2. Challenges to Dental Surface Treatment

2.1 Aging of materials (1/2)

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The Biological Aging of Titanium Implants

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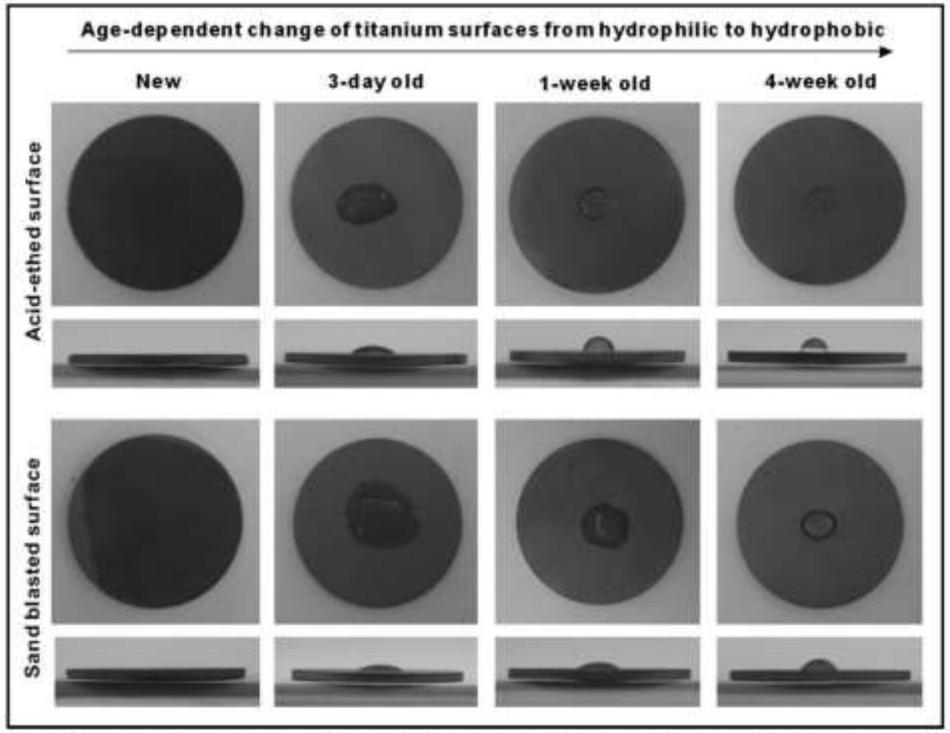

Fig. 2. Time-dependent degradation of hydrophilic property on titanium discs. Top and side view images of 10 microL of water placed on acid-etched and sandblasted titanium discs with different age.

One of the reviewed studies in this article demonstrated that implant fixation was enhanced 2.2 times, and BIC increased to 90% simply by the use of new titanium surfaces as compared with 4-week-old surfaces

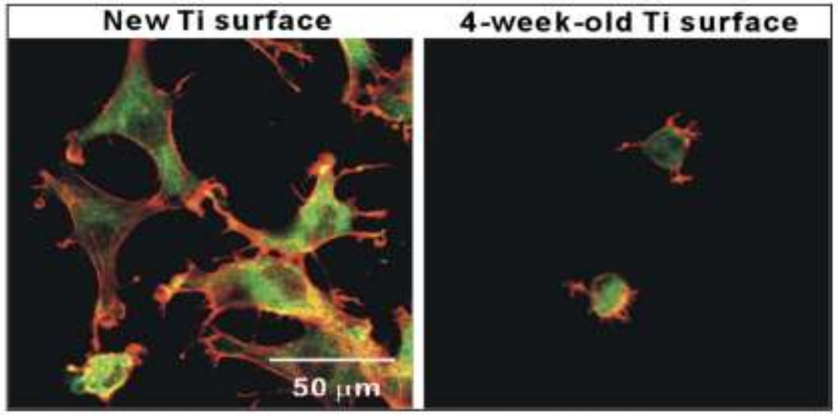

Fig. 1. Confocal laser microscopic images of bone marrow-derived osteoblasts 4 hours after seeding on acid-etched titanium discs with different age. The cells were stained with rhodamine phalloidin for cytoskeletal actin filaments (red) and anti-vinculin antibody for vinculin, a focal adhesion protein (green).

Fig. 3. Hydrophobic nature of commercial implant products. Side view images of 3 microL of water droplets placed on various implant surfaces are shown.

2. Challenges to Dental Surface Treatment

2.1 Aging of materials (2/2)

Time-dependent degradation of titanium osteoconductivity: An implication of biological aging of implant materials

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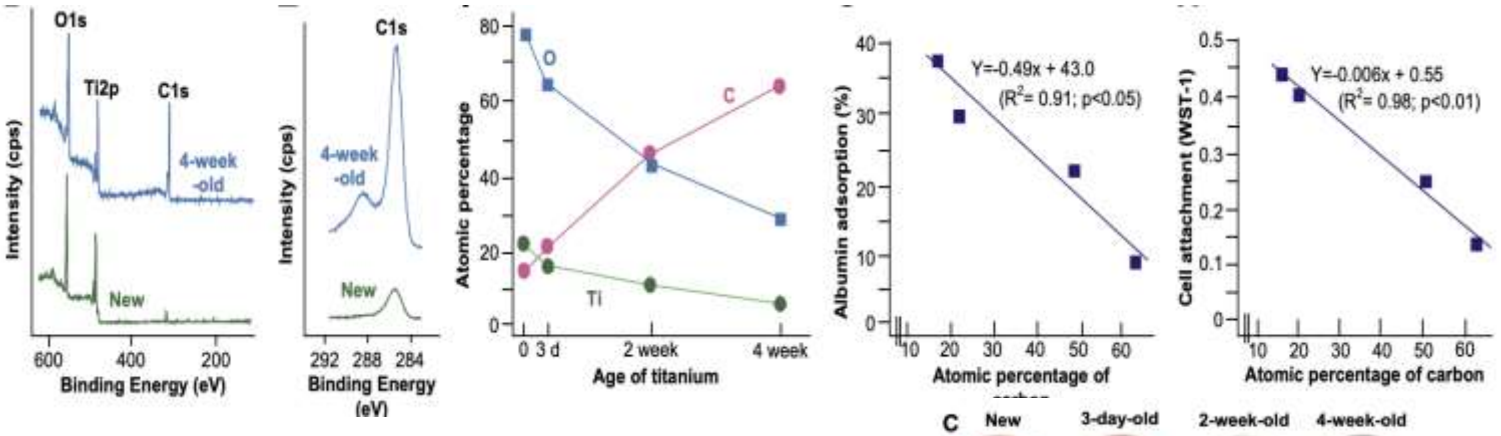

Hydrocarbon (non polar)

TiO2 (positively ➔ negatively)

This increase of surface carbon is because of an unavoidable deposition of carbon from the atmosphere onto titanium surfaces in a form of hydrocarbon.

More importantly, the capability of titanium surfaces to attract proteins and osteogenic cells was in a strong inverse correlation with the percentage of surface carbon, indicating that the surface carbon plays a crucial role in determining biological capability of titanium.

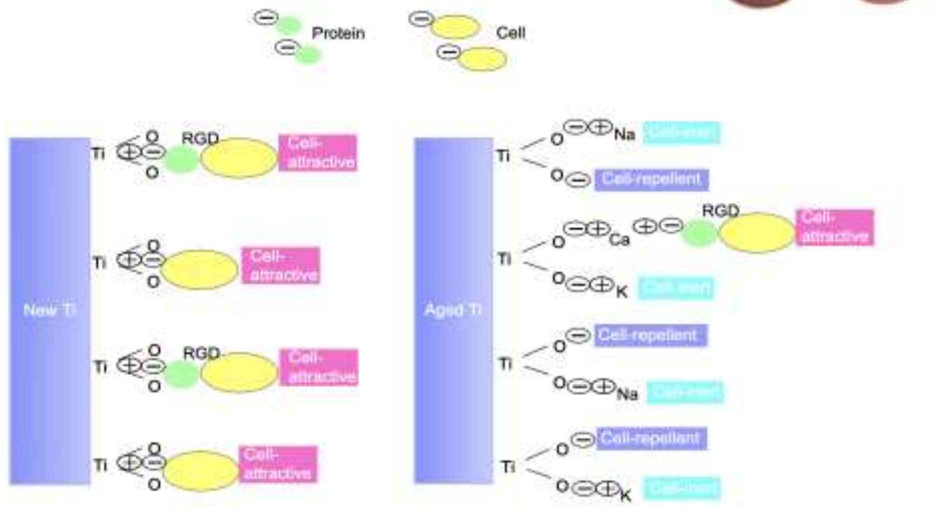

Fig. 8. Schematic description of the proposed mechanism of electrostatic interactions underlying the aged-dependent biological degradation of TiO_2 surfaces: the age-dependent conversion of titanium surfaces from bioactive to bioinert. The new TiO_2 surface (left) is abundant in cell-attracting terminals consisting of the RGD sequence or positively charged TiO_2 surface, which serve as chemoattractants without divalent cations such as Ca^{2+}. The old TiO_2 surface (right) involves cell-inert and cell-attractive terminals consisting of competitive binding of monovalent and divalent cations to negatively charged TiO_2 surface, respectively. The surface attracts proteins and cells only with divalent cations. When there are no sufficient cations available, a part of the old TiO_2 surface remains to be negatively charged, leaving these terminals cell-repellent.