Biofilm removal from rough titanium surfaces with dental decontamination methods and/or atmospheric pressure plasma

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Peri-implantitis is a common problem in implant dentistry [1]. Biofilms located on the implant cause inflammation of the periimplant tissue and lead to bone destruction. Removal of biofilm from titanium surfaces is a precondition for a complete resolution of inflammation and re-osseointegration [2]. Atmospheric pressure argon/oxygen plasma could solve the decontamination problem as well as re-establishing surface characteristics, which are supportive for bone regeneration [3, 4].

We used microstructured hydroxylapatite coated titanium disks (grit-blasted + dual acid-etched, diameter 5 mm, Biomet 3i, USA) covered with a 30 day old ex-*vivo* plaque biofilm. Removal of biofilm was performed with cold atmospheric pressure argon/1%O_2 plasma (PL), brush (BR), CO_2-laser (LA), water spray (WA) or with a combination of BR+PL, LA+PL, WA+PL, respectively. An untreated (UN), plasma treated (UN+PL), and a biofilm covered (BIO) disk served as control. Treatment time was 120 s for a single procedure or 120 s + 60 s (PL) for combined treatment approaches. Biofilm removal was assessed with scanning electron microscopy (SEM) and x-ray photoelectron spectroscopy (XPS). The atomic percentage of elemental content of nitrogen (in at.%), obtained by XPS, served as marker of proteinaceous biofilm remnants.

As expected the highest elemental content of nitrogen was observed at the BIO control group (11.3± 0.5 at.%)). After 60 s plasma treatment, no nitrogen was detected on UN+PL surfaces, indicating complete removal of contamination. Compared to the BIO control group, a significant reduction of the nitrogen content was obtained after PL (3.8±1.2 at.%), BR+PL (1.2±0.2 at.%), LA+PL (4.1±0.9at.%), and WA+PL (2.9±3.7 at.%) treatment. Consequently, the nitrogen was reduced to a level reflective of pristine disks.

This study demonstrates the efficiency of an atmospheric pressure plasma as additional treatment option for biofilm removal. Plasma could be the first step to develop a simple, safe, and effective method to remove the biofilm without destroying the elaborate surface geometry and to promote re-osseointegration of peri-implantitis affected implants.

References

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