Impact of the proliferation of fibroblasts through ceramic implants: an in vitro study
Ch. Kunert-Keil, T. Gredes, T. Gedrange
Orthodontic Polyclinic, E.-M.-Arndt University Greifswald

Implants have been used in dentistry for around 40 years. Various materials, such as titanium or zirconia ceramics, are used today to manufacture dental implants due to their biocompatibility. For a long time, there was no comparison between the osseointegration of conventional ceramic implants and that of titanium implants. Maxon Motor GmbH Sexau produces ceramic implants as OEM, for which it has developed a special chemical surface treatment to guarantee secure osseointegration. The effectiveness of this surface is being analyzed in an animal experiment to compare with other methods of surface treatment, and with other current ceramic implants on the market and "state-of-the-art" titanium surfaces. This in vitro study served as a pilot test for the ongoing animal experiment.

Materials and methods

Implants used
1) ZrO₂ ceramic implant Ø 4.0 x 10 mm – blasted surface developed by maxon-
2) ZrO₂ ceramic implant Ø 4.0 x 10 mm – mds surface developed by maxon-
3) ZrO₂ ceramic implant Ø 4.0 x 10 mm – etched surface developed by maxon-
4) ZrO₂ ceramic implant Ø 4.0 x 10 mm (Ziterion)
5) Standard implant Ø 4.1 x 10 mm SLA® (Straumann)

Cell culture
Mouse fibroblasts (1 x 10⁵ L929 cells; DSMZ GmbH, Germany) are placed in 48-well cell culture slides with a DMEM culture medium (Gibco) with 10% fetal bovine serum (Gibco) and antibiotics (1% penicillin/streptomycin, Gibco) at 37°C in a humidified atmosphere of 5% CO₂ and 95% air. The test implants are introduced to the cells and the cells with the implants are incubated for 3 weeks (figure 1). The medium is transferred every 3 days.

Cytotoxicity assay
The CytoTox-Glo™ assay (Promega, Germany) was used to quantify cytotoxicity (number of dead cells) and to assess the proliferation rate (total luminescence – dead cells). This involves measuring the luminescence that arises for 1 sec using a luminometer (Autolumat LB953, Berthold, Abb.2). The released luminescence is directly proportionate to the number of cells.

Results
✓ The "mds" and "blasted" ceramic implant surfaces developed by maxon significantly reduce the number of dead cells by 17% and 18% respectively (figure 3A), whereas the "etched" surface and comparative implants made of ceramic material and titanium show no major changes in cytotoxicity compared to untreated cells.
✓ The proliferation rate, i.e. the difference between overall luminescence and the luminescence of dead cells confirmed the results of the cytotoxicity test. Proliferation rose significantly by 1.29 or 1.26 times when the "mds" and "blasted" implant surfaces were used compared to untreated cells. Proliferation was unchanged when the other implants were used (figure 3B).

Summary
The ceramic "mds" and "blasted" surfaces developed by maxon promote cell proliferation more effectively than the "etched" surface. Both surfaces also cut better than ceramic surfaces currently available on the market and "state-of-the-art" titanium surfaces.