite side, a digital micrometer that measured the micromovements of the abutment during the lateral load application. Horizontal forces of 25 N/mm were tested on each implant, and the lateral movement of the abutment was measured by the digital micrometer at 10mm above the crest. A customized digitally controlled hand wrench (Fig.2) was used to measure the peak insertion torque.

Fig.2 – Digitally controlled hand wrench

Results

The statistical analysis with unpaired T-test showed no statistical differences between the average values of micromovements between different implants diameter in the same bone density (Table n.1, Graphs n.1-2). Both 4,1 and 4,7 implants, when inserted in Hard bone, showed micromotion values statistically lower (P<0,0001) than when the same implants were placed in Soft bone. The average insertion torque value for 4,7 diameter implants, in Soft bone, was significantly higher (P=0,0029) than that of 4,1 diameter implants. In Medium and Hard bone torque-in values were not statistically different (P=0,9065 and P=0,0516).

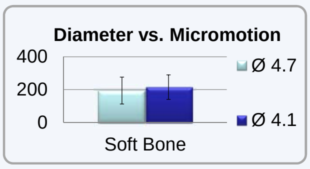
Table 1 – Statistical comparison of micromotion between 4,1 diameter implants and 4,7 diameter implants in different bone densities (S, M, H)

	Ø 4,1 mm *Average micromotion ± S.D. (µm)*	**Ø 4,7 mm** *Average micromotion ± S.D. (µm)*	**P value**
SOFT BONE	215,2 ± 75 (N=18)	193,7 ± 82 (N=18)	0,4174
MEDIUM BONE	29,83 ± 17 (N=24)	26,63 ± 9 (N=24)	0,3885
HARD BONE	21,17 ± 12 (N=24)	27,4 ± 11 (N=20)	0,1109

Conclusions

Results showed that increasing the implant diameter from 4,1 mm to 4,7 mm does not significantly reduce the level of micromotion. Bone densities influenced significantly the primary stability of implants regardless of implant diameter. In the soft bone the primary stability is not very high and so protocols of immediate loading in this type of bone are to be considered with caution.

Graph 1 – Comparison between implant diameter (mm) and average implant micromotion (µm) in Soft bone



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Presented at the 20th Annual Scientific Meeting of the European Association of Osseointegration
10-13 October 2012, Copenhagen, Denmark

EAO EUROPEAN ASSOCIATION FOR OSSEOINTEGRATION