

Detailed Failure Analysis of Dental Titanium Implants

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Aim of the investigation

The lifetime of a dental implant is determined by »external factors« which describe the loads the implant is exposed to, and by implant - specific properties (e.g. geometrical design, surface treatment, in rare cases material defects). Aim of our study is to elucidate the cause of implant failures by failure analysis and - if possible - to derive recommendations how to avoid these failures.

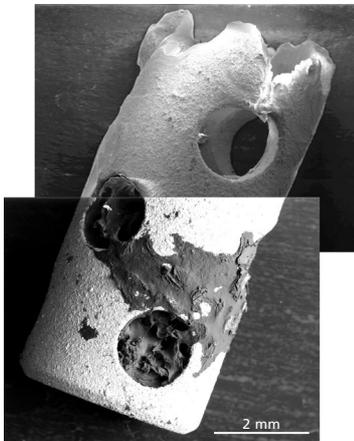
Method and Materials

The surfaces and the fracture surfaces of several explants which were provided by the »Bund der niedergelassenen implantologisch tätigen Zahnärzte in Deutschland (BDIZ)« were studied with a scanning electron microscope (SEM).

We present three cases which demonstrate the opportunities of the failure analysis.

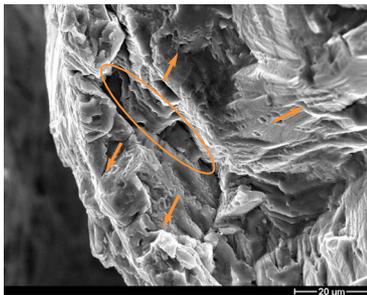
Results

Case 1: Hollow cylinder implant

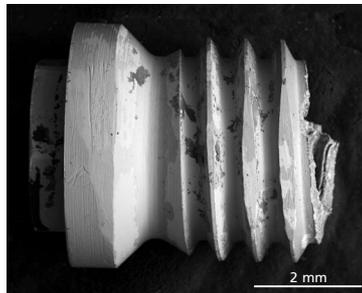


Starting point of the crack:

- Inclusion (material defect)
- Partial degeneration of the bone: higher loads in the region of the inclusion became critical

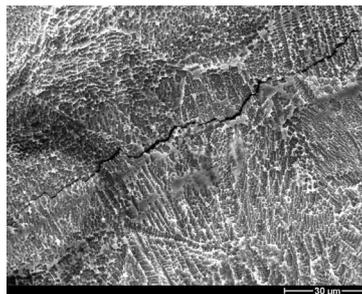


Case 2: Screw implant



Etching of the surface:

- Increased roughness, supports bonding with bone structure
- Created local etching pits and grooves following the grain boundaries
- Locally accumulated stresses
- Acceleration of fatigue failure

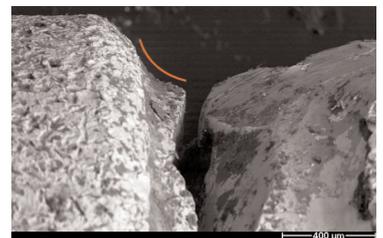
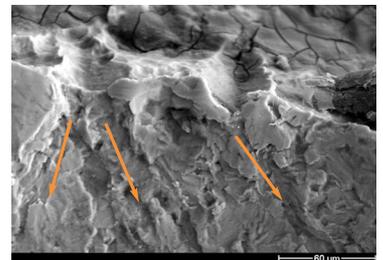


Case 3: Screw implant



Sandblasting of the implant:

- Increased roughness, supports bonding with bone structure
- Created notches on the surface
- Notches and step in the diameter of the implant lead to locally accumulated stresses
- Acceleration of fatigue failure



Conclusions

Failure analysis enables us to determine factors which contribute to the failure of implants. In particular for implants which underwent a roughening of the surface, it would be interesting to find the optimal surface roughness which on the one hand supports osseointegration and at the other hand results in a sufficient fatigue resistance.