Implant Surface Enhancement – Myth and Reality

Comparative Analysis of Currently Available Implants

Introduction

Implant surface characteristics are considered to play a mayor role in accelerating the processes which lead to osseointegration. Some manufacturers claim for a reduced healing time (6–8 or 8 weeks)[7]. Besides physical and chemical parameters like wettability, positive or negative surface charge and surface-free energy, the topography of dental implant surfaces can influence cell attachment und subsequent osseointegration[3–5]. Several cell types are involved in the process of osseointegration, such as osteoblast-like cells and other anchorage-dependent cells like fibroblasts. These cells show similar morphologic behaviour and affinity to rough titanium surfaces[2].

The aim of this article is to present the topographical aspects of currently available implant surfaces.

Material and Methods

Different commercially available dental implants have been investigated to compare surface roughness and reproducibility of advertised properties. Scanning electron microscopy (SEM) was used for topographical evaluation, backscattered electron imaging (BEI) was used for density and/or atomic number analysis. X-ray microanalysis (XRM) was used for elemental analysis.

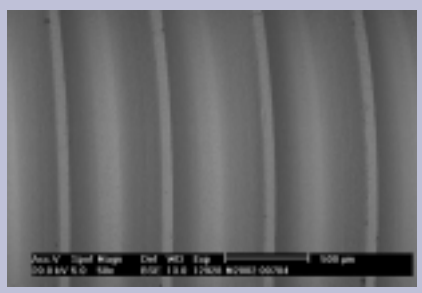

Figure A1 *Embedded particles on threads.*

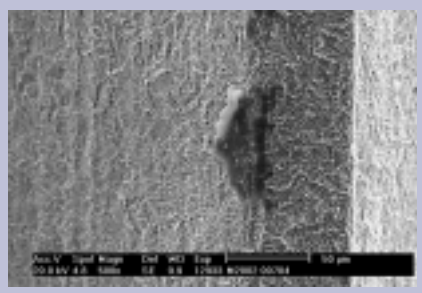

Figure A4 *Embedded particle; magnification 500x.*

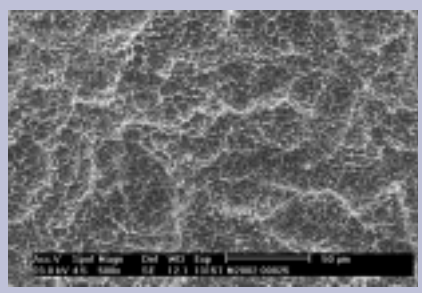

Figure B2 *Topography of grit-blasted and acid-etched surface.*

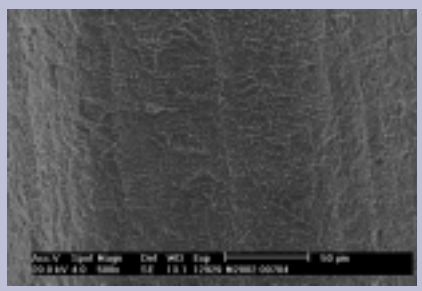

Figure A2 *Topography of solely acid-etched surface.*

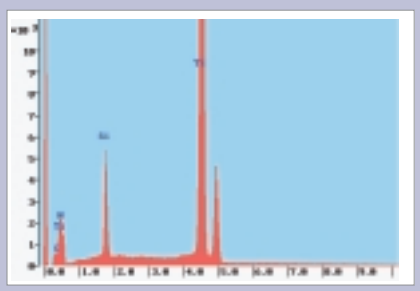

Figure A5 *XRM-analysis of embedded particle. Possible source: sealing cap used for protection while etching.*

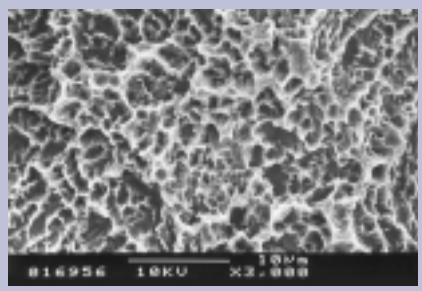

Figure B3 *Homogeneous topography of grit-blasted and acid-etched surface.*

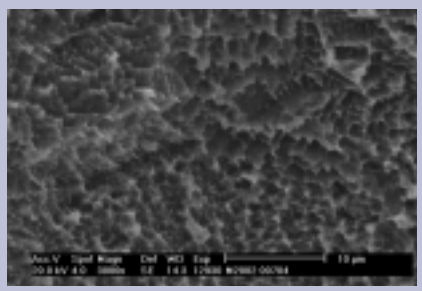

Figure A3 *Slightly inhomogeneous surface structures.*

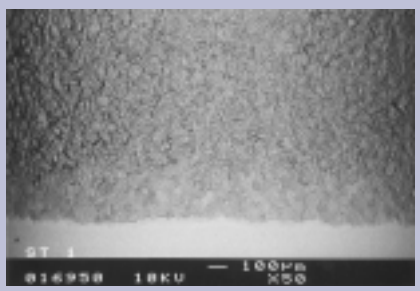

Figure B1 *Surface of grit-blasted and acid etched implant.*

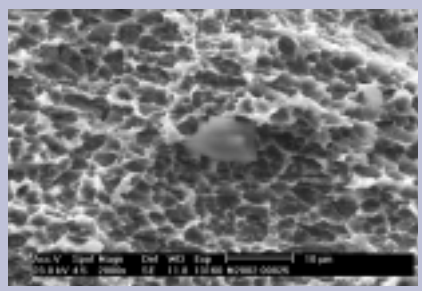

Figure B4 *Grit particle on surface; magnification 2000x.*

The above is based on information provided by the manufacturer.

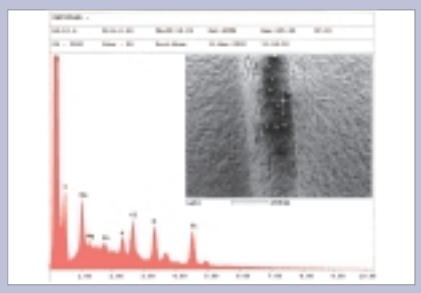

Figure B5 *XRM-analysis of surface; high concentration of phosphorus (claimed as pure TiO2-surface).*

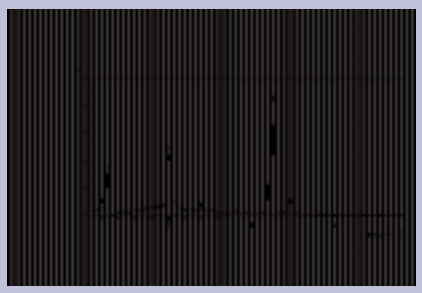

Figure C5 *XRM-analysis of surface; high concentration of phosphorus (claimed as pure TiO2-surface).*

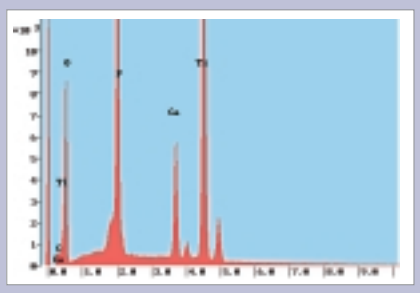

Figure D5 *XRM-analysis showing presence of calcium and phosphorus.*

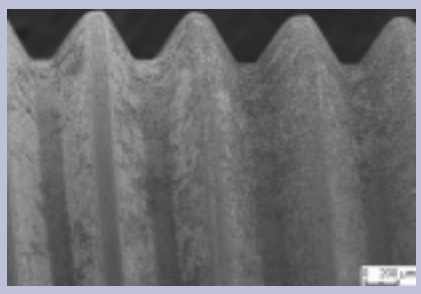

Figure C1 *Inhomogeneous surface morphology, produced by anodic oxidation.*

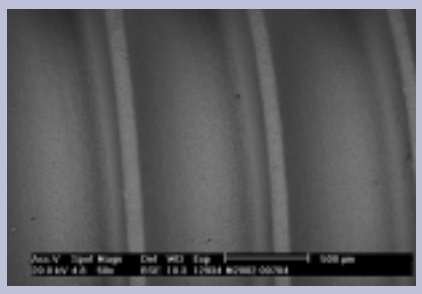

Figure D1 *Inhomogeneous porosities on threads.*

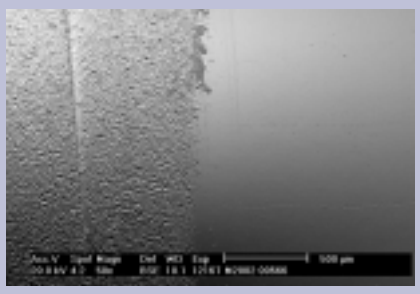

Figure E1 *Embedded particle on transition area.*

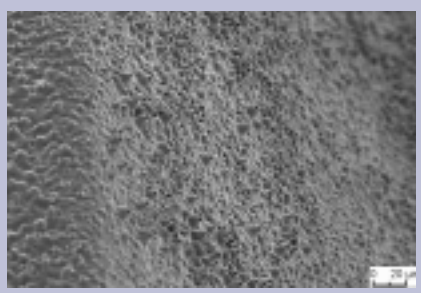

Figure C2 *Topography of surface produced by anodic oxidation; porous structures.*

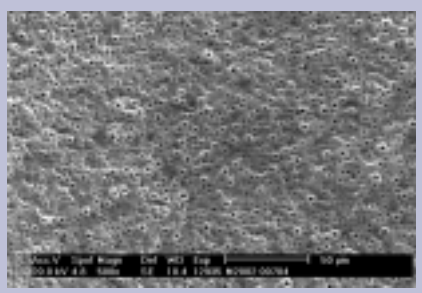

Figure D2 *Topography of surface produced by anodic oxidation; similarity to TiUnite surface.*

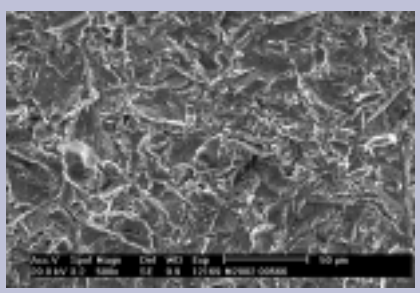

Figure E2 *Structure of solely grit-blasted surface.*

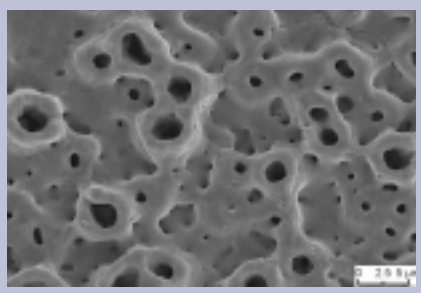

Figure C3 *Cracked surface and highly inhomogeneous distribution of porous structures.*

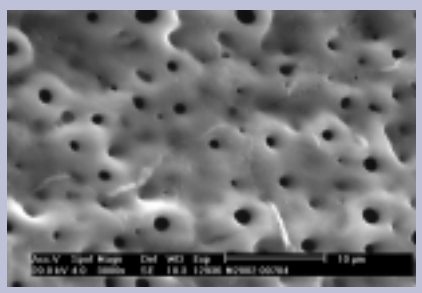

Figure D3 *Cracked surface and inhomogeneous distribution of porosities.*

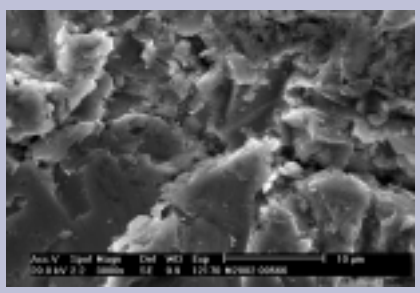

Figure E3 *Structure with presence of grit particles.*

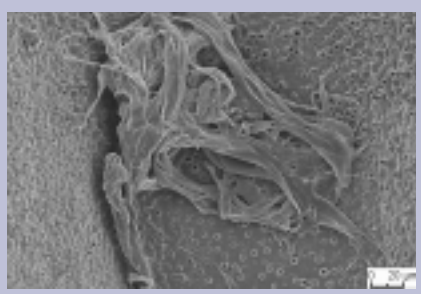

Figure C4 *Foreign fibrous particle on surface; magnification 500x.*

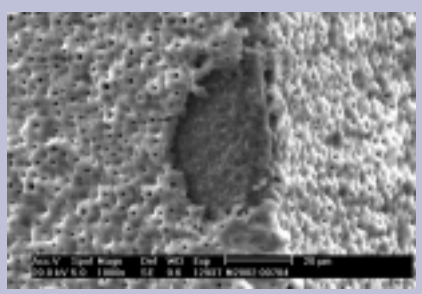

Figure D4 *Surface defect; magnification 1000x.*

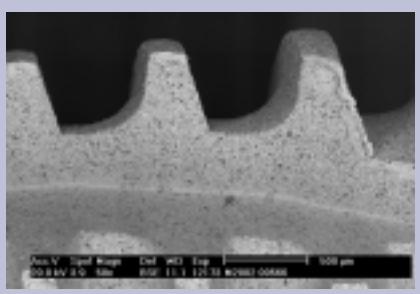

Figure E4 *Surface defect on threads; magnification 50x.*

The above is based on information provided by the manufacturer.

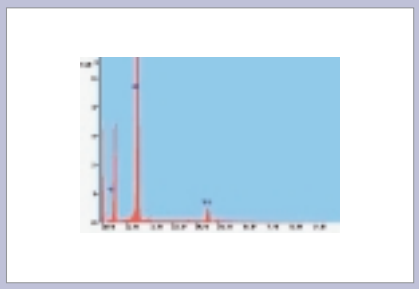

Figure E5 *XRM-analysis of grit particle; identified as aluminium oxide.*

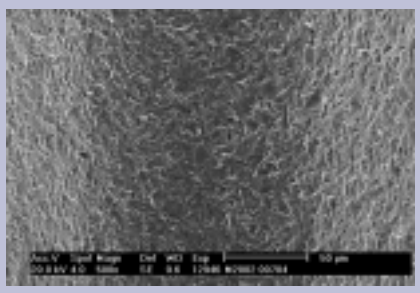

Figure F2 *Structure of titanium-blasted surface.*

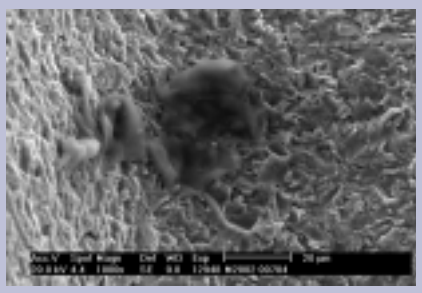

Figure F4 *Embedded particle; magnification 1000x.*

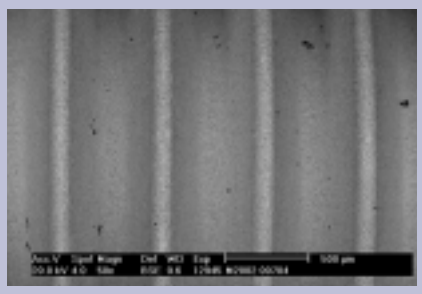

Figure F1 *Embedded particles on surface.*

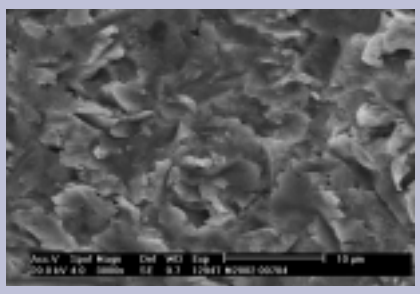

Figure F3 *Slightly inhomogeneous blasted surface.*

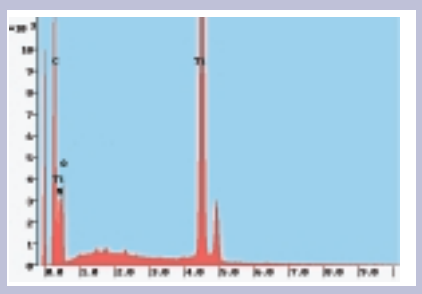

Figure F5 *XRM-analysis of embedded particle. Source: organic material.*

Conclusions

Some marketing claims on implant surface characteristics were critically evaluated and discussed on their clinical evidence. Embedded particles of the production process like grit particles could be observed as well as inhomogeneous structures.[1] Nevertheless, within the range of state-of-the-art implant surfaces very high success rates have been documented.[6] Topographical similarities of different implant surfaces could be observed. Consequently, the reduced healing times claimed for a specific surface could also be related to surfaces with similar topographies. Surface roughness values are not clearly related to topographical appearance. Further development of enhanced implant surfaces should lead to morphologic structures which are homogeneously distributed to enable an allover high level of close cell attachment. Limited data on the influence of embedded production particles on the implant surface are available. However, Paolantonio et al. have demonstrated that no statistic evidence could be provided to support the hypothesis that surface inorganic contamination could affect osseointegration of titanium dental fixtures.[8]

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