Influence of UV-light and non-thermal plasma on rough titanium surfaces in vitro

Introduction and Purpose

Various studies described positive effects of ultraviolet (UV) irradiation or non-thermal plasma (NTP) treatment on titanium and zirconia surfaces. The aim of this study was to determine and compare the effects of UV-light and non-thermal plasma treatment on rough titanium surfaces regarding the changes in wettability, surface chemistry as well as cell attachment and proliferation of murine osteoblast-like cells in vitro.

Methods

- Sandblasted and acid-etched titanium disks (grade 4, Fig. 1) were divided into a non-treated control group and two experimental groups either treated by UV-light (0.05 mW/cm² at λ = 360 nm and 2 mW/cm² at λ = 250 nm) or by NTP of argon (24W; -0.5 mbar) for 12 minutes each.
- Wettability was assessed using dynamic contact angle measurements (Surtens Universal, OEG, Germany).
- X-ray photoelectron spectroscopy (XPS) analysis was performed (Kratos Axis Nova, Kratos Analytical, UK).
- Murine osteoblast-like cells (MC3T3-E1, Sigma Aldrich, Germany) were used for in vitro experiments.
- Cell attachment was assessed using fluorescin diacetate / propium iodide staining (live-dead-staining) after 2, 24 and 72 hours and cytotoxicity assay (LDH).
- Proliferation was determined using an XTT assay.

Results

- UV-light and NTP treatment did not affect the surface structure or roughness parameters.
- UV light and NTP significantly increased wettability on the titanium surfaces (P < 0.001, Fig. 2).
- UV-light and NTP significantly decreased carbon remnants (P < 0.002, Fig. 3).
- NTP was even more effective in carbon removal than UV light (P = 0.03, Fig. 3).
- UV light and NTP significantly increased cell attachment compared to the non-treated disks (P < 0.001, Fig. 4).
- NTP significantly increased cell proliferation (P = 0.002, Fig. 5) compared to the non-treated as well as to the UV-treated disks.
- Neither NTP nor UV-light treatment resulted in cytotoxic effects.

Conclusions

Surface treatment by UV-light or NTP led to a significant reduction of carbon remnants and a significant increase in wettability on rough titanium surfaces. Both methods are able to increase the bioactive capacity of titanium surfaces in vitro with slight advantages for NTP in carbon removal and cell proliferation compared to UV-light. However, further studies are needed to confirm the identified effects as well as the determined advantage of NTP in vitro and in vivo.

Disclosure

This research project was granted by the Oral Reconstruction Foundation (CF11501). The UV and NTP devices were provided free of charge by the manufacturers. Titanium disks were provided by Camlog Biotechnologies AG. The authors declare no conflict of interest.

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Literature