A comparative study of osteoblast response to PEEK or titanium commonly used in dental implants.

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Statement of Purpose: Polyetherether ketone (PEEK) is a high performance thermoplastic which has gained momentum as an alternative to metals or ceramics for use in applications such as spinal fusion cages and orthopaedic devices. The biomaterial is often viewed as chemically inert but there is growing indication that the interaction at the tissue-material interface is favourable and indeed comparable to that of titanium.

The aim of this *in-vitro* study was to biologically evaluate whether PEEK could be a suitable candidate for dental implantation. Human primary osteoblast response was compared to the commercially pure titanium typically used for common dental implants.

Methods:

Implantable grade unfilled PEEK (PEEK-OPTIMA®, Invibio, Thornton Cleveleys, UK) was prepared as disks 10 mm in diameter. The surface presented to the cells was either injection molded (Ra=0.1) or machined (Ra=0.9). Commercially pure Grade 1 titanium disks were prepared from sheet stock (A.D.MacKay, Inc., Red Hook, New York). The titanium surface was presented as a hand polished 600 grit finish or a rougher unpolished surface (Ra=0.5).

Human primary osteoblasts (HOBs) derived from bone discarded from middle aged male and female patients after orthopaedic surgery were allowed to outgrow from the bone chips in DMEM/F-12 medium with 15% fetal bovine serum (FBS) and antibiotics. After 2-3 weeks of growth, HOBs were replated in the same medium onto sample disks at a density of 10,000 cells/cm^2. For mineralization studies, after one week in culture, the medium was changed to alpha-MEM with 15% FBS, and antibiotics with 50 µg/ml ascorbic acid added daily for 2 more weeks. For all cultures the entire medium was changed every 3-4 days. The HOB response was observed for initial adhesion at 4 hours, proliferation at 48 hours by [^{3}H]-thymidine incorporation and alkaline phosphatase activity at 72 hours. Mineralization (calcium content) was measured biochemically at 2 weeks of culture in alpha-MEM as described above. Experiments were repeated 2-3 times for each assay.

Results/Discussion:

All test materials demonstrated HOB adhesion at 4h. The cpTi showed no significant difference between surface type. Injected molded PEEK surfaces demonstrated no significant difference in the amount of adhesion when compared to cpTi. Proliferation, as measured by [^{3}H]-thymidine incorporation at 48 hours culture, showed that the injection molded unfilled PEEK had significantly greater (p=0.10) proliferation than all of the other test materials. The type of surface on titanium (polished or unpolished) or CFR-PEEK (injection molded or machined) did not have a significant effect on the proliferation.

ALP activity (µM/min/mg protein) at 72 hours was greatest on injection molded unfilled PEEK and polished titanium, with no significant difference between them. The surface finish within each material tested had some significant effect on the ALP activity measured.

Mineralization (calcium content) was greatest on machined unfilled PEEK surfaces, which were significantly higher than unpolished cpTi. There was no significant different between the best performing cpTi (unpolished) or the injection molded CFR-PEEK or unfilled PEEK (Figure 1).

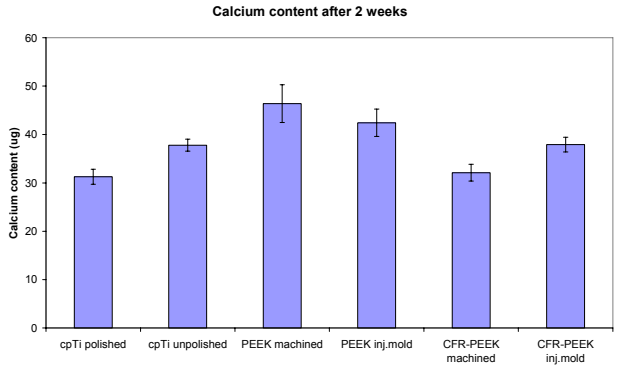

Figure 1. Calcium content measured from HOB culture on cpTi, PEEK or CFR-PEEK variants after 2 weeks culture.

Conclusions:

These results demonstrate that the *in-vitro* performance of two PEEK-based biomaterials is comparable to that of Grade 1 cpTi commonly used for endosteal dental implants. Further, some measured *in-vitro* parameters appear to be influenced by the surface finish of the material as generated using common manufacturing techniques such as polishing, injection molding or machining. The presence of mineralization suggests that PEEK may lend itself to osseointegration of dental implants and that further work should follow to investigate fulfilling the mechanical requirements of such an implant system.