Thyroid Cartilage Fracture Repair in Rabbits: Comparing Healing With Wire and Miniplate Fixation

2004/12/31  R2 Chang
Introduction

- Acute laryngeal trauma: uncommon; 1/14,500 to 42,500 ER
- Lack of consensus on management
- Repairing fractures of the larynx: stainless steel wire or suture
- Cadaver: laryngeal cartilage: maximum pullout strength: a 1.5-mm titanium adaptation screw in a 0.76-mm drill hole
Materials and Methods

- 8 adult male New Zealand white rabbits
- Complete vertical fracture: sharp incision, midthyroid ala
- Repair: one point fixation
  1. Surgical 26-gauge stainless steel wire
  2. Titanium miniplates and 1.3-mm screws, 0.76-mm drill holes
- 10 weeks, euthanized
## Results

<table>
<thead>
<tr>
<th>Rabbit No.</th>
<th>Weight (kg)</th>
<th>R Side Fixation</th>
<th>L Side Fixation</th>
<th>R Side Op Time (min)</th>
<th>L Side Op Time (min)</th>
<th>Operative Complications</th>
<th>Postoperative Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.8</td>
<td>MP</td>
<td>W</td>
<td>6</td>
<td>12</td>
<td>CT incision</td>
<td>SQ emphysema</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>W</td>
<td>MP</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>W</td>
<td>MP</td>
<td>4</td>
<td>5</td>
<td>Bleeding</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>MP</td>
<td>C</td>
<td>4</td>
<td>—</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>5.2</td>
<td>W</td>
<td>MP</td>
<td>12</td>
<td>4</td>
<td>Bleeding</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>W</td>
<td>MP</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>C</td>
<td>W</td>
<td>—</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>5.1</td>
<td>MP</td>
<td>W</td>
<td>4</td>
<td>6</td>
<td>Bleeding</td>
<td>0</td>
</tr>
</tbody>
</table>

*R = right; L = left; Op = operation; MP = miniplate and screw fixation; W = wire fixation; C = control; CT inc = inadvertent cricothyroid incision; bleeding = bleeding resulting from incision of the thyroid cartilage; SQ = subcutaneous.

- Wire fixation: 8 min
- Miniplate fixation: 4.3 min
Results-Gross findings

**Wire fixation:**
- Distraction: displacement of the fracture
  6/7: >0.8mm (average width of thyroid cartilage)
- Callus formation: 4/7: significant

**Miniplate fixation:**
- Contour: smooth; Distraction: 2/7: minimal
- No callus

**Control:**
- Compare to wire fixation
Typical callus formation
Results-Histologic findings

Wire fixation:

- Distraction: (7/7)
  mean: 1.77mm
  (1.08~2.28mm)
  for shortening
- Cartilaginous necrosis: (7/7)
Results-Histologic finding

Miniplate fixation

- Distraction:
  - 5/7: no distraction
  - 2/7: some overlap
  - but
  1. edge: in contact
  2. inner and outer perichondrium: intact
## Results

<table>
<thead>
<tr>
<th>Technique</th>
<th>Mean Distraction</th>
<th>SD</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>1.770</td>
<td>0.382</td>
<td>0.270</td>
<td>1.500</td>
<td>2.040</td>
</tr>
<tr>
<td>Wires</td>
<td>1.774</td>
<td>0.459</td>
<td>0.174</td>
<td>1.080</td>
<td>2.280</td>
</tr>
<tr>
<td>Plates</td>
<td>0.429</td>
<td>0.575</td>
<td>0.217</td>
<td>0.000</td>
<td>1.320</td>
</tr>
</tbody>
</table>

SD = standard deviation; SE = standard error.

- **Angulation**
Discussion

- Repairing thyroid fracture:
  - slow chondrogenesis: avascularity and low metabolism
  - accurate reduction and immobilization
- 1990, Woo, maxillofacial reconstruction; immediate and sustained rigid stability
Discussion

Study findings:

- Tolerated in vivo
- Rigid fixation
- Technically easy (T.G.D., E.F.P.)
- Operation time
- Larger screw/screw hole ratios maximized fixation strength
Discussion

Limitation in rabbits model: (increase wire erosion)
- Single point fixation
- Thin cartilage

Suggestions:
- Two point fixation
- Plate transverse all or most of the length or width of the thyroid
Conclusion

Miniplate fixation in rabbit model

- Well tolerated
- Easy to apply
- Alignment
- Cartilage healing