Biomechanical Evaluation of Cage Subsidence Performance of Three Porous Lateral Cage Designs

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Background

- Promising early (1-year) subsidence results on porous cages
  - 3.4%, 29 patients (Krafft et al., 2019)
  - 3.0%, 67 levels (Amini et al., 2021)

- A variety of porous cage designs

**Research Question**
How does subsidence performance vary across different porous cage designs?
Objective

Evaluate subsidence performance of three porous cage designs using standardized (ASTM) and novel clinically relevant biomechanical testing methods.

- Porous titanium (stress optimized body lattice + microporous endplates)
- Porous PEEK (surface porosity)
- Truss titanium (truss structure with roughened surface)
Testing for Static Subsidence (ASTM F2267)

Loading = 6mm/min

Subsidence (Block) Stiffness (N/mm)

- Porous Ti: 2867.7
- Porous PEEK: 2563.4
- Truss Ti: 2213.7

Decreasing resistance to subsidence
Cage Stiffness and Subsidence Performance

No correlation was observed between cage stiffness and subsidence performance

- The stiffest cage → worst subsidence performance
- Second stiffest cage → best subsidence performance
Clinically Relevant Subsidence Testing

Sinusoidal Load Simulating 3-month Postoperative Spinal Loading (4Hz to 216,000 cycles)

<table>
<thead>
<tr>
<th>Material</th>
<th>Subsidence Displacement (mm)</th>
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<tbody>
<tr>
<td>Porous Ti</td>
<td>0.056, 0.175, 0.288, 0.439</td>
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<tr>
<td>Porous PEEK</td>
<td>0.085, 0.141</td>
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<tr>
<td>Truss Ti</td>
<td></td>
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Decreasing resistance to subsidence
Clinically Relevant Subsidence Displacement (mm)

Distribution of Subsidence Damage over Test Block at 2400 N
The truss cage (vs. porous titanium cage) showed a 23% reduction in subsidence performance in standardized testing, but this difference was 150% in the clinically relevant subsidence test.

Clinically relevant dynamic subsidence testing may provide a useful supplement tool for a comprehensive evaluation of subsidence.
Conclusion

A porous titanium cage with body lattice and microporous endplate demonstrated the best subsidence performance consistently, using both standardized and clinically relevant testing methods, verified by laser scanning.

The porous PEEK cage provided the second-best subsidence performance and remains a competitive option considering the benefits of radiolucency.

While novel manufacturing methods allow us to produce cages with porosities that were previously unattainable using conventional methods, the specific implant design and choice of material ultimately play a significant role in subsidence performance.

Research Question
How does subsidence performance vary across different porous cage designs?

Porous titanium > Porous PEEK > Truss titanium
Limitations and Ongoing Research

1. Preclinical results are not necessarily indicative of clinical outcomes
2. Remaining research questions regarding the effect of:
   a. Implant-endplate mismatch
   b. Microporous endplate and body lattice
   c. Cage material