COMMENTARY ON:

What is the Best Material for an Interbody Cage?

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JOURNAL: Clinical Spine Surgery, 2020 May;33(4):137139. doi:10.1097/Bsd.0000000000000869

LEVEL OF EVIDENCE: Level 2a Peer-Reviewed, Systematic Review of Cohort Studies

Overview

What is the best material for an interbody cage? This relevant question was recently discussed by orthopedic surgeons at The Rothman Institute, Thomas Jefferson University Hospital, Phila, Pa., in an article published in *Clinical Spine Surgery.* Dr. Alexander Vaccaro and Dr. Eve Hoffman analyzed the literature for PEEK interbody devices for TLIF while Dr. Gregory Schroeder and Dr. Heeren Makanji provided their assessment of new 3D printed titanium cages.

Summary

The case for PEEK-OPTIMA™ Polymer

PEEK-OPTIMA polymer has been used for Interbody fusion for over two decades. It was chosen in the late 1990's for its material modulus, which closely matches cortical bone, biocompatibility, and radiolucency which allows for better fusion assessment on X-ray. The modulus of PEEK is close to cortical bone at 3.5 GPa while the modulus of solid titanium is 30 times higher at 100-110 GPa.[1] This means that a cage made from PEEK can have better stress distribution with bony endplates compared to a titanium cage. It also means that the graft material inside a PEEK cage sees more stress and should remodel into solid bone according to Wolff's law.[1,2] The authors report that,

> *"Stress shielding due to modulus mismatch is the proposed mechanism for the observed rate of subsidence of titanium anterior cervical cages of up to 26%."*[3–5]

The radiolucency of PEEK can provide more accurate fusion assessment on postoperative imaging or CT scan compared to titanium which is radiopaque.[6] The primary disadvantage of PEEK cited by the authors is that it is chemically inert which results in less cell adhesion and surface bone integration.

Enhancing PEEK for bone on-growth

With the aim of addressing these perceived disadvantages of PEEK, recent advances in surface modifications for PEEK have emerged including:

- Titanium coatings
- Surface porosity
- Surface chemistry changes with the addition of hydroxyapatite

These surface enhancements have been shown to improve direct bone contact with PEEK devices.[3,7] To address the perceived disadvantages of titanium, advances in 3D printing have allowed for more porous titanium devices with surface topography intended to provide bone ingrowth and lower cage stiffness to address material modulus.[8,9] The authors conclude that,

> *"Unfortunately, prospective trials comparing 3D-printed porous titanium cages to PEEK cages are lacking in the literature. However, the current literature comprising biomechanical analysis, ovine models, and retrospective human studies* ***support the continued use of PEEK cages in TLIF rather than titanium cages."***

3D Printed Titanium Cage for TLIF

Traditional titanium cages have been used for osteointegrative properties, but the high modulus of elasticity and stiffness has led to subsidence and implant migration.[10] To address the issue of subsidence, 3D printed porous titanium cages have been developed to decrease the stiffness of the cage and mitigate the probability of subsidence. Most of the published information on 3D printed cages has been on animal models, which have shown some promise for bone ingrowth.[11]

> However, there is a **lack of human clinical data comparing 3D printed cages to PEEK or Enhanced PEEK cages and the notch sensitivity of porous titanium has already resulted in one device recall.**

PEEK cages are superior to Titanium in transforaminal lumbar interbody devices

The authors looked at six published studies which clinically compared PEEK and titanium cages.[4-6,12-14] Only one of the studies was prospective and looked at ACDF rather than TLIF.[6] This prospective study showed improvement in clinical outcomes including Neck Disability Index, Oswestry Disability Index and Visual Analog Scale (VAS) in the support of PEEK at 7 year follow up. Only one of the two studies investigating TLIF cages collected data on patient reported outcomes and this study showed statistically significant decrease in VAS back pain scores at 12 months in the PEEK group compared with the titanium group.[12] Five out of the six studies were published prior to the availability of 3D printed titanium technology. There are no prospective studies comparing 3D porous titanium cages to PEEK cages.

The authors conclude that, until there is further data on new technologies, ***the literature continues to overwhelmingly support the use of PEEK cages for TLIF.***

Commentary

The interbody fusion market has seen a number of new surface enhancement technologies over the past decade including 3D printed Titanium and other roughened or porous surface technologies. While promising conceptually, these technologies still have a clinical burden of proof to demonstrate similar fusion rates, clinical outcomes, low subsidence rates and imaging compatibility when compared to PEEK-OPTIMA polymer.

ABOUT THE AUTHOR

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Michael Veldman is the Global Strategic Marketing Manager for Invibio Biomaterial Solutions where he has worked since 2011. Prior to joining Invibio, he spent 2 years at Novalign Orthopedics where he led the development of a minimally invasive IM Nail and prior to that he spent 9 years in Product Development at Medtronic Spinal & Biologics. He received a Bachelor of Science degree in Mechanical Engineering from Christian Brothers University in 1998 and an MBA from the University of Memphis in 2002.

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