Porcine model for early onset scoliosis created with a posterior mini-invasive method

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Introduction

To develop new nonfusion techniques for the treatment of EOS, a large animal model with remarkable growth potential is required.

However, a long tethering period or violation of the vertebral elements was required in most of the previous models.

Objective

- To create a reliable porcine scoliosis model representative of EOS without violation of the vertebral elements along the curve
10 female pigs (age, 5–6 weeks; weight, 5–7 kg) underwent posterior asymmetric tethering surgery.

- Spine tethering (T5-L3) + ipsilateral rib tethering (10\textsuperscript{th}-13\textsuperscript{th} rib)
- Serial X-ray films at 4-week intervals
- After an 8-week tethering period, the whole instrumentations were removed, and the pigs were observed for an additional 8-week period
Results

Figure 2.  a,b) Before the surgery, the porcine spine was normally aligned in the coronal and sagittal planes.  c) Immediately after the tethering surgery, a mild scoliosis of 27° was created.  d) Lateral radiograph showed the kyphosis was 55°.  e) 8 weeks after tether release, a significant scoliosis(72°) was observed.  f) The thoracic lordosis was 53° and the thoracolumbar kyphosis was 75°.  g) CT reconstruction showed a typical scoliosis.  h) Axial CT scan showed apex rotation of 38°.
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<th>Pig NO.</th>
<th>Cobb angle</th>
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<td>Immediate after tethering(°)</td>
<td>8w-Post-OP(°)</td>
<td>8w-Post-removal of tethering(°)</td>
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<td>1</td>
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Fig 3. Evolution of scoliosis in pigs during the 16 week period.
- The scoliosis aggravated during the 8-week tethering period.
- Four weeks after the tether release, a small decrease of the Cobb angle was observed.
- However, the scoliosis progressed over the next 12th to 16th weeks.
Figure 4. Eight weeks after removal of the tethering, coronal reformatted image of CT showed wedging of the apical vertebrae of Pig 7.
Discussion

Two prerequisites involved in setting up an appropriate EOS model

- provide a comparative size to human
  - Pigs: the most representative of humans in terms of spine shape
- experience rapid progression of scoliosis
  - age: 5-6 weeks
Several shortcomings of previous models

- passed the PHV when scoliosis was induced

- contralateral rib resections, the chest wall is severely destroyed
  - violate the integrity of the thoracic cage

- huge incision required, the paraspinal muscle is violated
  - increase the damage

- rough disturbance of the back
  - increase the risk of autofusion
  - limit fusionless correction investigations
Conclusion

- Using a mini-invasive tethering method, a rapidly progressive spinal deformity can be created in immature pigs.
- This method avoids violation of the spinal elements throughout the curvature and provides an ideal EOS model with great growth potential for further study of new nonfusion therapies.