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Evaluation of biocompatible Composites of Poly Ether Ether Ketone (PEEK) and Silicon Carbide as an Implants material

A Thesis Submitted to
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Abstract

Background

Commercially pure titanium is widely used as dental implant material although it was found that titanium exhibited high modulus of elasticity and the lower corrosion tendency in media representing conditions normally found in the human mouth. At the same time Ti alloys such as (Ti6Al4V) may lead to serious danger, It was reported that aluminum(Al) and vanadium (V) were dissolved from Ti alloy (Ti6Al4V) in oral media.

Polyetheretherketone (PEEK) is growing in popularity with an increased interest in the use of polyether ether ketone (PEEK) for orthopedic and dental implant applications due to its elastic modulus close to that of bone, biocompatibility, and its radiolucent properties PEEK with high chemical resistance, radiolucency, mechanical characteristics compared to those of human bones In addition, it can be repeatedly sterilized and shaped by machining and heat contouring to fit the contour of bones. Despite these excellent properties, PEEK is still categorized as bioinert due to its very low reaction with the surrounding tissue, which limits its potential applications.

Aim of this study

This study was done to evaluate the PEEK and PEEK composite through mechanical, morphological, biological and histological studies, and compare this implant screws material with ordinarily used commercially pure titanium dental implant material.

Material and method.

PEEK composites (PEEK and SiC with selected weight percentage ratio of (**0, 1.5%, 3%, 4.5%, 6%)** were fabricated using a compounding by melt blending technique by (Internal Mixer)at 365ºC, 5min., The in vitro study involved Samples preparation (sheets) cutting and machining into desired shapes according to ASTM standards, for mechanical tests which includes tensile strength, elastic modulus and flexural strength, physical tests which include

Differential Scanning Calorimeter (DSC), Thermo gravimetric analysis (TGA), Fourier Transform Infrared (attenuated total reflection) analysis (ATR/ FTIR), wettability and radioopacity, Morphological test that include scanning Electron Microscopy (SEM), SEM supported by EDX (energy dispersive X-ray analysis) and Atomic Force MicroscopyAFM.

The in vivo part of the study was done by implanting of screw-shaped implants (112 screws)(titanium ,pure PEEK, PEEK composite with 1.5%SiC (G1), peek composite with 4.5%Sic(G3) in the femur of New Zealand rabbits for mechanical test (torque removal test) 80 screws were used 20 screws for titanium subdivided 10 screws for each healing interval, and 60 for the PEEK and PEEK composite 20 for pure PEEK ,20 screws for G1 group and 20 screws for G2 group (subdivided 10 screws for each healing interval) After 2 and 6 weeks of healing period a removal torque was done for ten animals in each group, whereas the other (32 screws, 8 screws for Titanium and 24 screws for PEEK and PEEK composite subdivided to 4 screws for each healing interval)were used for histological testing and histomorphometric analysis with optical microscope.

Results

The results obtained from the in vitro experiments showed that the tensile strength, elastic modulus and flexural strength of polymer composite consisting from polyetheretherketone and Silicone Carbide nanofiller implant was increased comparing with pure PEEK with better wettability and radioopacity. In vivo test show that in the biomechanical test revealed that the force required to unscrew the implants from PEEK and SiC nanofiller show more torque removal on bone-implant interface after (2 and 6) weeks in rabbit femur also polymer composite had early bone formation at two weeks, and it showed mature bone at six weeks in comparison with pure PEEK .

Conclusions

The approach used in this study supports the ability of biocompatible PEEK composite that show better biomechanical and biological properties than pure PEEK, depending on that it suggested to be used as a promising alternative to titanium implants.