Cyclic and Load to Failure Properties of All-Suture Anchors in Synthetic Acetabular Cancellous Bone

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Disclosures

- Dr. Safran
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Introduction

- Metal, polyether ether ketone (PEEK) and various biocomposites have been routinely used in shoulder labral repair.
- However, there is a paucity of data on the performance of the more recently-developed all-suture anchors (ASAs) [1-3].
- In particular, ASAs have not been tested in acetabular bone, or bone substitute simulating the range of bone properties found in the acetabulum.
Questions

1. Do all-suture anchors have better or worse fixation than a commonly used standard suture anchor?

2. Is there variation in fixation between all-suture anchors of different designs?

3. Does high density bone affect the fixation of these various suture anchors?
Methods

Test all ASAs marketed for hip labral repair
  - 12 anchors
  - Bioraptor 2.3 PK = control (PEEK ribbed implant)
  - 7-11 anchors per group based on previous studies [1-3]

Sawbones with properties replicating:
  - High density – acetabular rim (30 pcf)
  - Low density – glenoid (20 pcf)
  - Based on multiple cadaveric studies [4-12]

Comparing outcomes in 20 pcf vs. 30 pcf for each anchor
  - Welch T-test

Comparing anchors to each other, in both densities
  - Welch ANOVA with Games-Howell post hoc test

Comparisons only made when at least 3 anchors survived (or were present)
# Commercially-Available All-Suture Anchors

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Drill size (mm)</th>
<th>Suture size</th>
<th># suture strands</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suturefix Ultra 1.7</td>
<td>Smith &amp; Nephew</td>
<td>1.7</td>
<td>2</td>
<td>1</td>
<td>hip and shoulder labrum</td>
</tr>
<tr>
<td>Suturefix Ultra 1.9</td>
<td>Smith &amp; Nephew</td>
<td>1.9</td>
<td>1</td>
<td>2</td>
<td>shoulder labrum</td>
</tr>
<tr>
<td>JuggerKnot 1.0</td>
<td>Biomet Sports Medicine</td>
<td>1.0</td>
<td>2-0 or 3-0</td>
<td>1</td>
<td>hand, small joint</td>
</tr>
<tr>
<td>JuggerKnot 1.4</td>
<td>Biomet Sports Medicine</td>
<td>1.4</td>
<td>1</td>
<td>1</td>
<td>shoulder labrum</td>
</tr>
<tr>
<td>JuggerKnot 1.45 #1</td>
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<td>1.45</td>
<td>1</td>
<td>1</td>
<td>hip labrum</td>
</tr>
<tr>
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<td>1.45</td>
<td>2</td>
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</tr>
<tr>
<td>JuggerKnot 1.5</td>
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<td>2</td>
<td>1</td>
<td>shoulder labrum</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
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<tr>
<td>JuggerKnot 2.9</td>
<td>Biomet Sports Medicine</td>
<td>2.9</td>
<td>2</td>
<td>2</td>
<td>rotator cuff</td>
</tr>
<tr>
<td>Y-Knot 1.3</td>
<td>ConMed Linvatec</td>
<td>1.3</td>
<td>2</td>
<td>1</td>
<td>hip and shoulder labrum</td>
</tr>
<tr>
<td>Y-Knot 1.8</td>
<td>ConMed Linvatec</td>
<td>1.8</td>
<td>2</td>
<td>2</td>
<td>shoulder labrum</td>
</tr>
<tr>
<td>Iconix 1</td>
<td>Stryker Endoscopy</td>
<td>1.4</td>
<td>2</td>
<td>1</td>
<td>broad, including hip</td>
</tr>
<tr>
<td>Iconix 2</td>
<td>Stryker Endoscopy</td>
<td>2.3</td>
<td>2</td>
<td>2</td>
<td>broad, including hip</td>
</tr>
<tr>
<td>Iconix 3</td>
<td>Stryker Endoscopy</td>
<td>2.3</td>
<td>2</td>
<td>3</td>
<td>broad, including hip</td>
</tr>
<tr>
<td>Iconix 25</td>
<td>Stryker Endoscopy</td>
<td>2.3</td>
<td>5</td>
<td>2</td>
<td>broad, including hip</td>
</tr>
<tr>
<td>Q-Fix 1.8</td>
<td>ArthroCare</td>
<td>1.8</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Q-Fix 2.8</td>
<td>ArthroCare</td>
<td>2.8</td>
<td>2</td>
<td>2</td>
<td>rotator cuff</td>
</tr>
</tbody>
</table>

Red arrowhead indicates anchor tested in this study
Methods

- Deployment Force: 40 N
- Cyclic loading protocol stages
  1. 10 – 50 N for 200 cycles, 0.5 Hz
  2. 10 – 100 N for 200 cycles
  3. Load to failure, 10 mm/s
In 20 pcf test blocks, the Bioraptor 2.3 PK and Q-Fix 1.8 showed significantly (p < 0.002) less peak displacement than all other anchors.

In 30 pcf test blocks, the Q-Fix 1.8 showed a trend towards less displacement than the Bioraptor 2.3 PK (p = 0.11) but not Iconix 25, and significantly less than all others (p < 0.02).
In 20 pcf test blocks, the Q-Fix 1.8 displaced less (p < 0.01) than all other anchors.

In 30 pcf test blocks, the Q-Fix 1.8 displaced less than all anchors (p < 0.02), except the Iconix 25 (p = 0.18)
- Higher failure loads in 30 pcf than 20 pcf for all anchors, except Iconix 2 (p = 0.09)
- No statistically significant differences among top performers in either 20 or 30 pcf blocks
- Anchors routinely failed by suture pullout, except the Q-Fix 1.8 which failed by suture breakage in 30 pcf blocks
Limitations

- Synthetic bone substitute
- Non-aqueous environment
- Absence of cortical layer
  - Does not affect majority of rotator cuff anchors [1, 13, 14]
  - However, cortical layer often disrupted by acetabuloplasty or preparation
- 400 Cycles
  - Based on previous studies Barber and Herbert
  - Hip / Shoulder often braced post-operatively
- Unknown clinically relevant load to failure, displacement
  - 250N in rotator cuff [15-18]
Discussion

- ASAs have improved *fixation* in higher density bone
  - Did not test *deployment* directly with imaging

- ASAs generally performed worse than control standard anchor
  - With exceptions - not in 20 pcf, with over 50 N load

- Q-Fix 1.8 outperformed all anchors including the control anchor in all testing conditions
References


