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Identification Card and Codification of the Chemical and Morphological Characteristics of 62 Dental Implant Surfaces. Part 3: Sand-Blasted/Acid-Etched (SLA Type) and Related Surfaces (Group 2A, main subtractive process).

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Background and Objectives

Dental implants are commonly used in dental therapeutics,but dental practitioners only have limited information about the characteristics of the implant materials they take the responsibility to place in their patients. The objective of this work is to describe the chemical and morphological characteristics of 62 implant surfaces available on the market and establish their respective Identification (ID) Card, following the Implant Surface Identification Standard (ISIS). In this third part, surfaces produced through the main subtractive process (sand-blasting/acid-etching, SLA-type and related) were investigated.

Materials and Methods

Eighteen different implant surfaces were characterized: Straumann SLA (ITI Straumann, Basel, Switzerland), Ankylos (Dentsply Friadent, Mannheim, Germany), Xive S (Dentsply Friadent, Mannheim, Germany), Frialit (Dentsply Friadent, Mannheim, Germany), Promote (Camlog, Basel, Switzerland), Dentium Superline (Dentium Co., Seoul, Korea), Osstem SA (Osstem implant Co., Busan, Korea), Genesio (GC Corporation, Tokyo, Japan), Aadva (GC Corporation, Tokyo, Japan), MIS Seven (MIS Implants Technologies, Bar Lev, Israel), ActivFluor (Blue Sky Bio, Grayslake, IL, USA), Tekka SA2 (Tekka, Brignais, France), Twinkon Ref (Tekka, Brignais, France), Bredent OCS blueSKY (Bredent Medical, Senden, Germany), Magitech MS2010 (Magitech M2I, Levallois-Perret, France), EVL Plus (SERF, Decines, France), Alpha Bio (Alpha Bio Tec Ltd, Petach Tikva, Israel), Neoporos (Neodent, Curitiba, Brazil). Three samples of each implant were analyzed.

Superficial chemical composition was analyzed using XPS/ESCA (X-Ray Photoelectron Spectroscopy/Electron Spectroscopy for Chemical Analysis) and the 100nm in-depth profile was established using Auger Electron Spectroscopy (AES). The microtopography was quantified using optical profilometry (OP). The general morphology and the nanotopography were evaluated using a Field Emission-Scanning Electron Microscope (FE-SEM). Finally, the characterization code of each surface was established using the ISIS, and the main characteristics of each surface were summarized in a reader-friendly ID card.

Descriptions of the surfaces

Straumann SLA (Sand-blasted, Large-grit, Acid-etched; ITI Straumann, Basel, Switzerland) was a sand-blasted/acid-etched surface. Some inorganic pollution with silicon was detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

Ankylos (Dentsply Friadent, Mannheim, Germany) was a sandblasted/acid-etched surface. The surface was covered with alumina particles (Al2O3) and many other inorganic pollutions were detected with sodium, fluorine, calcium, phosphorus (as phosphate), zinc, chloride and sulfur (as sulfate). The surface was moderately microrough and nanosmooth, but heterogeneous all over the implant (particularly because of the many residues). The surface tested here was an early version of Ankylos; the latest version was in theory the same than Xive and Frialit.

Xive S (Dentsply Friadent, Mannheim, Germany) was a sand-blasted/acidetched surface (process called Friadent Plus). Some inorganic pollutions with calcium and sulfur were detected. The surface was maximally microrough, nanosmooth, and homogeneous all over the implant.

Frialit (Dentsply Friadent, Mannheim, Germany) was a sand-blasted/acidetched surface (process called Friadent Plus). Some inorganic pollutions with silicon and fluorine were detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant. Frialit and Xive were supposed in theory to be almost the same surface, while they presented practically some clear differences.

Camlog Promote (Camlog, Basel, Switzerland) was a sand-blasted/acidetched surface. Some inorganic pollutions with zinc and calcium were detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

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Dentium Superline (Dentium Co., Seoul, Korea) was a sand-blasted/acidetched surface. Some inorganic pollution with silicon was detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

Osstem SA (Osstem implant Co., Busan, Korea) was a sand-blasted/acidetched surface. Some inorganic pollution with silicon was detected. The surface was maximally microrough, nanosmooth, and homogeneous all over the implant.

Genesio (GC Corporation, Tokyo, Japan; was a sand-blasted/acid-etched surface. No pollution or chemical modification was detected. The surface was maximally microrough, nanosmooth, and homogeneous all over the implant.

Aadva (GC Corporation, Tokyo, Japan) was a sand-blasted/acid-etched surface on a grade 5 titanium core. No pollution or chemical modification was detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

MIS Seven (MIS Implants Technologies, Bar Lev, Israel; Figure 1) was a sandblasted/acid-etched surface on a grade 23 ELI (Extra Low Interstitials) titanium core. No pollution or chemical modification was detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

ActivFluor (Blue Sky Bio, Grayslake, IL, USA) was a sand-blasted/acidetched surface on a grade 5 titanium core. Some inorganic pollutions with silicon and phosphorus were detected. The surface was minimally microrough, nanosmooth, and homogeneous all over the implant.

Tekka SA2 (Tekka, Brignais, France) was a sand-blasted/acid-etched surface on a grade 5 titanium core. Several inorganic pollutions with calcium, phosphorus, silicon, iron and barium were detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

Twinkon Ref (Tekka, Brignais, France) was a sand-blasted surface on a grade 5 titanium core. The surface appeared impregnated with low levels of calcium, and covered with alumina particles (Al2O3) and a thick organic pollution (thick carbon overcoat all over the implant). Some other inorganic pollutions were detected with silicon, sulfur (as sulfate), chloride and zinc. The surface was minimally microrough, nanosmooth, and heterogeneous all over the implant.

Bredent OCS blueSKY (Bredent Medical, Senden, Germany) was a sandblasted/acid-etched surface. A calcium residual impregnation and several inorganic pollutions with magnesium, silicon and barium were detected. The surface was moderately microrough, nanosmooth, and homogeneous all over the implant.

Magitech MS2010 (Magitech M2I, Levallois-Perret, France) was a sandblasted/acid-etched surface on a grade 5 titanium core. It was impregnated with low levels of calcium and covered with small alumina (Al2O3) particles. Several inorganic pollutions with silicon, fluorine, zinc, magnesium and sulfur were detected. The surface was minimally microrough, nanosmooth, and heterogeneous all over the implant.

Results

From a chemical standpoint, in the 18 different surfaces of this group, 11 were based on a commercially pure titanium (grade 2 or 4) and 7 on a titanium-aluminium alloy (grade 5 or grade 23 ELI titanium). 4 surfaces presented some chemical impregnation of the titanium core, and 5 surfaces were covered with residual alumina blasting particles. 15 surfaces presented different degrees of inorganic pollutions, and 2 presented a severe organic pollution overcoat. **Only 3 surfaces presented no pollution (and also no chemical modification at all): GC Aadva, Genesio, MIS SEVEN®**. From a morphological standpoint, all surfaces were microrough, with different microtopographical aspects and values. All surfaces were nanosmooth, and therefore presented no significant and repetitive nanostructures. 14 surfaces were homogeneous and 4 heterogeneous. None of them was fractal.

Discussion and Conclusion

The ISIS systematic approach allowed to gather the main characteristics of these commercially available products in a clear and accurate ID card. The SLA-type surfaces have specific morphological characteristics (microrough, nanosmooth, with rare and in general accidental chemical modification) and are the most frequent surfaces used in the industry. However they present different designs, and pollutions are often detected (with blasting/etching residues particularly). Users should be aware of these specificities if they decide to use these products.

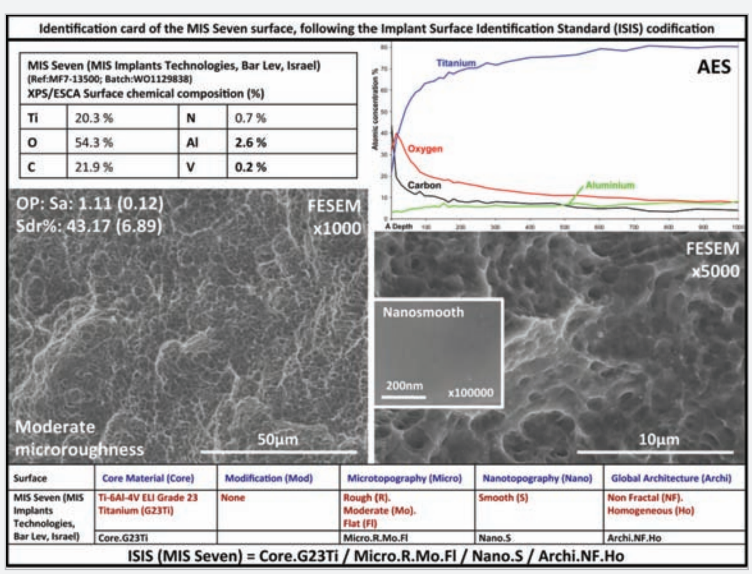

Fig. 1 Identification Card of the MIS SEVEN® surface.

The MIS Quality System complies with International Quality Standards: ISO 13485:2003 - Quality Management System for Medical Devices, ISO 9001: 2008 - Quality Management System and CE Directive for Medical Devices 93/42/EEC. MIS products are cleared for marketing in the USA and CE approved.

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