Topographical Aspects of Distinctive Titanium Surfaces - Comparative Analysis of Available Implant Surfaces

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Introduction

Implant surface characteristics are considered to play a major role in accelerating osseo-integration. Distinctive surface modifications are offered by implant manufacturers recommending a reduced healing time of 6 to 8 weeks. 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 and subsequent osseointegration. Osteoblast-like or other anchorage-dependent cells, e.g., fibroblasts, show similar morphologic behaviour and their affinity to rough titanium surfaces. The topographical aspects of currently available implant surfaces and their serial reproducibility are compared.

Material and Methods

Different commercially available dental implants have been investigated by scanning electron microscopy (SEM) to compare surface roughness and reproducibility of the properties advertised. Backscattered electron imaging (BSE) was used for density and/or atomic number analysis, and x-ray microanalysis (XRM) was used for elemental analysis. The results of differently engineered implant surfaces will be compared and discussed for solely etched, solely blasted and grit-blasted acid-etched treatments.

Results

3i Osseotite® (Solely acid-etched)

- Embedded particles on threads
- Topography of solely acid-etched surface
- Slightly inhomogeneous surface structures
- Embedded particle, magnification 50x


Straumann SLA® (Grit-blasted/acid-etched)

- Surface of grit-blasted and acid etched implant
- Topography of grit-blasted and acid-etched surface
- Homogeneous topography of grit-blasted and acid-etched surface
- Grid particle on surface, magnification 2000x

XRM-analysis of small particles on thread, source: organic material.

Nobel Biocare TiUnite® (Anodic oxidation)

- Inhomogeneous surface morphology, produced by anodic oxidation
- Topography of surface produced by anodic oxidation, similarly to TiUnite surface
- Convex surface with inhomogeneous distribution of porosities
- Ceramic fuses on particle on surface, magnification 50x

XRM-analysis of surface high concentration of phosphorus (claimed as pure TiO2 surface).

ZL TICER® (Anodic oxidation)

- Inhomogeneous particles on threads
- Topography of surface produced by anodic oxidation, similarly to TICER surface
- Convex surface with inhomogeneous distribution of porosities
- Surface detail, magnification 1000x

XRM-analysis showing presence of calcium and phosphorus.

Ankylos® (Solely grit-blasted)

- Embedded particle on transition area
- Structure of solely grit-blasted surface
- Structure with presence of grit particles
- Surface detail on threads, magnification 50x

XRM-analysis of grit particle, identified as aluminium oxide.

Astra TiOblast® (Solely titanium-blasted)

- Embedded particles on surface
- Structure of titanium-blasted surface
- Slightly inhomogeneous blasted surface
- Embedded particle, magnification 1000x


Conclusion

Discrepancies can be noted between the surface properties advertised by implant manufacturers and the actual appearance of the surface morphology. Embedded particles of the production process like grit particles can be observed as well as inhomogeneous structures. Nevertheless, within the range of state-of-the-art implant surfaces very high success rates have been documented. Topographical similarities of different implant surfaces can be observed. This could lead to the conclusion that 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 allowed high level of close cell attachment. Limited data on the influence of embedded production particles on the implant surface is available. However, Piattelli et al. has demonstrated that no statistic evidence could be provided to support the hypothesis that surface inorganic contamination could affect osseointegration of titanium dental fixtures.

References