Single-incision slings: a strength comparison of immediate and delayed extraction forces of five anchor types in a rabbit model

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Introduction
Synthetic mid-urethral slings are the new “gold standard” surgical therapy for female stress urinary incontinence. Single-incision slings (minislings) are the most recent type of mid-urethral sling.

Components of single-incision slings:
1. Polypropylene mesh
2. One of these methods to secure mesh ends:
   - “Velcro-style” secure tip (TVT Secur™)
   - Needleless™ fascial pocket
   - Anchor

Anchors secure the ends of sling onto the obturator internus muscles. These are critical in the immediate postoperative phase prior to fibrosis securing the mesh in place.

Ideal anchor would be:
- Easily deployable
- Immediately stable
- “Permanent” after tissue healing

Study Goal
We compare the physical characteristics and force required to insert anchors from five different anchor-based single-incision slings, as well as the force needed to extract anchors immediately after implantation and 30 days post-implantation in a rabbit rectus femoris model.

Methods
Slings used were the following:
1. AMS Miniarc®
2. Boston Scientific Solyx™
3. Promedon Ophira
4. Bard Ajust™
5. Coloplast Altis®

Measurements of each anchor were recorded. One anchor of each type was implanted into the rectus femoris muscle of a 6-month old New Zealand white rabbit. After 30 days, anchors were extracted by applying steadily increasing force to the mesh perpendicular to the muscle. Anchors were also implanted with immediate extraction for comparison.

Data collected for each anchor:
- Anchor measurements
- Mean insertion force (n=3)
- Mean immediate extraction force (n=2)
- 30-day extraction force (n=1)

Results

<table>
<thead>
<tr>
<th>Anchor</th>
<th>Length of anchor (mm)</th>
<th>Width at barbs opposing extraction (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor 1</td>
<td>7.25</td>
<td>4.9</td>
</tr>
<tr>
<td>Anchor 2</td>
<td>9.2</td>
<td>4.55</td>
</tr>
<tr>
<td>Anchor 3</td>
<td>26.5</td>
<td>3.85</td>
</tr>
<tr>
<td>Anchor 4</td>
<td>5.5</td>
<td>9.76</td>
</tr>
<tr>
<td>Anchor 5</td>
<td>4.4</td>
<td>6.47</td>
</tr>
</tbody>
</table>

Table 2. Percentage difference in force between insertion to extraction.

Conclusions
- Insertion forces of all anchors are similar
- Mean insertion forces range from 7.3 to 13.2N
- Not statistically different when compared by paired t-tests

Immediate extraction forces vary between anchors
- Anchors 2 and 3 have the lowest mean immediate extraction forces
- Anchors 4 and 5 have the highest mean immediate extraction forces

Delayed extraction forces vary between anchors
- Anchor 2 has the lowest 30-day extraction force
- Anchors 4 and 5 have the highest 30-day extraction forces

Variation in insertion and extraction forces can be attributed to differences in anchor characteristics
- There are considerable differences in the design of each anchor for the studied slings
- The shape, orientation, number, and size of the barbs on each anchor may contribute to the differences in insertion and extraction forces
- Anchors 4 and 5 have the highest surface area to counteract extraction. This may be why they have the highest extraction forces

Anchor extraction forces are much higher than physiologic forces experienced by sling
- Lin et al. showed that in vivo tension exerted on proximal urethral slings during cough ranges from 0.42 and 0.48N
- These forces are much lower than any of the immediate extraction forces found in this study (3.5 to 22N)
- Can infer that it would be extremely difficult to dislodge a properly placed anchor with physiological cough or Valsalva

References

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