Mechanical Strength and Stiffness of Biodegradable and Titanium Osteofixation Systems

A Comparison

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Scope (1)

Traumata
Scope (2)

Traumata
Background (1)

- Goals trauma surgery
  - adequate reponation
  - adequate fixation
- Plates and screws are generally used
Background (2)
• Degradable versus non-degradable
• Biodegradable fixation systems
  – great variety in dimensions
  – coarse dimensions
  – co-polymer compositions
• Mechanical characteristics differ substantially
  → hamper surgeons to select fixation system
Objective

To present relevant mechanical data in order to simplify the selection of an osteofixation system
Materials and Methods (2)

- 6 Biodegradable and 2 titanium osteofixation systems
- Plates/screws fixed to 2 PMMA blocks
<table>
<thead>
<tr>
<th>Brand name</th>
<th>Composition</th>
<th>Screw Diameter</th>
<th>Plate Length</th>
<th>Plate Width</th>
<th>Plate Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioSorb FX</td>
<td>SR 70L/30DL PLA</td>
<td>2.0</td>
<td>25.5</td>
<td>5.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Resorb X</td>
<td>100 DL-Lactide</td>
<td>2.1</td>
<td>26.0</td>
<td>6.0</td>
<td><strong>1.1</strong></td>
</tr>
<tr>
<td>Inion 2.0</td>
<td>LDL Lactide/TMC/PGA</td>
<td>2.0</td>
<td>28.0</td>
<td>7.0</td>
<td>1.3</td>
</tr>
<tr>
<td>LactoSorb</td>
<td>82 PLLA 18 PGA</td>
<td>2.0</td>
<td>28.5</td>
<td>7.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Polymax</td>
<td>70L/30DL PLA</td>
<td>2.0</td>
<td>28.0</td>
<td>6.0</td>
<td>1.3</td>
</tr>
<tr>
<td>MacroPore</td>
<td>70L/30DL PLA</td>
<td>2.0</td>
<td>25.0</td>
<td>6.7</td>
<td><strong>1.2</strong></td>
</tr>
<tr>
<td>KLS Martin</td>
<td>Titanium (pure)</td>
<td><strong>1.5</strong></td>
<td>18.5</td>
<td>3.5</td>
<td><strong>0.6</strong></td>
</tr>
<tr>
<td>KLS Martin</td>
<td>Titanium (pure)</td>
<td>2.0</td>
<td>25.5</td>
<td>5.0</td>
<td><strong>1.0</strong></td>
</tr>
</tbody>
</table>

sizes in mm
Materials and Methods (2)

- Statistical analysis
  - SPSS version 12.0
  - One-Way ANOVA
  - Significant p < 0.05

<table>
<thead>
<tr>
<th>Test</th>
<th>Property</th>
<th>Strength</th>
<th>Stiffness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bending</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Torsion</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Materials and Methods (1)

- Subjection to:
  - tensile
  - side bending
  - torsion
Results (1)

Mean Strength Tensile Test

- **Degradability**
  - Degradable
  - Non degradable

- **Systems**
  - BioSorb
  - Resorb
  - Titanium

- **Mean Strength (N)**
  - 0.00
  - 200.00
  - 400.00
  - 600.00
  - 800.00
Results (2)

Mean Stiffness Tensile Test

- **Degradability**
  - Degradable
  - Non degradable
Results (3)
Results (4)
Discussion (1)

- PMMA blocks versus bone
- *In vitro* data versus clinical application
Conclusions

- Tensile test: 1.5 and 2 mm titanium systems significantly stronger and stiffer than biodegradable systems
- Side bending test: 2 mm titanium system significantly stiffer than biodegradable systems
- Torsion test: 2 mm titanium system significantly stiffer than biodegradable systems
- SD of titanium plates larger than of biodegradable plates

Clinical importance
- Large significant differences titanium and biodegradable are clinically relevant
Conclusions

- Conclusions (cont.)
  - BioSorb FX most favorable strength and stiffness
  - Including cross-section Biosorb FX system is superior
  - Resorb X and MacroPore least strong and stiff

- Clinical importance
  - Large significant differences titanium and biodegradable are clinically relevant
Acknowledgements

- Manufacturers
  - Linvatec Biomaterials Ltd.
  - KLS Martin
  - Inion Ltd.
  - Walter Lorenz Surgical Inc.
  - Synthes
  - Macropore Inc.
Thank you for your attention