Open sup-pectoral biceps tenodesis: A biomechanical comparison of interference screw and various fixation techniques

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BACKGROUND

- Injuries of the long head of the biceps (LHB) tendon are frequently responsible for pain and discomfort at the shoulder.
- Surgical treatment consists of biceps tenodesis, with fixation of the tendon at the proximal humerus.
  - Variety of fixation methods
  - Suprapectoral or subpectoral placement
  - Three different visualization techniques
- Tenodesis has proven to provide clinical benefits, but the optimal fixation technique has not been identified in biomechanical or clinical studies.

STUDY OBJECTIVE

- Evaluate the mechanical properties of six biceps tenodesis fixation techniques.

METHODS

- Forty-two fresh frozen human cadaver upper extremities were obtained from the Maryland State Anatomy Board (mean age, 70.5 years [range, 54 to 89 years; SD, 9.8 years], 69% male specimens).
- Specimens were excluded from the study if they demonstrated degenerative or surgical changes.
- Specimens were randomly divided into 6 tenodesis technique groups, with 7 specimens in each group:
  - Interference Screw
  - Endobutton
  - Double-loaded 2.9 mm Suture Anchor
  - Double-loaded 1.9 mm Suture Anchor
  - Single-loaded 1.7 mm Suture Anchor
  - Soft Tissue
- Biceps tenodesis procedures were performed in an open manner per the manufacturer’s published surgical techniques.
- After tenodesis, specimens were loaded onto a materials testing machine and underwent load to failure testing with force directed parallel to the humerus.
- The effects of treatment, age, gender, and bone mineral density were analyzed with a generalized linear and latent mixed model (GLLAMM) to account for specimen pairing on donors.

RESULTS

<table>
<thead>
<tr>
<th>Technique</th>
<th>Age [yr]</th>
<th>Male/Female</th>
<th>BMD [g/cm²]</th>
<th>Failure Load [N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interference Screw</td>
<td>70.7 ± 5.3</td>
<td>6/1</td>
<td>.802 ± .093</td>
<td>78.6 ± 20.5</td>
</tr>
<tr>
<td>Endobutton</td>
<td>69.4 ± 8.0</td>
<td>4/3</td>
<td>.700 ± .118</td>
<td>126.0 ± 33.1</td>
</tr>
<tr>
<td>DL-2.9mm Anchor</td>
<td>73.9 ± 5.2</td>
<td>5/2</td>
<td>.701 ± .116</td>
<td>122.9 ± 30.6</td>
</tr>
<tr>
<td>DL-1.9mm Anchor</td>
<td>68.0 ± 4.1</td>
<td>4/3</td>
<td>.739 ± .083</td>
<td>110.6 ± 21.2</td>
</tr>
<tr>
<td>SL-1.7mm Anchor</td>
<td>69.9 ± 5.1</td>
<td>5/2</td>
<td>.749 ± .144</td>
<td>131.9 ± 36.8</td>
</tr>
<tr>
<td>Soft Tissue</td>
<td>71.3 ± 5.8</td>
<td>5/2</td>
<td>.749 ± .067</td>
<td>98.3 ± 19.5</td>
</tr>
</tbody>
</table>

Secondary Analyses

- There was no statistically significant difference found amongst treatment groups in terms of ultimate failure loading after analysis with GLLAMM (P=0.532).
- Comparing the 95% confidence interval of the interference screw treatment group (81.9-99.1N) to the 95% CI of the endobutton (102.9-169.1N) and DL-2.9 mm anchor groups (102.9-162.8N) suggests that the interference screw treatment is significantly weaker.
- Utilizing a 112 N reference mark, which approximates force on LHB tendon during performance of activities of daily living and post-surgical physical rehabilitation, rules out interference screw, DL-1.9 mm suture anchor, and soft tissue tenodesis as viable treatment options.
- Failure mainly occurred at the tendon (35/42), indicating that the most important factor for initial strength is not the attachment site but the quality of the biceps tendon.

CONCLUSIONS

- Of the six biceps tenodesis techniques that were evaluated, only interference screw fixation was significantly weaker than any other construct.
- Endobutton, DL-2.9 mm anchor, and SL-1.7mm anchor are capable of withstanding demands of ADLs and physical rehabilitation.

LIMITATIONS

- Tenodesis was performed on human cadaveric specimens, which may not accurately represent in vivo strength of fixation constructs.
- Surrounding tissues were removed during preparation of specimens, thus their effect on fixation strength was eliminated.

IMPLICATIONS

- Many fixation approaches provide similar biomechanical strength, thus other factors may drive clinical decision making.
  - Clinical ease of use
  - Costs
  - Time required to perform
  - Effects on rehabilitation
- Further biomechanical and clinical studies are needed to discover optimal tenodesis technique.

REFERENCES