Oct 17, 2016

"Monday Morning Pearls of Practice by Bobby Baig"

baig@buildyoursmile.com

Prosthodontic Associates
2300 Yonge St, suite 905
Toronto, M4P1E4
www.buildyoursmile.com

Mechanical Integrity of Retrieved Dental Implants

K Shemtov-Yona et al 2015

Introduction:

Implants have high rate of occurrence of mechanical failures over prolonged periods, one may wonder whether those observed fractures actually initiate at the very late stages of the implant life, or whether small cracks might develop at rather early stages, while going unnoticed during the usual follow-up evaluations. They are only seen and diagnosed when the fractured implant leads to complete loss of the prosthesis, and collapse of the rehabilitation procedure. Scanning the surfaces of failed implants, which failed (but did not fracture) due to bone loss and implant's mobility, after prolonged time of use, has never been performed so far. Yet, as will be shown in this paper, scanning the surface of retrieved implants that had to be removed because of purely biological complications, is likely to contain a wealth of new information related to the presence of developing micro-cracks in the structure.

Purpose:

The study reports a thorough scanning electron examination of the surface of 100 late failed implants. The presence of micro cracks is extensively characterized with regards to their frequency, location on the implant, origin and probable failure causes.

Material and Methods:

Collection of Implants:

1. One hundred implants were collected from four private clinics located in Israel.

2. All the implants were extracted most likely due to bone loss and/or lack of bone support.
3. Considered as "failed" implants. Unfortunately, no medical record of the failed dental implants was made available, such as implant material, intra-oral location, service years, carried rehabilitation, proximity to additional implants or degree of bone loss.

Implants cleaning:

The collected implants were covered with debris of bone and organic materials that had to be removed in order to perform a complete reliable examination. All implants were cleaned according to a cleaning protocol described.

Layers to be removed	**Chemical Solution**	**Time in solution**
Blood and soft tissues	Sodium hypochlorite 3%	<10 mins
Organic layer	Acetone	30 mins
Inorganic layer	EDTA 17%`	As needed

Implants Examination:

All implants were examined for early signs of mechanical failures (e.g. cracks) by using scanning electron microscopy.

For each examined implant, 5 primary properties were evaluated:

1. Characterization of the implants diameter and length.
2. Identification of the surface treatment if any.
3. Presence of defects and their characterization.
4. Identifications of the defects' location.
5. Involvement of embedded foreign particles with the observed defects.

RESULTS:

Implants composition type:

The SEM-EDX analyses indicated that

1. 89% of the 100 implants were made of titanium alloy Ti–6Al–4V.
2. 11% of Commercially Pure Titanium.

Implants surface treatments:

1. 94% of the implants underwent a specific surface treatment.
2. 6% of the implants were as machined only.

Implants surface treatments types:

1. Titanium plasma spray (TPS) (30%),
2. Anodizing (1%)

3. Grit-blasting and etching (50%),
4. Grit blasting only (9%),
5. Etching only (4%).

Defects types: Categorized Based on Length and Appearance of the defect: 62% have defects

1. Defects that had a length exceeding 0.5mm were defined as "full cracks". (34%)
2. Defects with a length between 25 mm and 100 mm were defined as "crack-like defects" (28%)
3. The observed defects on the examined commercial implants before implantation and loading, were quite abundant, and consisted essentially of craters.
4. No signs of wear or tool markings, all indicative of a surgical procedure, were observed in the vicinity of the defects. It can therefore, be reasonably assumed that the present crack like defects and full cracks were in fact generated during the implant's use.
5. The observations might indicate that CP-Ti is more prone to developing mechanical damage. This may be based on the fact that, for a similar geometry and mastication loads, the relative (normalized by yield strength) stress is lower for the stronger Ti alloy as compared to the CP-Ti.

Defect Location:

1. A definite correlation exists between the defects location and the defect type. Although most defects were observed on the implant's threads, all the defects that were observed on the implant's neck were full cracks, pointing to the implant's neck as the potentially preferential site for failures.

Conclusions:

Mechanically sound dental implants were retrieved because of biological complications. Examination of 100 implants' surfaces and characteristics revealed the following:

1. About 60% of the examined implants contained crack like defects or full cracks.
2. Commercially pure Titanium implants were more damaged than Titanium alloy Ti–6Al–4V implants.
3. When surface roughening included grit blasting, the involvement of embedded foreign particles was evident, and a strong connection to the defects evolution was seen.
4. No correlation between the implants' width and length and defect occurrence or nature was identified.
5. Because biological failures occur firstly, they don't allow for later mechanical failures of earlier in vivo damaged implants.
6. The present observations suggest that the occurrence of mechanical failures of dental implants is likely to increase as the frequency of biological failures that necessitate implant extraction will diminish.

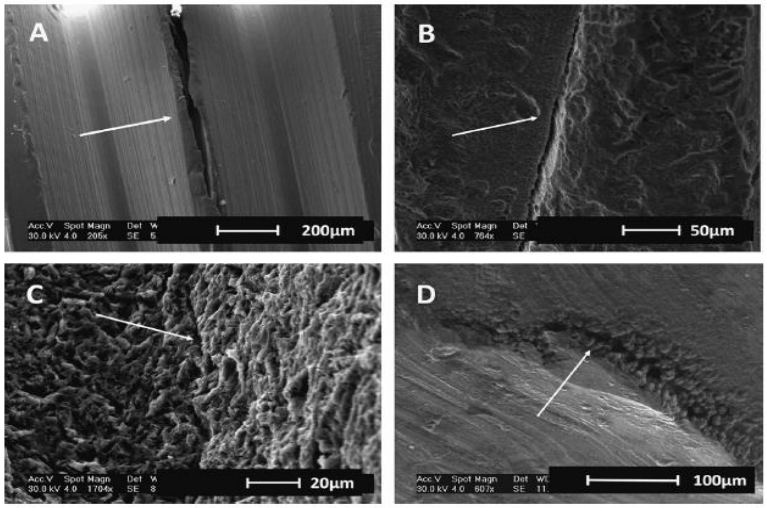

Fig. 2 – "Full cracks" (white arrows): SEM micrographs of surface defects defined as "full cracks". (A) As-machined, (B) Grit-blasted and etched, (C) TPS, and (D) Anodized. The white arrows mark "full cracks".

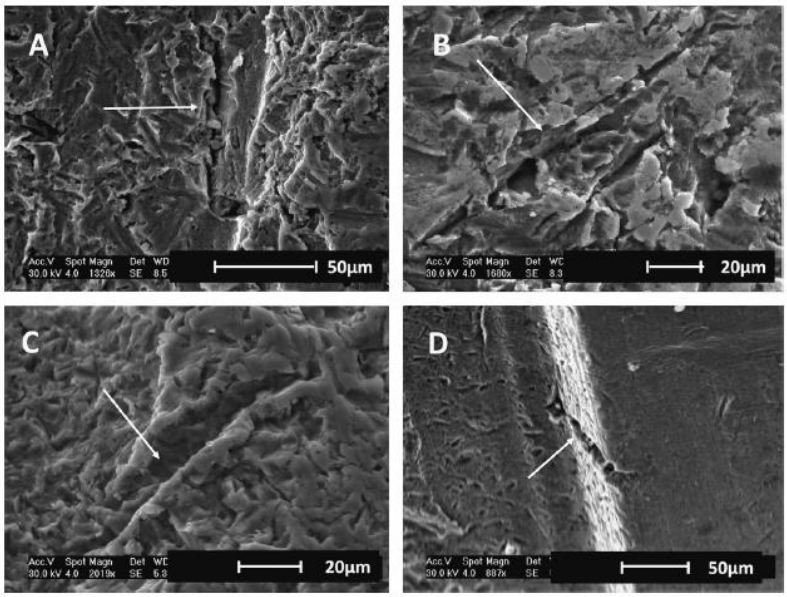

Fig. 3 – "Crack-like defects (white arrows)": SEM micrographs of surface defects defined as "crack-like" (A and B) Grit-blasted and etched. (C) Coated TPS. (D) Grit-blasted only.

Authors comments and recommendations:

1. To encourage dental implant manufacturers and dentists to find ways to reduce "metal fatigue".
2. The localized structural damage that occurs when a metal is subjected to repeated applied loads.
3. Over time, metal fatigue causes many of the implant-related fractures.
4. "Embedded particles appear to be linked to the generation of surface defects that evolve into full cracks."
5. The effect of time and the wear and tear of daily use may also contribute the potential for manufacturing flaws to develop into cracks and subsequently lead to the ultimate failure of the materials of which they are made.

Reference:

1. Berglundh, T., Persson, L., Klinge, B., 2002. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J. Clin. Periodontol. 29 (Suppl. 3), 197–212.
2. De Boever, A.L., Keersmaekers, K., Vanmaele, G., Kerschbaum, T., Theuniers, G., De Boever, J.A., 2006. Prosthetic complications in fixed endosseous implant-borne reconstructions after an observations period of at least 40 months. J. Oral Rehab. 33, 833–839.
3. Dhima, M., Paulusova, V., Lohse, C., Salinas, T.J., Carr, A.B., 2014. Practice-based evidence from 29-year outcome analysis of management of the edentulous jaw using osseointegrated dental implants. J. Prosthodont. 23, 173–181.
4. Gealh, W.C., Mazzo, V., Barbi, F., Camarini, E.T., 2011. Osseointegrated implant fracture: causes and treatment. J. Oral Implantol. 37, 499–503.
5. Goodacre, C.J., Bernal, G., Rungcharassaeng, K., Kan, J.Y., 2003. Clinical complications with implants and implant prostheses. J. Prosthet. Dent. 90, 121–132.
6. Le Gue ́hennec, L., Soueidan, A., Layrolle, P., Amouriq, Y., 2007. Surface treatments of titanium dental implants for rapid osseointegration. Dent. Mater. 23, 844–854.
7. Leinenbach, L., Eifler, D., 2006. Fatigue and cyclic deformation behaviour of surface-modified titanium alloys in simulated physiological media. Biomaterials 27, 1200–1208.
8. Manor, Y., Oubaid, S., Mardinger, O., Chaushu, G., Nissan, J., 2009. Characteristics of early versus late implant failure: a retrospective study. J. Oral Maxillofac. Surg. 67, 2649–2652.
9. Morgan, M.J., James, D.F., Pilliar, R.M., 1993. Fractures of the fixture component of an osseointegrated implant. Int. J. Oral Maxillofac. Implants 8, 409–414.
10. Novovic, D., Dewes, R.C., Aspinwall, D.K., Voice, W., Bowen, P., 2004. The effect of machined topography and integrity on fatigue life. Int. J. Mach. Tool Manu. 44, 125–134.
11. Papaspyridakos, P., Chen, C.J., Chuang, S.K., Weber, H.P., Gallucci, G.O., 2012. A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. Int. J. Oral Maxillofac. Implants 27, 102–110.
12. Pjetursson, BE, Thoma, D, Jung, R, Zwahlen, M, Zembic, A., 2010. A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years. Clin. Oral Implants Res. 23 (Suppl. 6), 22–38.
13. Pjetursson, B.E., Asgeirsson, A.G., Zwahlen, M., Sailer, I., 2014. Improvements in implant dentistry over the last decade: comparison of survival and complication rates in older and newer publications. Int. J. Oral Maxillofac. Implants Suppl. 308-24, 29.
14. Pommer, B., Bucur, L., Zauza, K., Tepper, G., Hof, M., Watzek, G., 2014. Meta-analysis of oral implant fracture incidence and related determinants. J. Oral Implant 2014/2639.