

Effect of covalently bound RGD-peptide on PEEK on human osteoblasts

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Background and Aim

Due to its excellent properties, the high-performance biomaterial PEEK (polyetheretherketone) might represent a viable alternative to titanium as implant material. However, due to its bioinertness PEEK has to be surface-modified to achieve a sufficient osseointegration when being used as material for dental implants. Therefore, a coating of the covalently bound peptide Arg-Gly-Asp-Ser (RGD) on the PEEK surface might represent a possible solution to enhance cell adhesion onto PEEK.



Fig.1 Different types of Polyetheretherketone (PEEK)

Aim: The Aim of the study was to evaluate the effects of a RGD-peptide coating on human osteoblasts in vitro compared to titanium and pure PEEK assuming that the covalently bound RGD-peptide enhances the cell adhesion and cell differentiation.

Methods and Materials

Twenty Disc-shaped specimens were fabricated from PEEK (Vestakeep® i2 R, Evonik Industries, Essen, Germany) and titanium (n=10). The samples were polished up to 4000 grit. Afterwards, ten of the PEEK samples were coated by RGD-peptide (RGD-PEEK) by means of Schiff base formation using ethylene diamine and following crosslinker-mediated fixation of the RGD-peptide, whereas ten samples were left untreated (PEEK). Surface roughness and -wettability were detected.

Each sample was incubated at 37 °C with 1 ml cell suspension containing 30,000 human osteoblasts. To evaluate the cell adhesion, cell differentiation and cell viability, the cell-covered area (CCA), the alkaline phosphatase (ALP) and the metabolization of alamar blue (AB) were determined after 1 and 21 days.

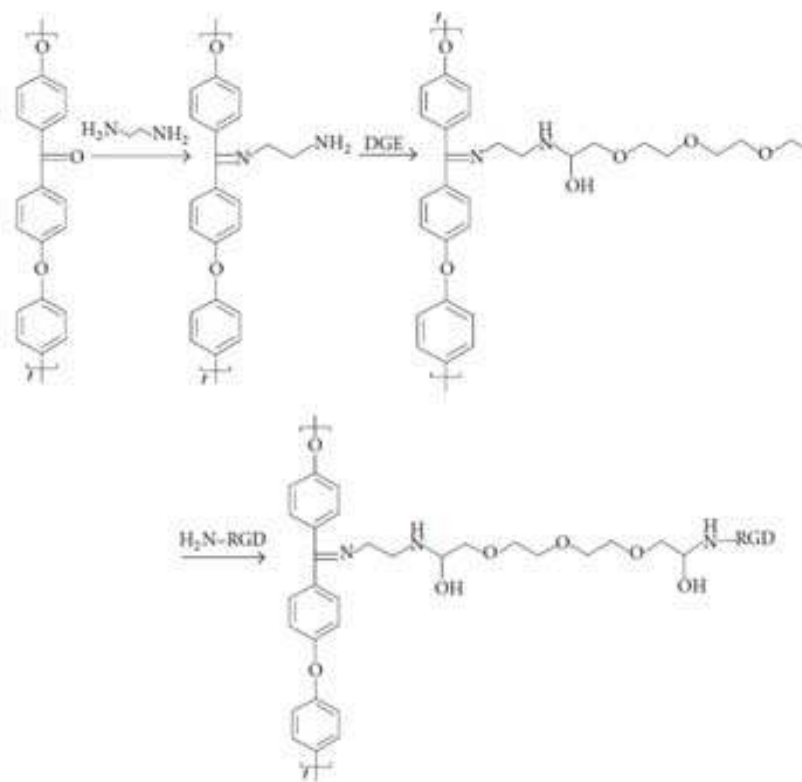


Fig.2 Reaction scheme for the cell-adhesive modification of PEEK. Surface activation was achieved via Schiff base formation using a diamine. Subsequent coupling of a diepoxide crosslinker afforded the covalent conjugation of the RGD-peptide [1]

Results

After 1 and 21 days, the PEEK-samples showed the highest CCA ($21.4 \pm 5.8 \%$ and $36.8 \pm 15.6 \%$), followed by RGD-PEEK ($14.8 \pm 1.6 \%$ and $33.0 \pm 3.9 \%$) and titanium ($7.7 \pm 4.7 \%$ and $31.0 \pm 18.4 \%$), whereas the increase in the CCA was significant for the RGD-PEEK samples. The differences in the CCA between the three groups were not significantly different.

After 1 day, the PEEK-samples showed the highest ALP extinction value (0.2 ± 0.01), followed by RGD-PEEK (0.19 ± 0.04) and titanium (0.07 ± 0.02). The ALP values increased after 21 days, whereas RGD-PEEK showed the highest extinction value (0.51 ± 0.16) which was significant different to day 1, followed by PEEK (0.31 ± 0.11) and titanium (0.29 ± 0.15). No significant difference was found between the groups 21 days. The extinction values of AB increased from day 1 to day 21 for all groups (PEEK: from 0.89 ± 0.06 to 1.23 ± 0.06 ; RGD-PEEK: from 0.87 ± 0.06 to 1.18 ± 0.02 ; titanium: from 0.95 ± 0.2 to 1.15 ± 0.06).

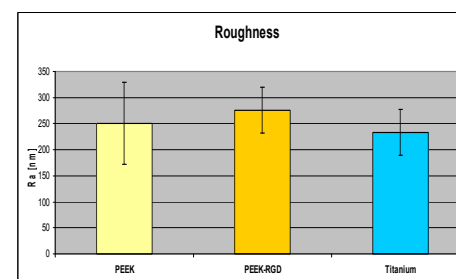


Fig.3 Roughness after surface modification

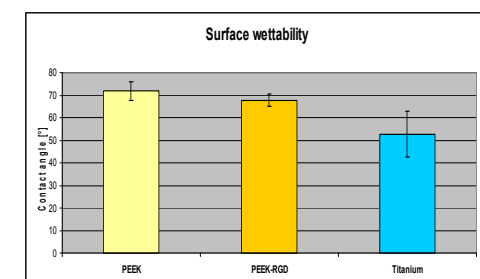


Fig.4 Surface wettability

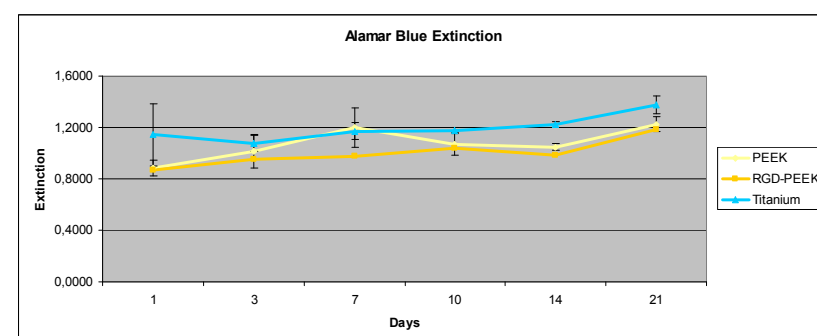


Fig.5 AlamarBlue Extinction from Day 1 to Day 21

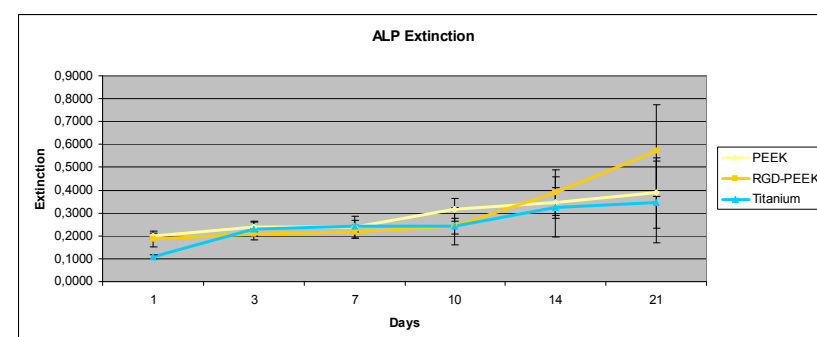


Fig.6 ALP Extinction from Day 1 to Day 21

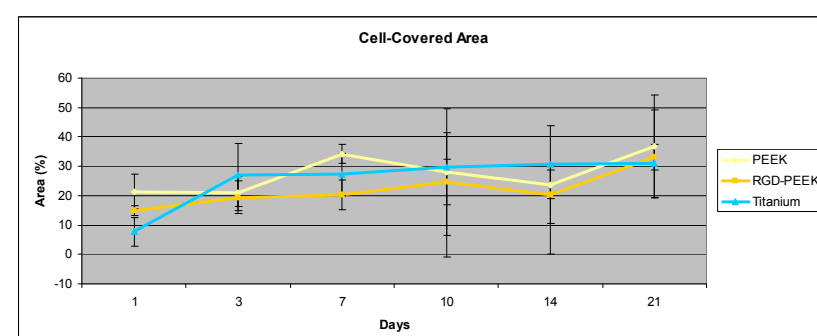


Fig.7 Cell-Covered Area from Day 1 to Day 21

Conclusions

Regarding the parameter ALP, which reflects the cell differentiation of the osteoblasts, and the CCA, representing the cell adhesion ability of the distinct surface, the covalently bound RGD-peptide as PEEK coating seems to represent one option to achieve a sufficient osseointegration of a PEEK dental implant. This has to be evaluated in vivo.

References

- [1] Covalent Grafting of the RGD-Peptide onto Polyetheretherketone Surfaces via Schiff Base Formation, *The Scientific World Journal*