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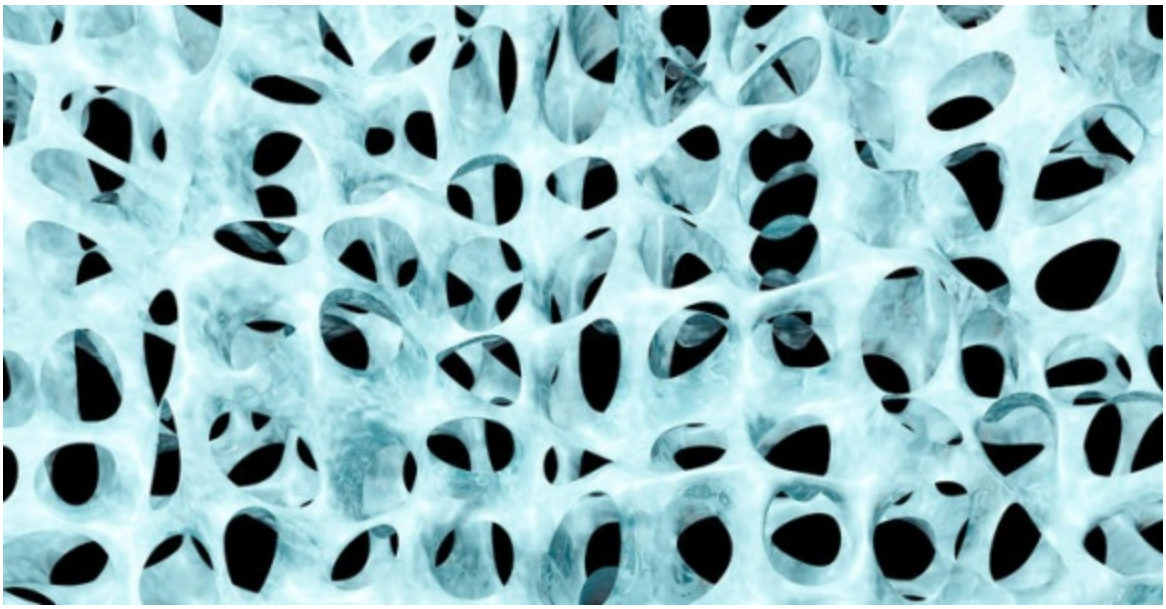
Facilitating Greater Osseointegration Properties with a Deeply Porous Titanium Scaffold on PEEK

International Society for the Advancement of Spine Surgery (ISASS17) Meeting Highlight

Written by Lynne Schneider, PhD [1]

In the search to reduce fixation-related complications and infections associated with current interbody fusion cages, investigators have pursued various methods for integrating a titanium surface onto PEEK to promote osseointegration.

At the International Society for the Advancement of Spine Surgery's 17th Annual Conference (ISASS17) in Boca Raton, FL, Richard D. Guyer, MD [2] presented findings from a study that compared surface abrasion and bone interface strength of implants with titanium plasma spray (TPS) coating versus a deeply porous titanium scaffold surface on PEEK. Dr. Guyer is Co-Founder and Fellowship Director of the Texas Back Institute in Plano.



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Dr. Guyer noted that "bioactive implants have changed the way we deal with fusions." He explained that while PEEK has favorable loading properties, it is biologically inert and hydrophobic, and thus inhibits osseointegration. Coatings can introduce potential wear debris or abrasion when an interbody fusion cage is inserted into the disc space.

This study compared surface abrasion and implant-bone interface strength (or osseointegration) of TPS-coated PEEK (thickness 140µm, pore size <50 µm, porosity 20% to 40%) with a 3D titanium scaffold, made of porous layers of titanium bonded together and injection molded with the PEEK (Nanovis, Inc., thickness 750 µm, pore size 500 µm, porosity 70%).

The amount of device surface abrasion was assessed by measuring the percent reduction in mass of each test sample prior to and after the load testing. An axial compressive load was applied and held constant while horizontally displacing the abrasion block across each sample. Testing was conducted using 7 different loads, from 100N to 1,000N in 150N increments; the abrasion block was placed approximately 2.5 mm from the edge of the sample pad. Each sample underwent 10 horizontal displacement cycles, in which the block cycled horizontally 0-25 mm using sine waveform with a frequency of 0.1 Hz, to simulate abrasion.

Push-out testing was conducted by drilling holes 4 mm in diameter and 10 mm deep that were drilled into the os frontale region of a swine. The implants were press-fit into the holes, and the skull sections containing the implants were harvested 5 weeks later after the animals were euthanized. The push-out testing was performed using an MTS machine with a push rate of 6 mm/min. Load-deformation curves were used for the analyses. Shear strength (MPa) was extracted from the output to record the bonding strength between each implant and the surrounding bone. Maximum force was normalized by the actual implant surface area in contact with the surrounding bone when calculating shear strength.

Mean abrasion for TPS-coated PEEK ranged from 14% (at 100N) to 84% (at 1000N), compared to less than 1%, regardless of the applied load, for the scaffold. Findings using the swine model reported significantly greater mean push out strength of scaffold pins versus TPS-coated PEEK pins (10.2 MPa vs 5.7 MPa; $P<0.05$).

In summary, the study found that a deeply porous titanium scaffold on PEEK was associated with significantly less risk of coating abrasion and significantly greater push out strength than TPS on PEEK. When asked what he believes is the most pertinent factor contributing to osseointegration, Dr. Guyer responded, “It is not technique or the substance, but rather the surface topography.” The deep porosity of the titanium scaffold allows the bone cells to grow down and through the implant. Fusing titanium onto PEEK allows it to become a desirable place for bone cells to attach to.

Footnotes:

Guyer RD, Abitbol J-J, Ohnmeiss DD, Yao C. Comparison of abrasion and osseointegration associated with titanium plasma spray coated PEEK vs. a deeply porous titanium scaffold on PEEK. Presented at: ISASS17, 17th Annual Conference, Boca Raton FL, April 12-14, 2017.

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