Growth Patterns of the Neurocentral Synchondrosis in Immature and Growing Vertebra

Richard M. Schwend, MD; Laurel C. Blakemore, MD; John A. Schmidt, PhD; Behrooz Akbarnia, MD
Disclosures

- Richard M. Schwend MD
  - K2M Research Support
  - POSNA BOD
  - Project Perfect World BOD
  - Miracle Feet Medical Advisory Board
  - AAP Executive Committee, COM, PPC
- John Schmidt PhD
  - K2M research support
- Laurel Blakemore MD
  - K2M Research Support, Board of Surgical Advisors, Consulting Agreement
  - SRS Board of Directors, member at large
  - Associate Editorial Board
- Julie Reigrut MS
  - K2M Research Support
- Behrooz Akbarnia MD.
  - K2M Research support to institution and royalties.
  - DePuy Synthes grants to institutions royalties.
  - Ellipse technology grants to institution, consultant stock.
  - K Spine consultant, stock
• Acknowledgments: This project received research funding from K2M Inc.

• We also acknowledge assistance from Lyman Jellema, Curator, Physical Anthropology, Hamann-Todd Osteological Collection, the Cleveland Museum of Natural History, 1 Wade Oval Drive, Cleveland OH 44106. 216 231 4600 X3276
Neurocentral Synchondrosis (NCS)

• Previous authors have described growth patterns and postulated on effects of early closure

Parent *Spine* 2004
Goal

- To evaluate the NCS in all three regions of the spine in children aged 1-18 YO.
• Hamann-Todd Osteological Collection provided the bones of 32 complete pediatric cadaveric osteologic specimens aged 1-18 years (ages 2 and 9 missing from series)
• 733 vertebral body specimens
Vertebra and Rib Analysis

- 6226 individual photographs of all vertebral bodies and ribs were obtained from these specimens. Quantitative measurements were taken with image analysis software and were analyzed.
- 32,000 separate measurements were analyzed.
NCS Measurement

- left and right sides of each NCS along with the actual width of the pedicle at same location were measured.
- Dividing NCS by the pedicle width and multiplying by 100 gives the percentage open of the growth plate
NCS Measurement

The % NCS is Open = NCS/Width

1441, 10YO Male, 68.71%
Different Spine Regions Behaved Differently

• Cervical:
  - By 5y the cervical spine has virtually closed with only 10% of the NCS remaining.

• Lumbar:
  - is still nearly 50% open at 5y and closed by 10y.
Different Spine Regions Behaved Differently

- Thoracic
  - only 25% closed at 5y and remains open through 17y.

- t-testing showed that there was no difference between the left and right NCS data.
Thoracic spine NCS

1557 - T6, 3YO, Male
100% Open

526 – T9, 11YO, Female
35% L, 47% R
### Findings to Date

#### Cervical & Lumbar – NCS fully closed by 10y

#### Thoracic open to 18y
Spinal Canal Size

• (data presented previously at Zorab)
• by 5y Canal \( \sim 71\% \) of final size
• by 10y Canal is \( \sim 95\% \) of final size
  - transverse growth
  - cervical spine and L5 greatest increase

• Growth of canal area for all VBs and ages is \( 6.2\text{mm}^2/\text{year} \)
Other studies

- **Maat Spine 1996**
  - 2 pediatric cadaveric specimens- considered NCS fused by age 6
- **Yamakazi JPO 1998**
  - MRI 91 pts – thoracic NCS closed at 11-16 yrs
- **Cannadell Rev Med Univ Navarra 1974**
  - cadaveric- fused 11-14 yrs
Instrumenting NCS can affect spinal growth (in pigs anyway)

• Cil *Spine* 2005  
  ▪ lumbar PS in newborn pigs resulted in shortened PS and 20-26% canal narrowing

• Zhang *JBJS* 2008  
  ▪ unilateral TPS in pigs can produce scoliosis

• Pekmezci *Spine* 2009  
  ▪ ant. lumbar fusion caused canal narrowing

• Zhou *JBJS* 2014  
  ▪ TPS in pigs caused 20% loss canal area
But not in kids?

- Ruf *Spine* 2002
  - 16 1-2 yo pts, T and L PS, 3 pts 6+ yr f/u
  - no stenosis by MRI in those 3 (? all lumbar)

- Olgun *Spine* 2012
  - 15 pts <5 yo, no effect on canal dimensions at 2 yr f/u

- *Elsebaie (IMAST 2010)*-reported 7 1-2 yo’s w/anterior screws combined with anterior fusion \(\rightarrow\) 10-20% canal size decrease
Conclusions

• NCS closes later in the thoracic spine than in other regions

• The implications for treatment of spinal deformity in children are still not understood
Thank You