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Comparison of low temperature and high temperature etched implant surfaces: an experimental animal study

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Introduction

One of the decisive factors for a long-term implant success is the structure of the implant surface (1-3).
Therefore, it has been the aim of the present experimental animal study to evaluate the performance of a newly developed high temperature etched implant surface (HTEIS) of the XiVE implant during a loading period of 6 months and to compare it to a well established low temperature etched implant surface (LTEIS).

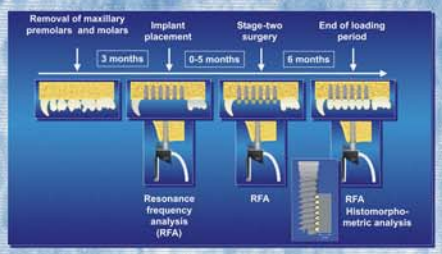

Fig. 1: Flow chart of the design of the study.

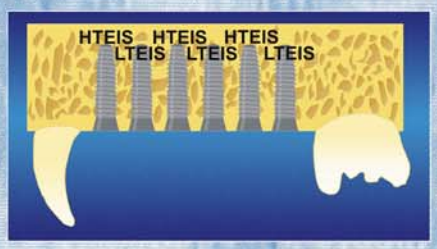

Fig. 2: Distribution of high temperature etched implant surfaces (HTEIS) and low temperature etched implant surfaces (LTEIS) in the maxilla.

Material and Methods

In 9 mini pigs, 3 premolars and the first molar were removed in the maxilla bilaterally (Fig. 1). After 3 months, 6 implants (XiVE®, Friadent GmbH, Mannheim, Germany) were installed on each side of the maxilla. Each maxilla received cylindrical, self tapping screw implants of 3.8 mm in diameter and 13 mm in length with either a low temperature or a high temperature etched implant surface (Figs. 2 and 3). A total of 108 implants was placed. The implant stability was assessed by the resonance frequency analysis (RFA) (Fig. 4) at the time of installation, at stage-two surgery and after a loading period of 6 months (Osstell, Integration Diagnostics, Gothenburg, Sweden). The implant stability quotient (ISQ) was documented. The implants were loaded immediately in 2 mini pigs with fixed provisional restorations. After 1 month another 2 animals, after 2, 3 and 4 months 1 mini pig and after 5 months 2 mini pigs received prosthetic supply. The mini pigs were followed up monthly. Broken bridgework was repaired.

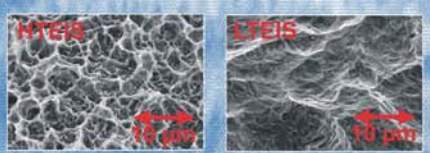

Fig. 3: SEM images of the different implant surfaces.

Fig. 4: Implants immediately after installation.

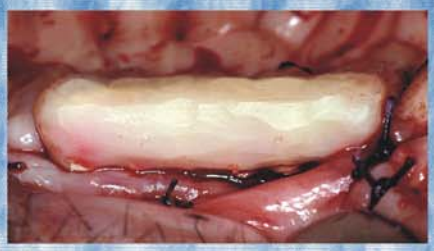

Fig. 5: Fixed provisional bridge immediately after installation.

Fig. 6: Fixed provisional bridge after 6 months of loading.

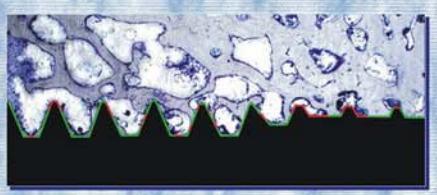

Fig. 7: Determination of bone-to-implant contact (green: bone-implant-contact, red: no bone-to-

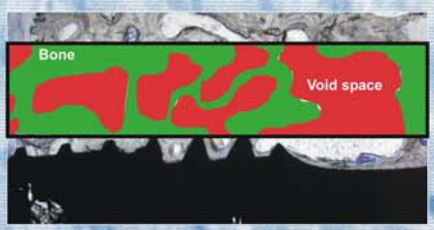

Fig. 8: Determination of the peri-implant bone density.

Results

There were no relevant differences for the implant stability (ISQ) at the different points of time of the data assessment for the two implant surface modifications. At the time of implant placement an ISQ value of 74.3+/-7.8 was found for LTEIS and 74.9+/-5.3 for HTEIS, respectively. At the end of the loading period ISQ values of 69.3+/-6.2 were assessed for LTEIS and 69.2+/-6.2 for HTEIS, respectively (Table 1). The histomorphometrical assessment of the bone-to-implant contact revealed that there were no relevant differences between the two implant surfaces. LTEIS showed a bone-to-implant contact percentage of 74.8+/-20.8 % and HTEIS a percentage of 72.1+/-24.4 %, respectively (P=0.176). The peri-implant bone density was 56.3+/-18.9 % for HTEIS and 59.1+/-17.5 % for LTEIS (P=0.204). The crestal bone resorption was silghtly reduced in the implants with the high temperature etched surface compared to the low temperature etched surface (2.1+/-0.8 mm HTEIS, 2.3+/-0.9 mm LTEIS). The differences were not statistically significant (P=0.492). However, the number of implant failures was decisively reduced by 36 % with the high temperature etched implant surface compared to the low temperature etched implant surface (P=0.0220 at stage-two surgery, P=0.0012 at the end of the observation period)(Table 2).

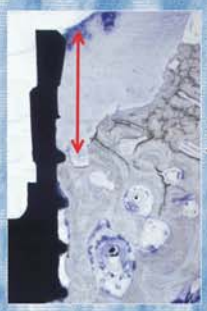

Fig. 9: Determination of the crestal bone loss.

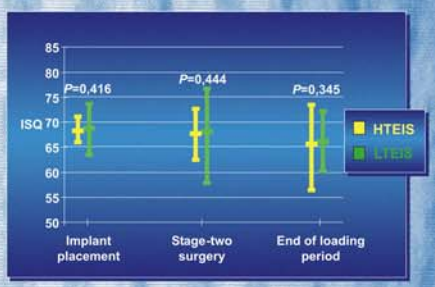

Table 1. Implant stability (ISQ) determined by the resonance frequency analysis.

Table 2: Implant failures.

Discussion

In-vitro-experiments have shown that the increased microroughness of high temperature etched implant surfaces facilitate the adhesion of osteoblasts compared to low temperature etched implant surfaces. The latter have been successful in providing excellent bone-to-implant contact in the recent years (1-3). However, it seems that high temperature etched implants surfaces bring upon an additional improvement in implant treatment. Because of the demading conditions of the experimental animal trial without oral hygiene and test groups subjected to immediate loading high implant failure rates are not surprising (1). However, even under these demanding circumstances that can hardly be found in humans, the new surface with improved microroughness performed better with statistical significance. Therefore, it seems that the high temperature etched implant surface will bring an improved success rate of implant therapy in very demanding situations like immediate loading in the maxilla. The analysis of the mechanisms of improved implant success by enhanced microroughness will be the focus of further research.

References

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The study protocol was approved by the Animal Care Committee of the Regional Government of Mittelfranken (Ansbach, Germany, approval number 621.2531.31-10/98).

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