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Microarray analysis of peri-implant tissue behaviour next to different titanium implant surfaces

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Aim

The aim of this split-mouth study was to evaluate the behaviour of soft and hard tissue around implants with two different surface treatments.

Materials and methods

10 patients (5 men, 5 women) were treated with fixed partial dentures supported by implants. Each patient received at least 2 implants (1 control, 1 test) into an edentulous quadrant. The control implants (Osseotite, OSS) had a dual acid-etched (DAE) surface in the apical portion and a machined coronal part; test implants (Full Osseotite, FOSS) had a completely DAE surface. Machined healing abutments were placed on control implants and DAE abutments on test ones. After 3 months from surgery, a mini-invasive sample of soft tissue was collected from the first 7 patients recruited for the study (4 women and 3 men). The samples were analysed by microRNA (miRNA) microarray. Standardised periapical radiographs were taken to investigate interproximal bone levels at baseline (immediately after implant insertion), 2 months, 6 months, and 1 year post-implant placement. Plaque index (PI), bleeding on probing (BOP) and periodontal depth (PD) were recorded at 3 and 6 weeks, and at 2, 3, 6 and 12 months post-implant placement. Differences in bone resorption over time were evaluated with the Friedman test followed by post-hoc Wilcoxon signed ranks tests. Differences in bone resorption, PI, BOP and PD between the two types of implants over time were assessed by the repeated measures ANOVA test for ranked data. A p $\leq$0.05 was considered statistically significant. Statistical analyses were carried out with SPSS v.20. Microarray data were processed by GeneSpring® software, and their overall variability was examined by box-plot analysis, scatter-plot analysis, hierarchical cluster analysis (HC) and principal component analysis (PCA). Individual miRNAs modulated by the experimental treatments and measured clinical parameters were identified by volcano-plot (thresholds 2-fold and P<0.05), support vector machine and k-nearest neighbour analyses.

Results

Control implants showed greater bone resorption compared to test ones; however, the difference was not statistically significant. Greater plaque accumulation was found for test surfaces, but the difference was not statistically significant. No statistically significant differences in BOP and PD were found. miRNA microarray analysis led to the following findings:

- ✓Implant sites with low plaque accumulation and absence of BOP had a gene expression profile similar to those with plaque deposits and an absence of BOP; sites with both high PI and high BOP had a completely different profile.
- ✓Implant sites with BOP present presented similar gene expression profiles independently from the type of implant surface.
- ✓Implant sites with high PI and normal bone resorption had a different expression profile than the other experimental conditions.
- ✓Implant sites with normal bone resorption despite high BOP differed from the other experimental conditions. This gene expression profile resembled that of FOSS implants.
- ✓Implant surface affected bone resorption: groups having similar bone resorption characteristics (normal vs. increased) clustered differently according to the implant type.

Conclusions

DAE surfaces showed more plaque accumulation than machined ones; however, this did not affect the health of soft peri-implant tissue. In fact, BOP values did not differ between test and control implants. Furthermore, DAE surfaces induced lower bone resorption compared with machined ones. miRNA analysis suggested that soft tissue inflammation is more related to a specific host characteristic (gene expression profile) rather than to the presence of plaque or to a given implant surface. Some specific miRNA profile might be able to protect implant sites from bleeding and bone resorption irrespective of plaque accumulation. Possible future applications of the present findings include the use of the identified biomarkers for diagnosis and as drugs or coatings for implant surfaces in order to improve the health of peri-implant tissues.

Fig.1 Test implant on the left and control implant on the right.

Fig.2 Test and control healing abutments.

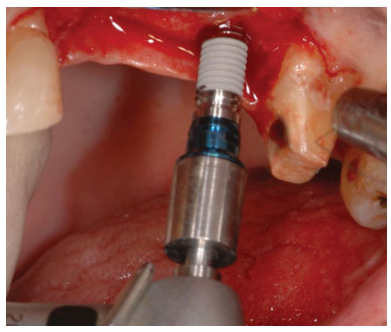

Fig.3 Intraoperatory view.

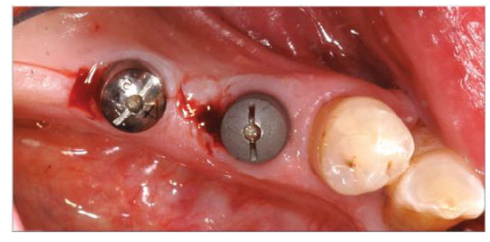

Fig.4 Mini-invasive bioptic samples taken from peri-implant mucosa surrounding a machined healing abutment (on the left) and a modified (DAE) healing abutment (on the right) 3 months after implant insertion.

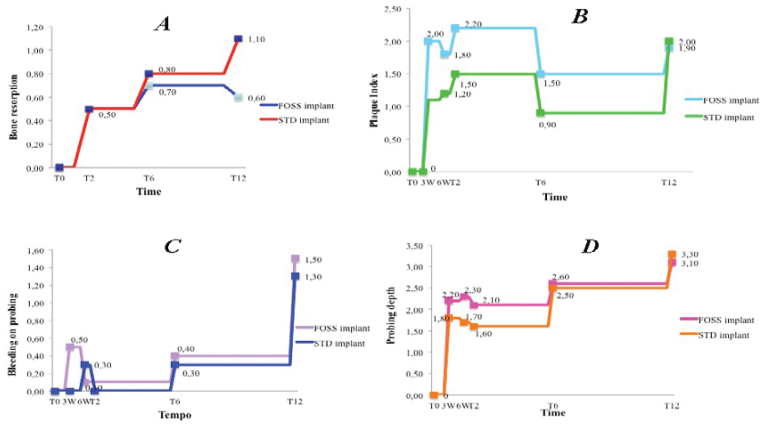

Fig.5 A) Bone resorption B) Plaque index C) Bleeding on probing D) Probing depth over time.

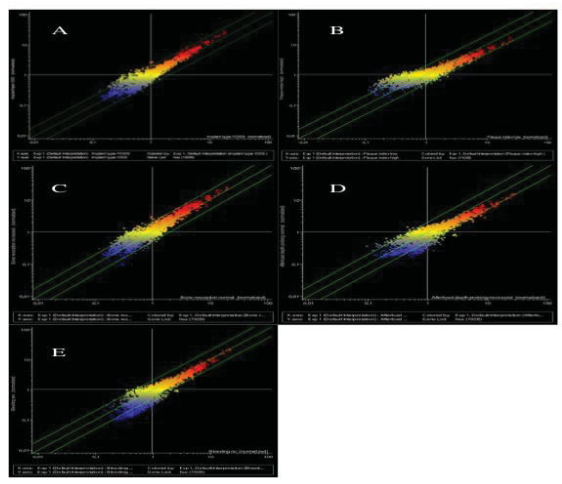

Fig.6 (A) Scatter plot representing 96 differently expressed miRNA between OSS (vertical axis) and FOSS (horizontal axis) implants. (B) Comparison of miRNA expression between implants with high PI and those with low PI. Differences <2-fold were observed for 230 miRNAs, mainly expressed at low intensity. (C) Scatter plot of bone resorption. (D) Scatter plot related to PD. (E) Scatter plot related to BOP.

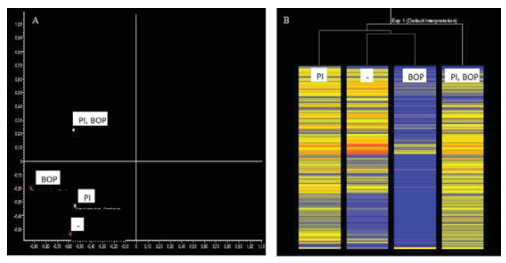

Fig.7 (A) Supervised principal component analysis of variance (PCA) for plaque index (PI) and bleeding on probing (BOP). (B) Unsupervised hierarchical cluster analysis (HC). Columns from left to right: 1st, sites with high PI and no BOP; 2nd, sites with low PI and no BOP; 3rd, sites with low PI and presence of BOP; 4th, sites with high PI and presence of BOP

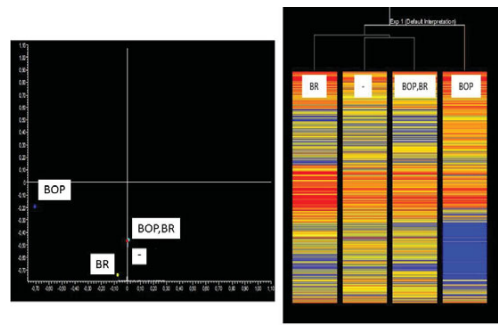

Fig.9 Supervised principal component analysis of variance (PCA) (left panel). The sites with high bleeding on probing (BOP) and normal bone resorption (BR) (spot on the left) had an expression profile different than the other sites. This finding was confirmed by unsupervised hierarchical cluster analysis (HC) (right panel). Columns from left to right: 1st, sites with high BR and no BOP; 2nd, sites with neither BR or BOP; 3rd, sites with both BOP and BR; 4th, sites with high BOP but no BR.

References

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