Cervical Spine Deformity Treatment: Positioning, Imaging, and Navigation

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DISCLOSURES

• No financial disclosures
• No conflicts of interest related to this talk
WHERE TO START

- Patient
  - Big or small
  - Anatomic considerations

- Surgeon
  - Technical ability, experience, comfort

- Situation
  - Deformity vs. trauma
  - Treatment plan

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PRE OP IMAGING – WHICH IMAGING BEST?

• Assess Deformity
  1. Instability – Flex/ext x-rays vs MRI
  2. Basilar Invagination – MRI
  3. Static Deformity – Rotational CT

• Anatomic Assessment
  1. Spinal Cord
  2. Vertebral Arteries – position, course, variation
  3. Fixation potential
PRE OP IMAGING – WHICH IMAGING BEST?

• Flexion – Extension MRI

*Flexion-Extension Cervical Spine MRI in Children With Skeletal Dysplasia: Is It Safe and Effective?*

*William G. Mackenzie, MD, FRCS(C),* *Arjun A. Dhwale, MD,* *Matthew M. Demczko, BSc,†*

• 6/31 patients showed no cord compression on MRI

• Vertebral Artery Location – CT scan

*Location of the Vertebral Artery at C1 in Children: How Far Out Laterally Can One Safely Dissect?*

*Rachel Y. Goldstein, MD, MPH, Caleb D. Sunde, BS, Peter Assad, MD, MPH, John Grimm, MD, David L. Skaggs, MD, MMM, and Lindsay Andras, MD*

<table>
<thead>
<tr>
<th>Age Group (yr)</th>
<th>Mean Distance from Midline (Range) (mm)</th>
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<tbody>
<tr>
<td>&lt;2</td>
<td>11.94 (8.14 to 16.24)</td>
</tr>
<tr>
<td>2 to &lt;4</td>
<td>13.80 (10.00 to 18.87)</td>
</tr>
<tr>
<td>4 to &lt;6</td>
<td>14.28 (10.40 to 18.00)</td>
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<tr>
<td>6 to &lt;8</td>
<td>14.40 (10.30 to 18.50)</td>
</tr>
<tr>
<td>≥8</td>
<td>15.54 (11.80 to 20.80)</td>
</tr>
<tr>
<td>Total</td>
<td>13.97 (8.14 to 20.80)</td>
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PRE OP IMAGING – WHICH IMAGING BEST?

- High riding vertebral artery

**Atlantoaxial Transarticular Screw Fixation for a High-Riding Vertebral Artery**

- 7/27 patients showed high riding VA
PRE OPERATIVE PLAN

• Approach – depends on deformity
  1. Anterior
  2. Posterior

• Head Fixation
  1. Horseshoe
  2. Mayfield
  3. Halo

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
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<tbody>
<tr>
<td>Ease of positioning</td>
<td>Less stable head fixation</td>
</tr>
<tr>
<td>Stable head positioning</td>
<td>No post-op immobilization</td>
</tr>
<tr>
<td>Stable head position; post-op immobilization</td>
<td>Bulky posteriorly; awkward to attach to bed</td>
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PRE OPERATIVE PLAN

- Head Fixation
PRE OPERATIVE PLAN

• Head Fixation - 11yo symptomatic OO
PRE OPERATIVE PLAN

• Implants
  1. Segmental
     - Size appropriate
     - Occiput
  2. Wiring options

• Bone Graft
  1. Autograft ICBG
     - Positioning and draping consideration
  2. Allograft
  3. BMP?
     - Consent

- plate-rod vs. occipital plate

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PRE OPERATIVE PLAN

- Implants

3 yo - Downs Syndrome
- C1 decompression
- Weakness and hyperreflexia
- O-C2 fusion with fib allo
- Unilateral VA injury during dissection
- Stenosis at C1
PRE OPERATIVE PLAN

• Implants

6 months post-op
- Progressive neuro compromise to quadreparesis
- Nonunion, cont instability, basilar invagination
- Revision C1 decom, O-C2 with ICBG
PRE OPERATIVE PLAN

• Navigation / Imaging
  1. Positioning of bed
  2. Positioning of equipment
  3. What imaging systems needed and order of need

• Neuromonitoring
  1. When
     - Pre and post flip?
  2. Positioning of wires
INTRA-OP

• Patient Positioning
  1. Arms
  2. Iliac Crest
  3. Head fixation and positioning
     - Imaging
     - Navigation
  4. Room Set up
INTRA-OP

- Patient Positioning
INTRA-OP

• Imaging

1. Depends on plan
2. C-arm \(\rightarrow\) O-arm \(\rightarrow\) C-arm
3. O-arm management
   a) How to drape
      - Free
      - Circular drape
   b) Post implant scan
   c) Saving images

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INTRA-OP

• Implants
  1. Occiput
     - Size of occiput vs implants
     - Plates vs plate-rods
  2. C1 fixation
     - Lateral mass screws
     - Occipital wiring
  3. C2 fixation
     - Options based on size of posterior elements
     - Vertebral artery – position and condition
INTRA-OP

6 year old girl
- Downs Syndrome
- Myelopathic on exam
O-C2 fusion

- C1 lateral mass
- C2 laminar hook
- C2 intralaminar screw
INTRA-OP

• Implants
  4. Subaxial cervical spine
    - size
    - imaging
  5. Bailout plan

• Bone grafting
  1. Placement of graft
    - facet grafting
    - O-1 grafting
INTRA-OP

- Navigation
  1. Room set up
  2. Reference frame planning and positioning
  3. Turn bed 90 degrees
  4. What to navigate
     - cactus, drill, screw
  5. Bailout plan

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INTRA-OP

• Navigation
POST-OP

• Immobilization
  1. Halo vest
  2. Pin-less halo
  3. C-collar
CONCLUSIONS

1. Many challenges in cervical spine work
2. Not traditionally our “wheel house”
   - Repetition builds confidence and expertise
   - Help from a partner or neurosurgery colleague is ok!
   - Pre-op planning is key to success
3. Know the anatomy and goal
   - Patient specific variables
   - Room set up
   - Positioning
   - Implants
4. Navigation is helpful but not perfect!

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