Cages and Bone Healing

Celeste Abjornson, PhD
Director of the Integrated Spine Research Program

Disclosures

My department receives research support from:
- DePuy Synthes®; Integra® LifeSciences; Bacterin International, Inc.; NuTech®; Vertical Spine, Alphatec Spine, Nuvasive

I am a consultant to Centinel Spine and Paradigm Spine

Objectives

…from the aspect of bone healing

1. Stable fixation of motion segment
   - Optimized screw trajectories
   - Resistance to axial, torsional and bending movement
   - Eliminate need for fixation outside of load profile

2. Optimal load transfer
   - Footprint contact on cortical rim
   - 80% of load is transmitted through the anterior column of the spine
   - Comply with Wolff’s law to afford superior fusion outcomes

3. Materials
   - Osteo-Compatiable
   - Cell-Compatiable

4. Bone Graft Choice
   - Direct contact
   - Conductive over time

5. Radiolucency
   - Allows for assessment of fusion
Stable Fixation

- Screw angles direct the spine's axial forces along the long axis of screw.
- Reduces bending moment, preventing de-rotation and screw back-out.
- Converging screws are more resistant to implant pullout.

Optimal Load Transfer

- Lag effect creates compressive fixation.
- Provides constant compressive forces enhancing fusion in line with Wolff’s Law

Materials

**Osteo-Equivalent Modulus**

- Exhibits a modulus of elasticity similar to bone.
- Presents a reduced risk of subsidence relative to all-titanium.

Compared with all-titanium cages, PEEK cages have been shown to be six times less likely to experience subsidence.²
Introduction – Benefits of CPTi

- CPTi coat creates rough, osteoconductive surface
  - Short-term stability due to increased friction
  - Long-term stability due to bone cell adhesion to the titanium

![Image of CPTi coat creating rough surface]

**SIZE DOES MAKE A DIFFERENCE**

- Pore depth favorable for cell proliferation by balancing porosity and pore depth

![Image of pore depth and cell proliferation]

The Science

- hMSCs placed on CP Ti coated PEEK coupons
  - Cultured 24 hrs
  - Stained

- Living hMSC cells
  - Significant cell count
  - Strong adhesion

- Cell proliferation
  - Cell migration

- Pore depth is physiologically matched providing a surface that facilitates cell attachment, migration and proliferation of bone forming cells
Comparison of Coarse and Fine Topography

Coarse Roughness  Fine Roughness

Cell Count between Different Roughnesses

Coarse Roughness  Fine Roughness

28 cells/0.257 mm²  54 cells/0.257 mm²
Graft Containment Area

Maximize graft area is key

Ease of getting graft well packed

---

Bone Graft Choices

...just because you use it in the gutters doesn’t make it a good choice for your interbody
Generation of lamellipodia and filopodia by cell shows that the cells are responding to the scaffold microenvironment. This indicates cell attachment to the scaffold, healthy cell motility and viability within scaffold.

Cell Proliferation and Migration is Vital

What is the ideal graft?

A composite of the right components

<table>
<thead>
<tr>
<th>Cells</th>
<th>Matrix</th>
<th>Signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host or Cultured</td>
<td>Structure or Void Filler</td>
<td>DBM or Growth Factor</td>
</tr>
</tbody>
</table>
Thank You