Mesenchymal Stem Cell Behaviour On Different Titanium Implant Surfaces : An In Vitro Study

Abstract

The success of a dental implant is based on the osseointegration that is defined as the direct contact between the bone tissue and the dental implant surface, without fibrous tissue growing at the interface. The biological fixation of an implant to bone is influenced by numerous factors, including surface chemistry and surface topography. Therefore in our study our aim was to determine the cell growth on various surfaces of titanium implants. Four different types of titanium plate samples and a polished plate sample (with no surface modification) as a control group were prepared. Mesenchymal stem cells isolated from the marrow of Sprague-Dawley male rats incubated and after confluency was reached the cells were trypsinized, replated and incubated again. Mesenchymal stem cells at 4th passage were lifted from the plates and seeded onto each sterilized titanium sample. At the end of 3 days incubation time absorbance was determined by an Elisa Plate Reader. As a result cell proliferation was excessive in all modificated groups in contrast with the control group.

Background and Aim

The aim of dental implants is osseointegration of the implant with the surrounding bone as well as the maintenance and functional restoration of the existing bone. To accomplish this successfully, there are many factors to consider in the interaction between the implant material, most commonly pure titanium or titanium alloys in dental applications, and the surrounding tissue in the patient.

The biological fixation of an implant to bone is influenced by numerous factors, including surface chemistry and surface topography.Therefore in our study our aim was to determine the cell growth on various surfaces of titanium implants. Also with the results of this study we aim to have further researches.

Methods and Materials

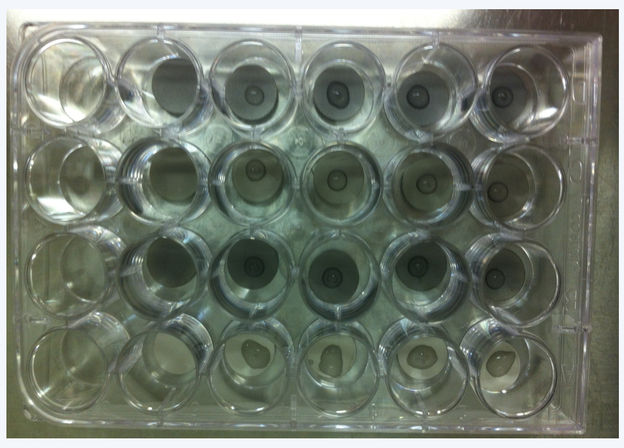
Coin shaped titanium plates (CSTPs) have been produced to be cultured within bone marrow derived mesenchymal stem cells (BMDMSCs) for this study. Two for each CSTPs have been acidified / covered by the 4 types of materials below and remaining 2 CSTPs were machined.

- TiO2
- BCP
- TiO2 + HF
- TiO2 + HNO3

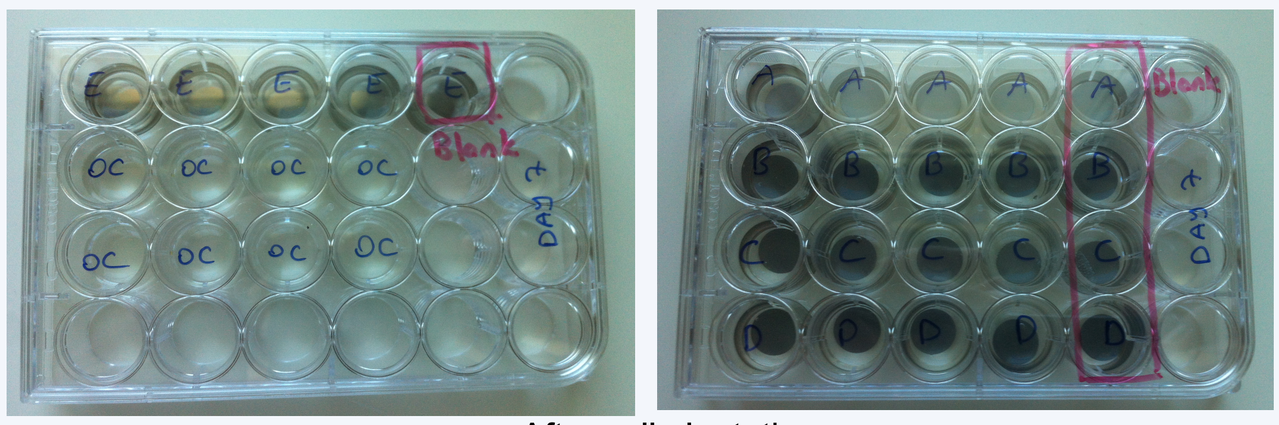
BMDMSCs have been incubated under conditions of 37°C temperature, moisture 90%, CO_2 5% within the medium of High Glucose DMEM (without phenol red) which consists of 10% FBS, 2 mM L-glutamine and 1% of penicilin, streptomycin ve amphotericin till T75 cell culture plate is covered.

Sterilized CSTPs have been entitled and each one has been aligned in the 24 well plate. 20,000 BMDMSCs have been seeded on the surface of CSTPs within 20 µL medium. 4 types of CSTP samples with cells and 1 CSTP sample as blank have been used for each time points (1st and 7th days). BMDMSCs have been seeded on the surface of 24 well plate for positive control as well and entitled as only cell (OC).

Cell proliferation has been analysed by using CellTiter 96® AQ_{ueous} One Solution Cell Proliferation Assay (MTS) on the 1st and 7th days.



During cell plantation

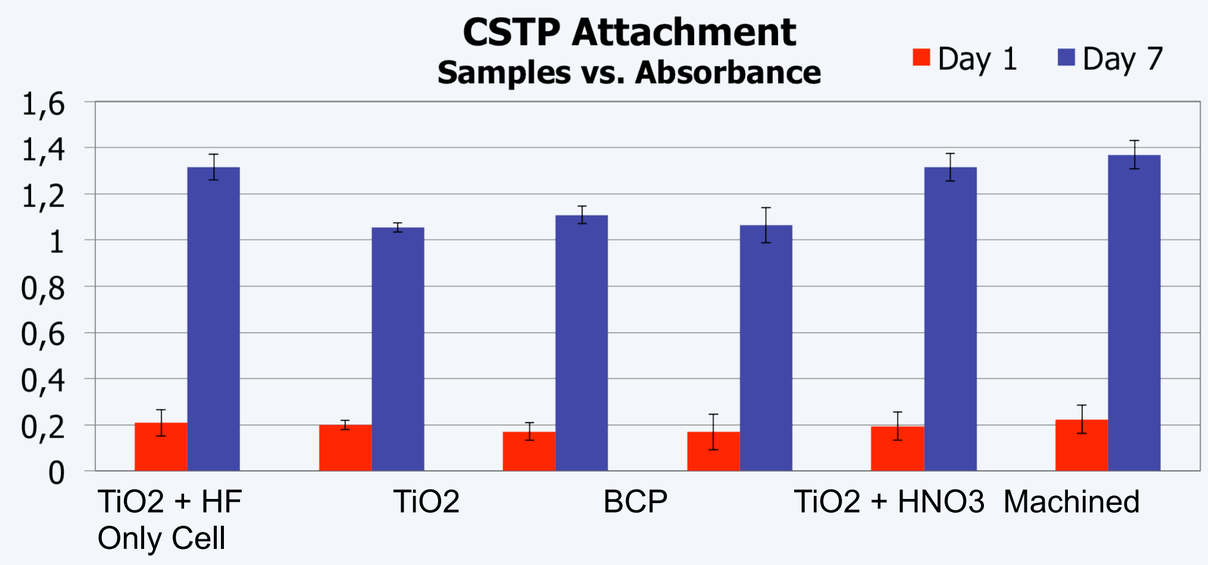


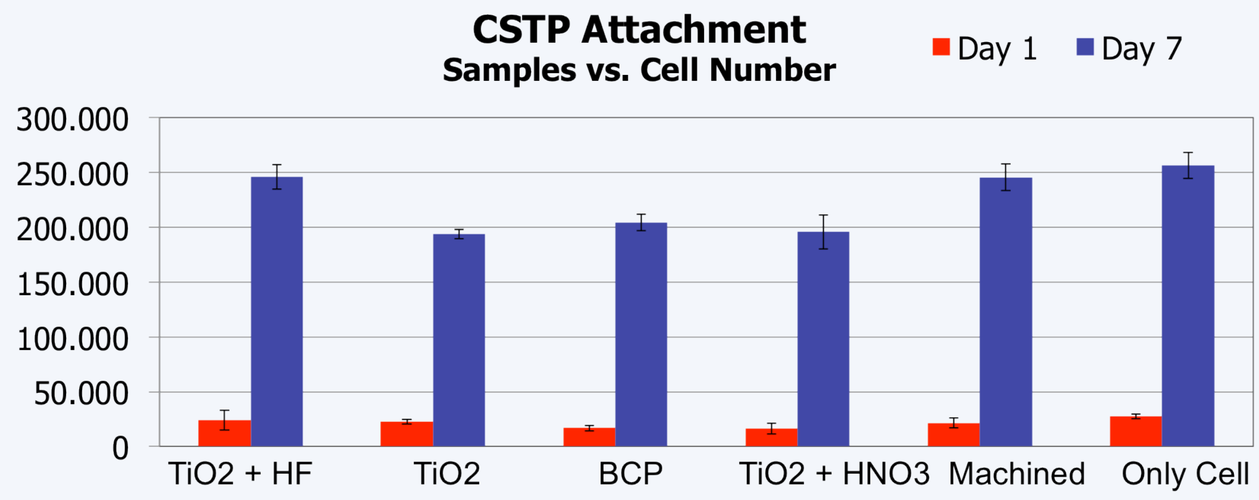
After cell plantation

Results

Cell culture was performed on sterilized titanium plates during 1-day and 7-day period. In MTS Cell Proliferation Assay, TiO2 + HF surface has procured 13% and TiO2 %5 more cell proliferation than machined surface a day after cell plantation. Comparing machined surface, 22% and 24% less cell proliferation has been observed on the BCP and TiO2 + HNO3 samples respectively.

Comparing machined surface, 0.1% more cell proliferation has been observed on TiO2 + HF 7 days after cell plantation. On the BCP, TiO2 and TiO2 + HNO3 samples, less cell proliferation has been observed as 17%, 21% and 20% respectively with regard to machined surface.





Conclusions

Although we have observed minor differences at the end of Day 1, differences have risen at the end of Day 7. With reference to these results, TiO2 + HF and machined samples correlates with the control group for cell proliferation. According to literature, these figures may not be parallel with osseointegration values. Osseointegration value may be more for the surface which the cell proliferation is less. It is significiant to see cell proliferation on surfaces for further studies.

References

1.S. Lavenus et al. , Behaviour of mesenchymal stem cells, fibroblasts and osteoblasts on smooth surfaces, Acta Biomaterialia 7 (2011) 1525–1534.

2. L.F. Cooper et al., Fluoride modification effects on osteoblast behavior and bone formation at TiO2 grit-blasted c.p. titanium endosseous implants, Biomaterials 27 (2006) 926–936 .