# Small Spinal Cord with Thoracic Congenital Vertebral Anomalies

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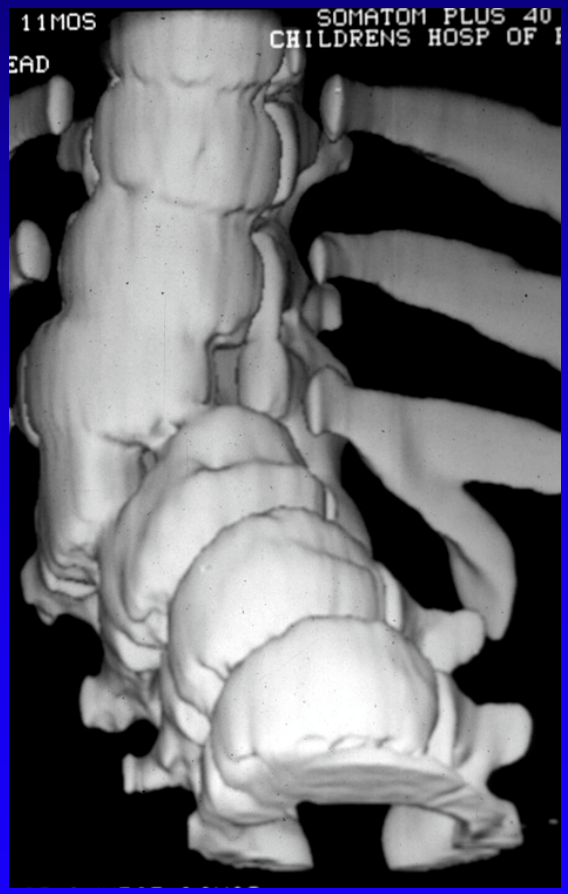
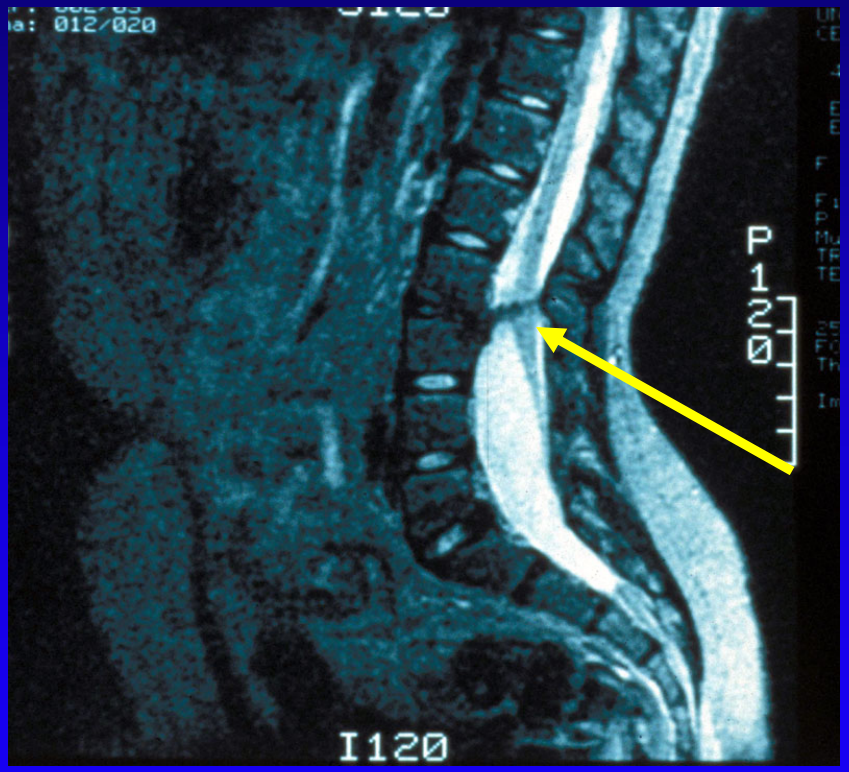


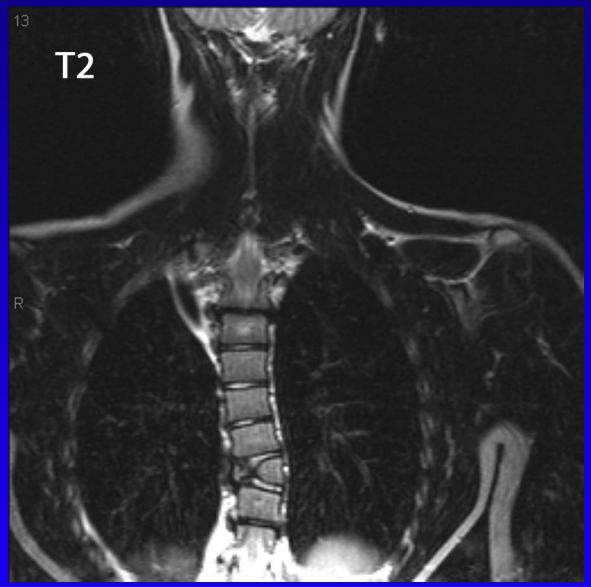
# Congenital Scoliosis And Intraspinal Anomalies

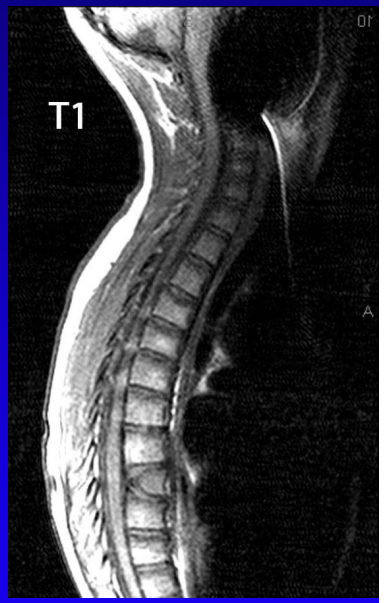
- Association well documented
- Increased surgical risk
- MRI recommended before treatment



# Neurologic Risk in Congenital Vertebral Anomalies

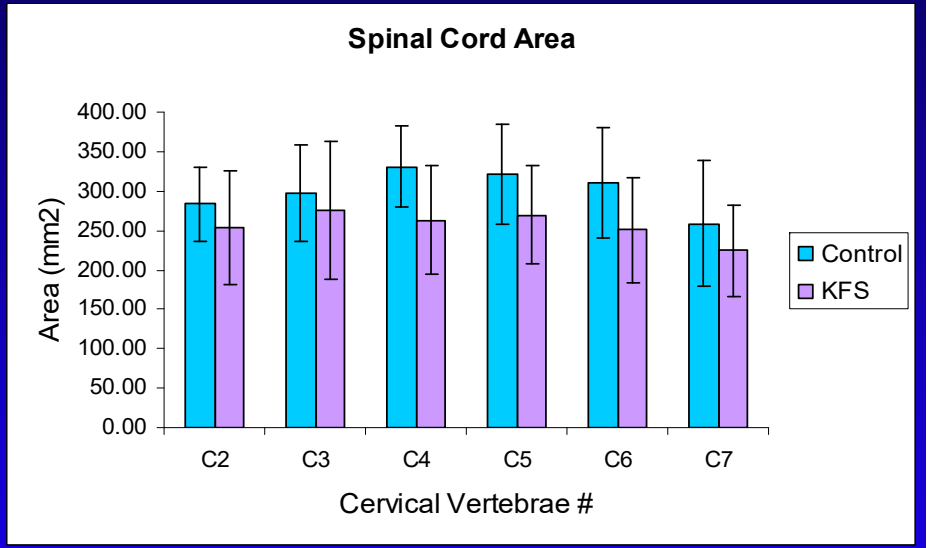
- Association known with intraspinal anomalies
- No documentation of risk with *normal appearing* cords



# Klippel Feil Study

- 15 patients studied
- Spinal cord smaller at all level vs controls
- Significant at two levels
  - Auerbach et al Spine: 2008

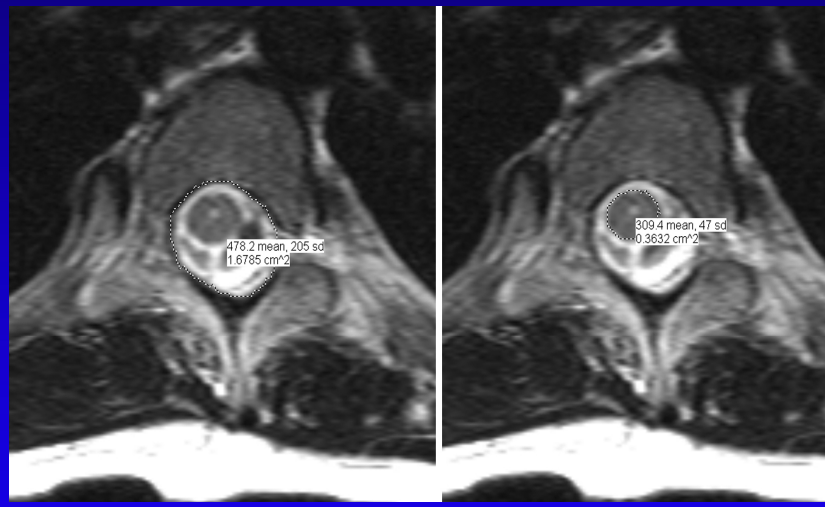


# Present Study Hypothesis

**Spinal cord would also be small in patients with congenital vertebral anomalies of the thoracic spine**

# Methods & Materials

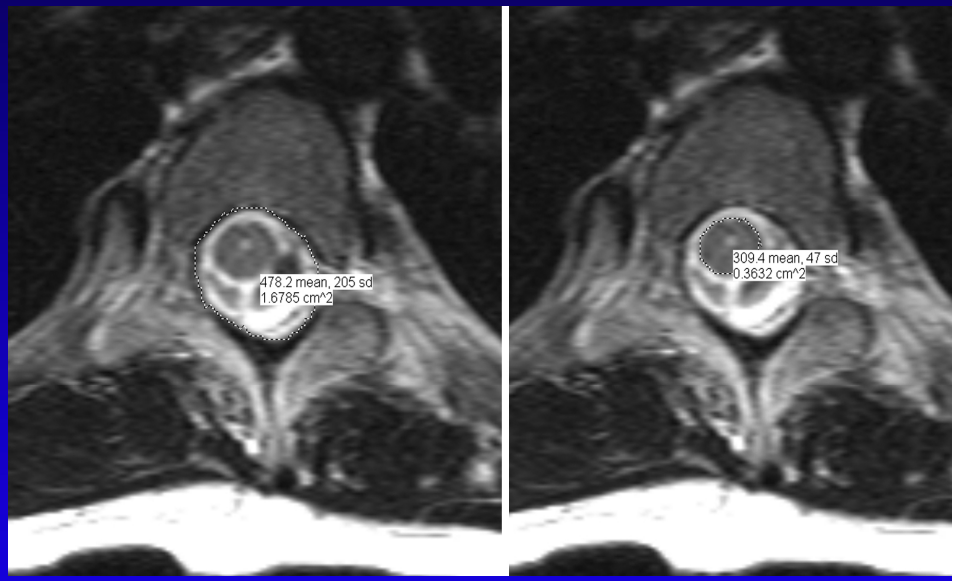
- 30 consecutive children in cohort
  - 15 formation failure
  - 15 segmentation defect
- 30 age matched controls
- Axial T2 digital images
- Prasad Measurements with soft-ware tool




Prasad Technique

# Methods & Materials

- 12 thoracic levels measured x 3avg
- Cohort vs controls (n=60)
- Intra-cohort:Formation vs Segmentation (n=15)
- Impact of intraspinal anomalies




Prasad Technique

# Materials & Method:

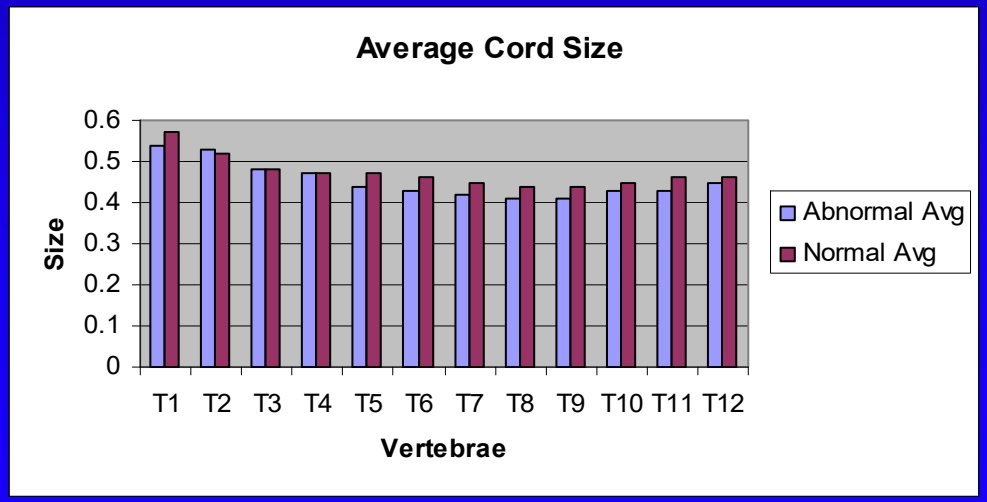
## We analyzed:

- All 12 thoracic levels vs controls
- Pathologic segments vs controls
- Adjacent levels vs controls
- 15 hemivertebrae vs 15 congenital fusions
- Impact of associated intraspinal anomalies

# Results: Spinal Cord Size:

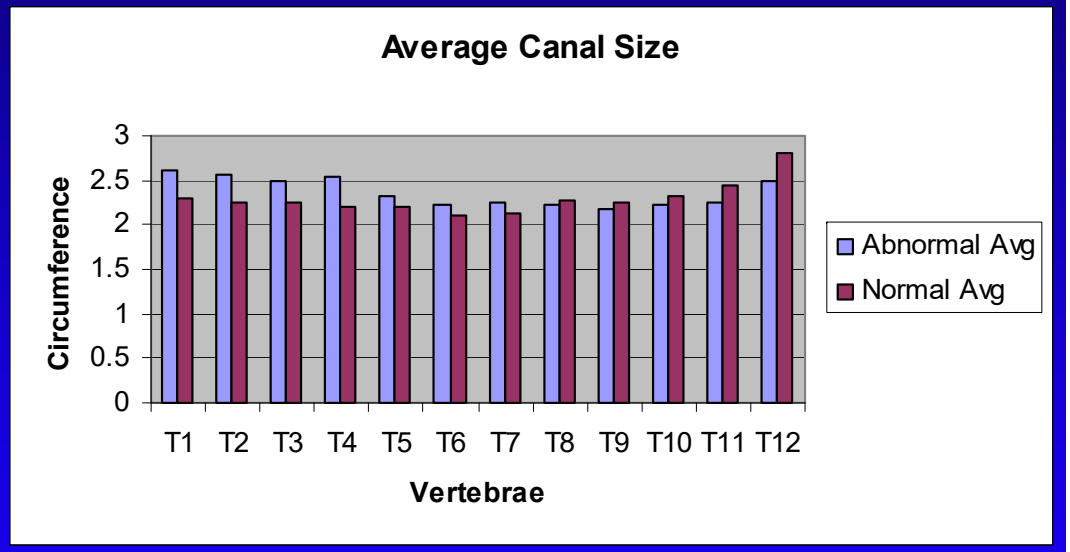
## Cross-sectional Area (n= 30)

- Cord smaller in cohort subjects
  1. Mean C-Sect area all levels (p=<0.01)
  2. Pathologic segments only (p=<0.01)
  3. Pathological + adjacent levels (p=< 0.01)



# Results: Spinal Canal Size:
## Cross-sectional Area (n= 30)

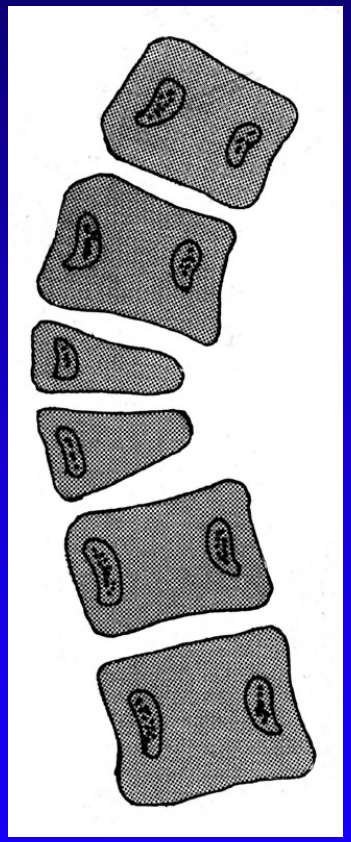
- Canal smaller for cohort (p=0.01)
- Not in all cases
- SAC normal (30/30)
- 0 encroachment (0/30)



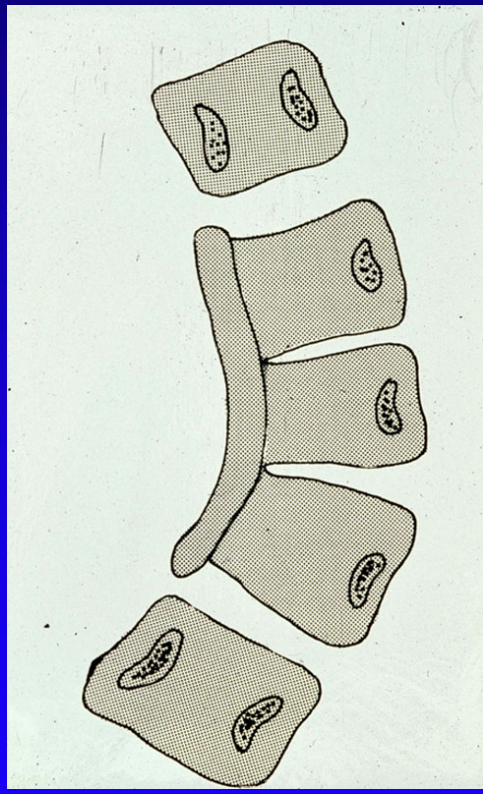
# Results: Formation vs Segmentation

## Cross-sectional Area Cord (n= 15 vs 15)

- No significant cord size difference
- Formation failure: 87% of normal cord size
- Segmentation failure: 87.5% of normal cord size



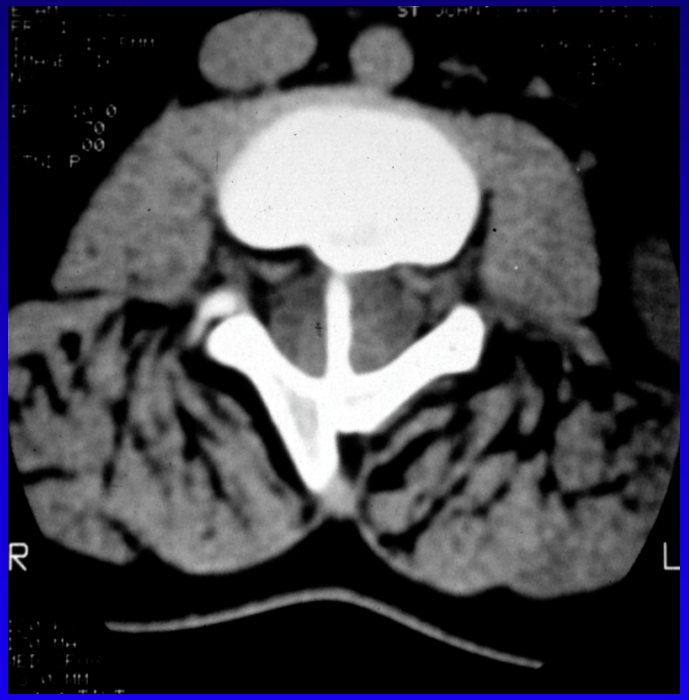
n=15



n=15

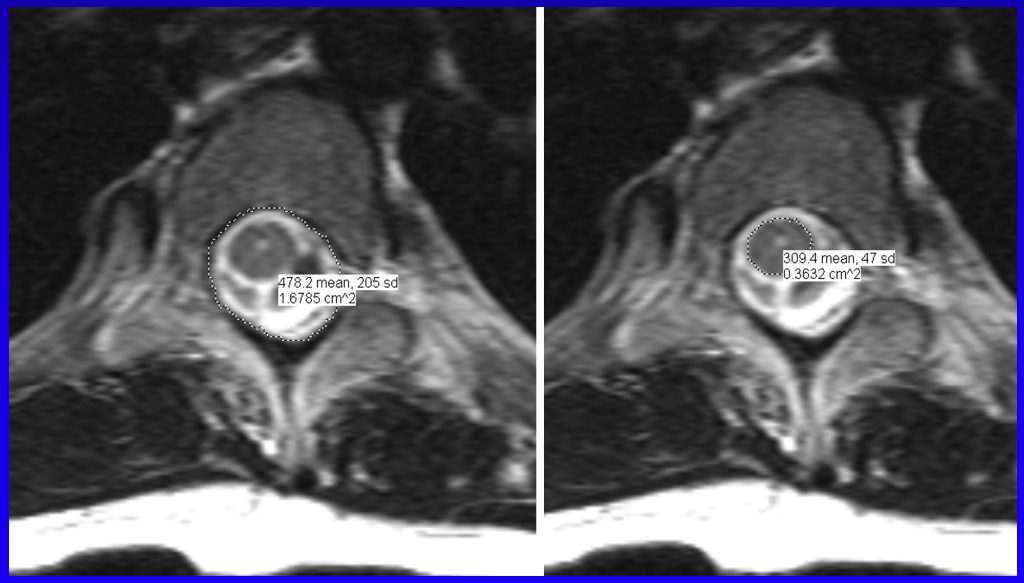
# Impact of Intraspinal anomalies

- Tethered cord p=0.01
- All others no impact p=0.9
  - Chiari malformation
  - Hydromyelia
  - Diastematomyelia
  - Lipoma
  - Teratoma



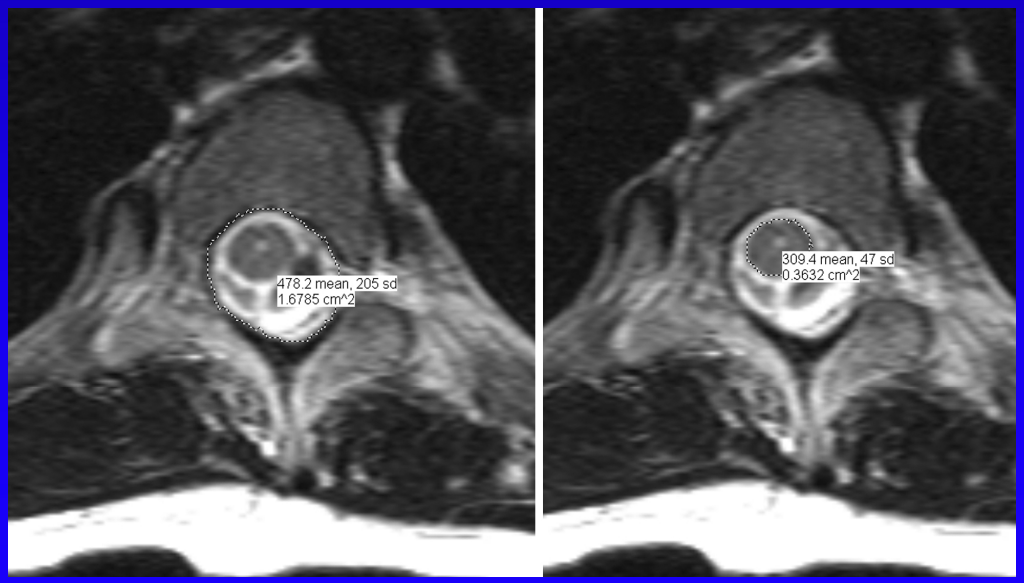
# Discussion

- **We have now observed 3 separate cohorts with vertebral anomalies and significantly small spinal cords**



# Discussion Question

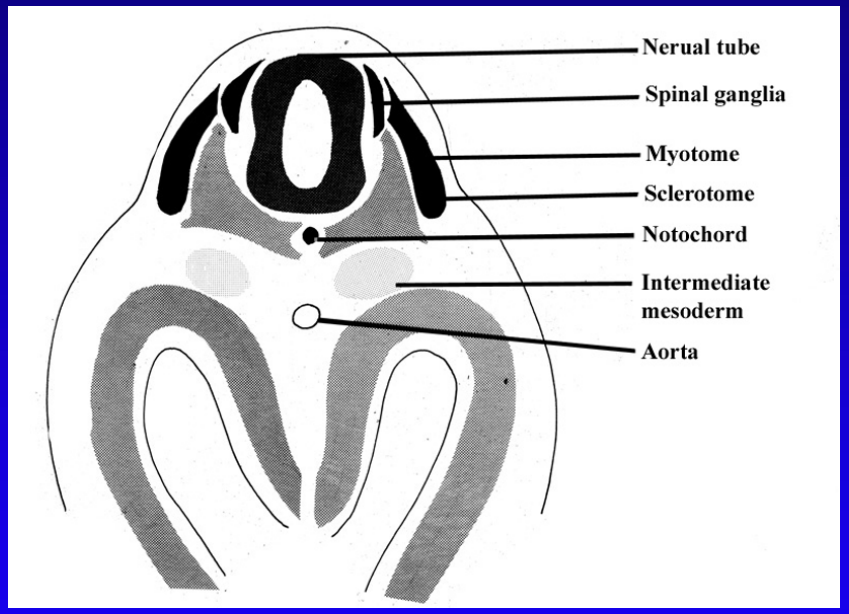
- **Is this a primary developmental problem?**
- **Is it Apoptosis?**
- **Evidence suggests a defect in primary development**
  - ***Investigation in progress with animal model***



# Development vs Apoptosis

***Induction from neural tube and notocord***

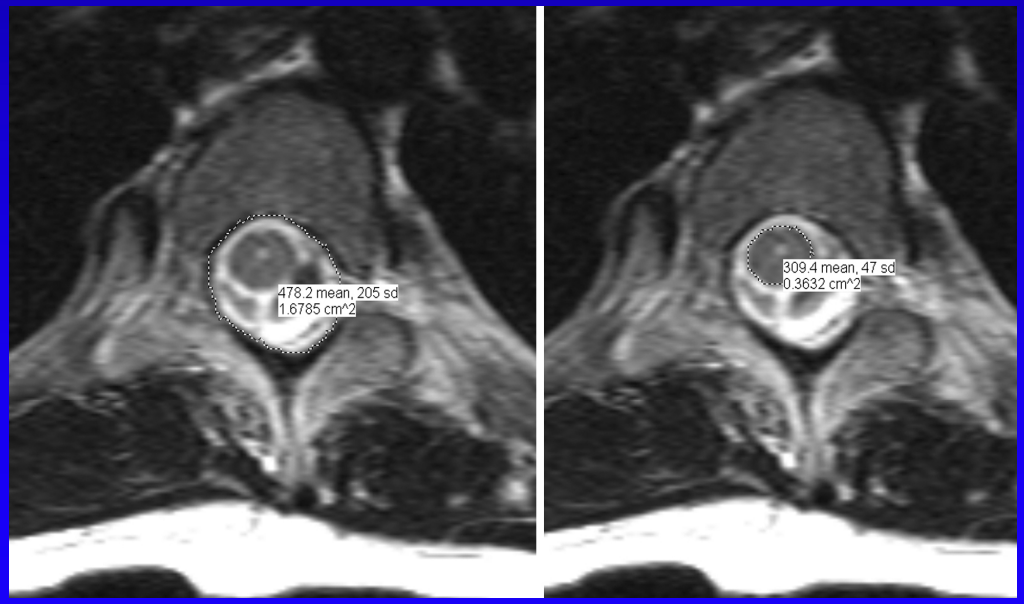
- ***Small cords seen in all ages***
- ***Encroachment on SAC not observed***
- ***Likely a neural tube defect***



# Discussion Question

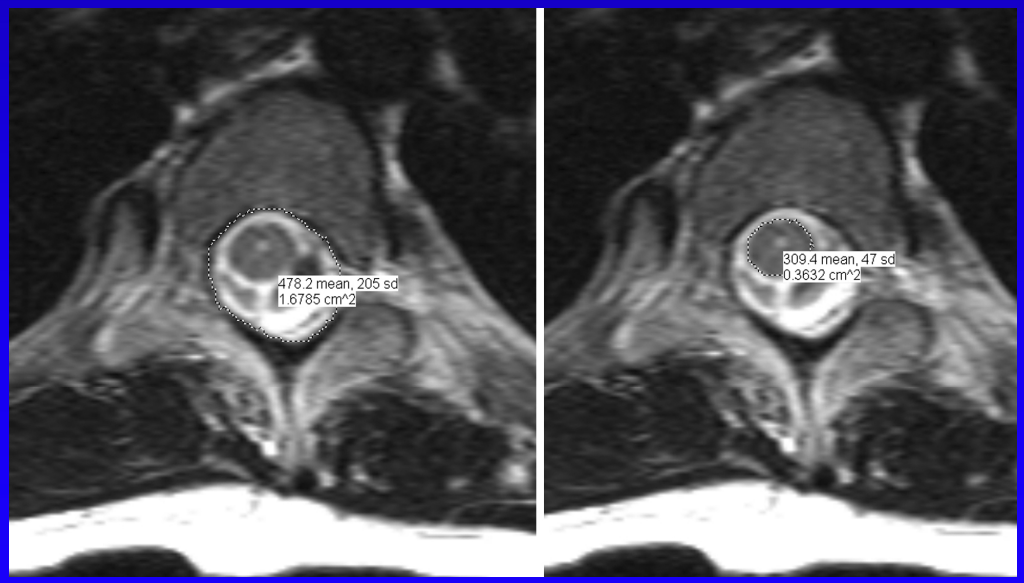
## Why is the spinal cord small?

- Too few axones
- Small axones
- Both few and small
  - We are now investigating this



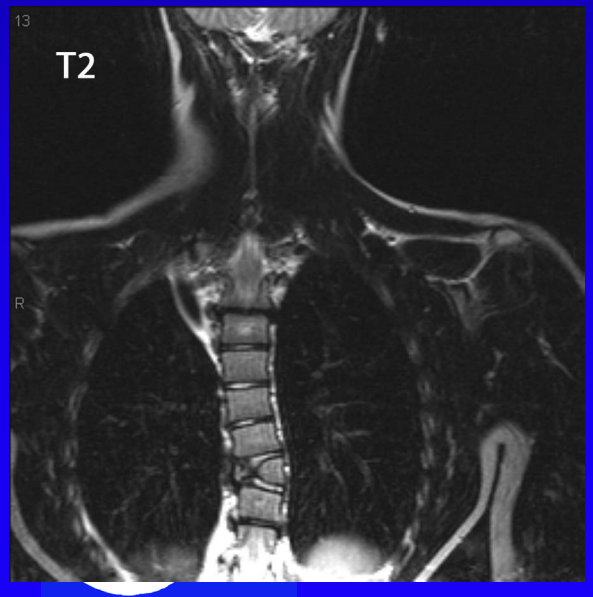
# Conclusion

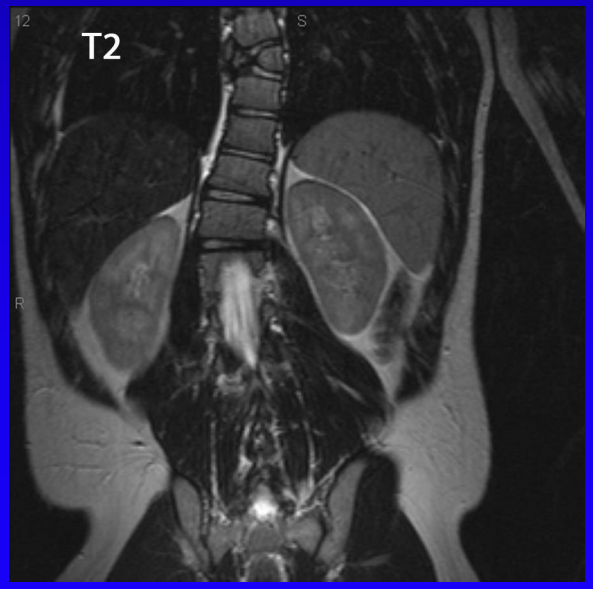
- Small spinal cord can be expected with congenital scoliosis
- Likely a primary defect
- Likely associated with neurological risk



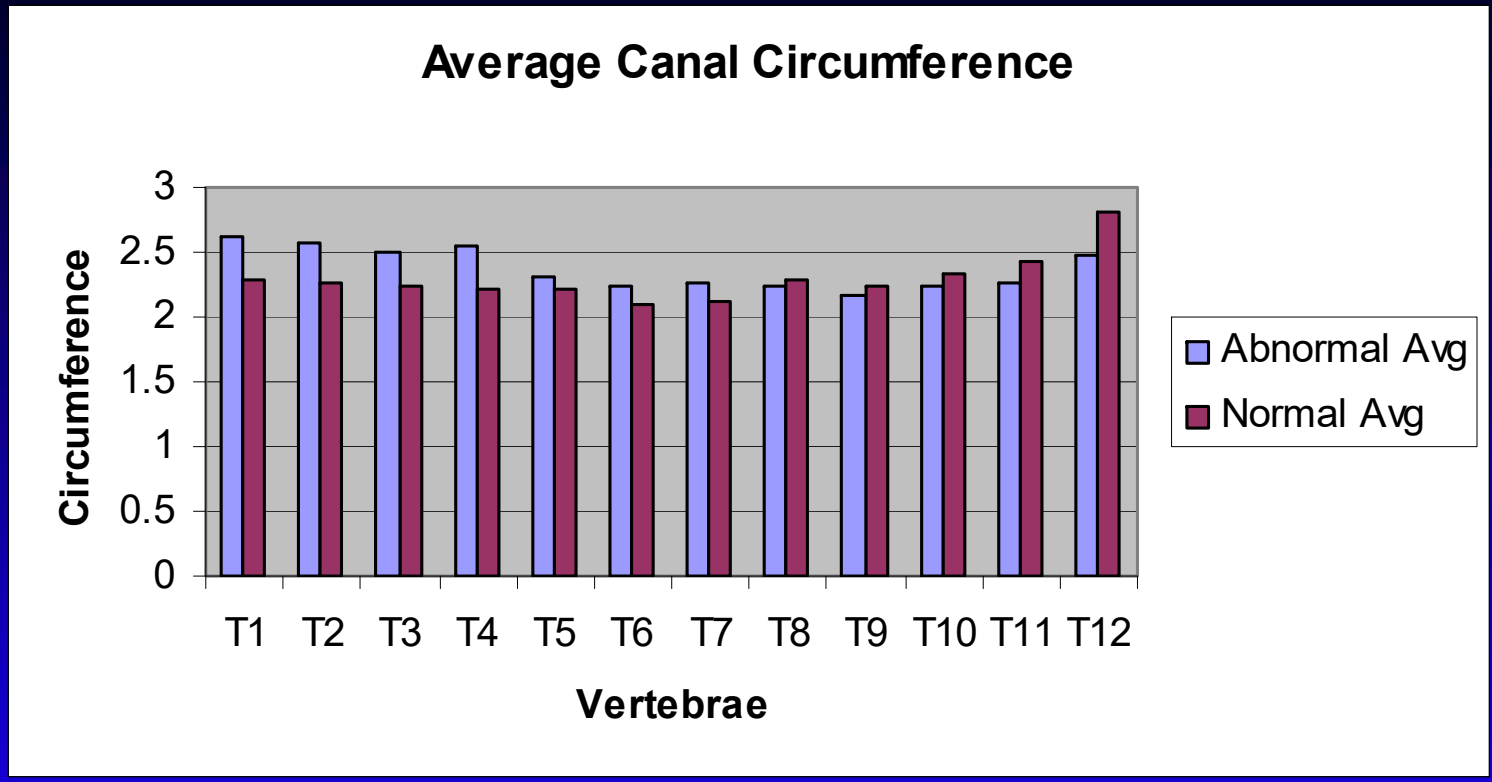
# Conclusion

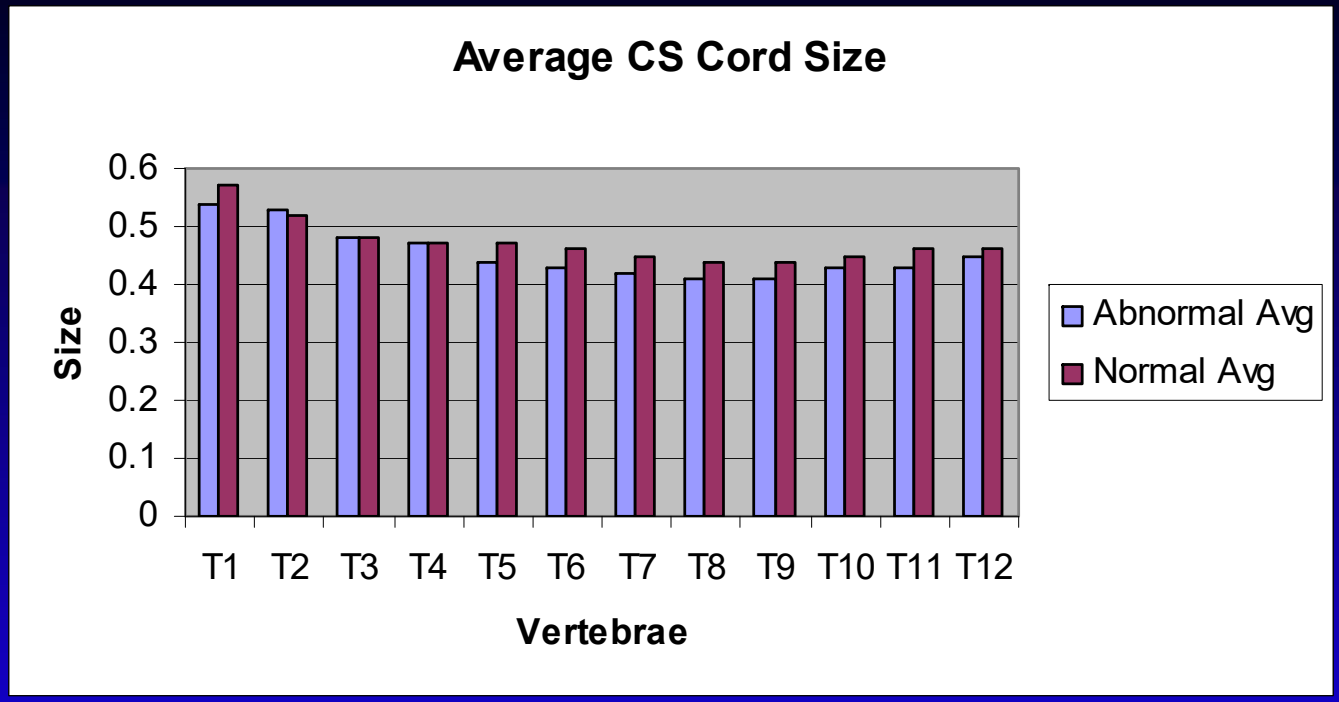
**For now, the small cord in these patients is as important as other neural tube defects**



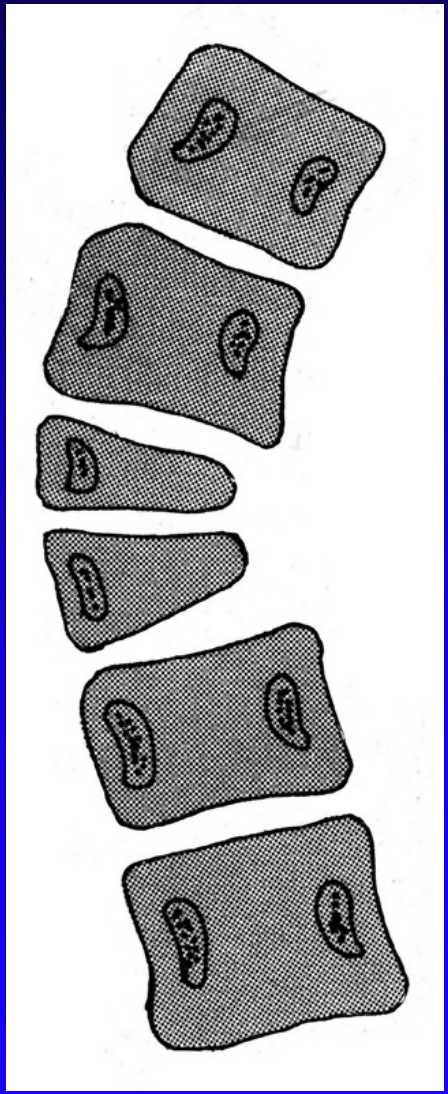

# Thank You


Average Canal Circumference
Circumference
3
2.5
2
1.5
1
0.5
0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Vertebrae
Abnormal Avg
Normal Avg


Average CS Cord Size
Size
0.6
0.5
0.4
0.3
0.2
0.1
0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Vertebrae
Abnormal Avg
Normal Avg

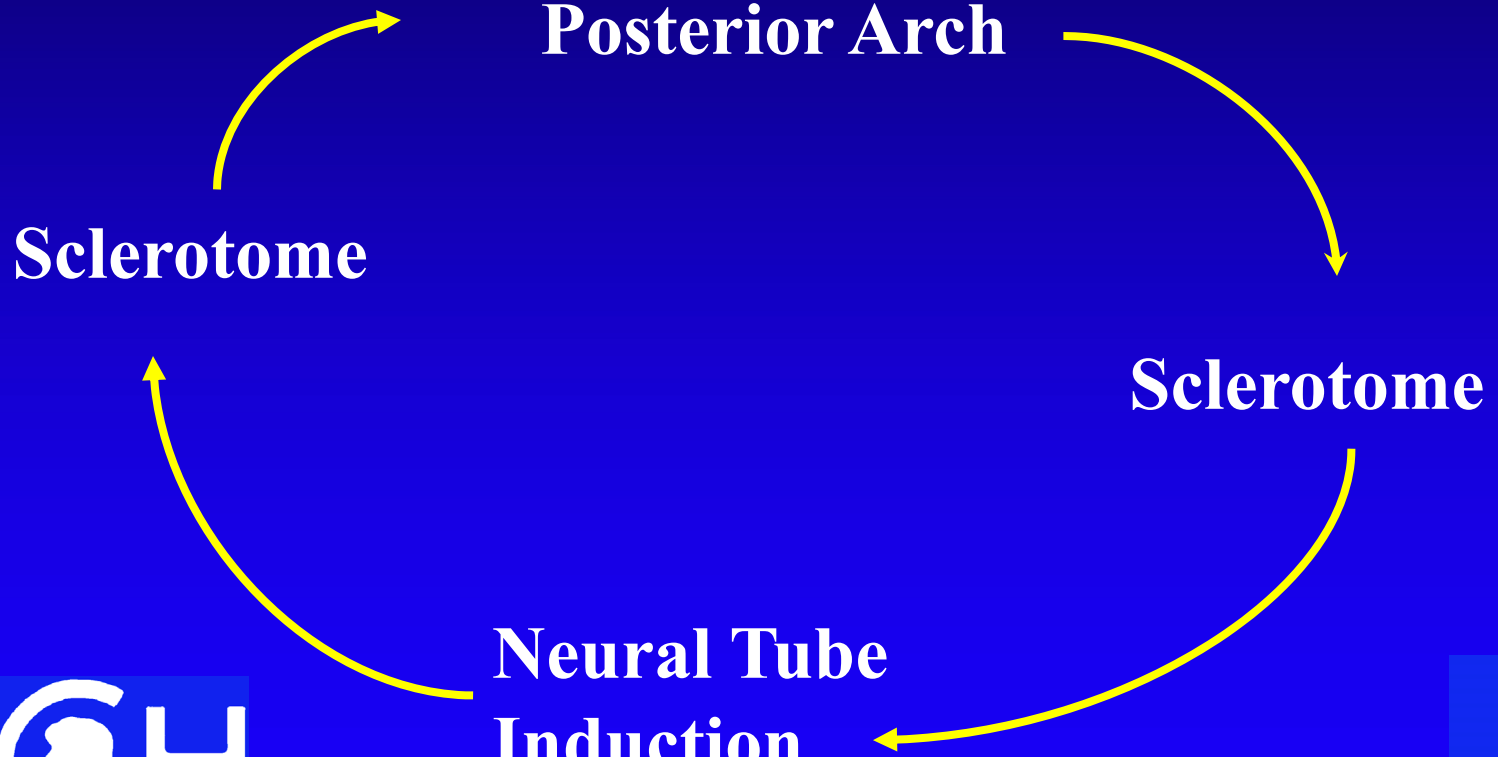
# Definition

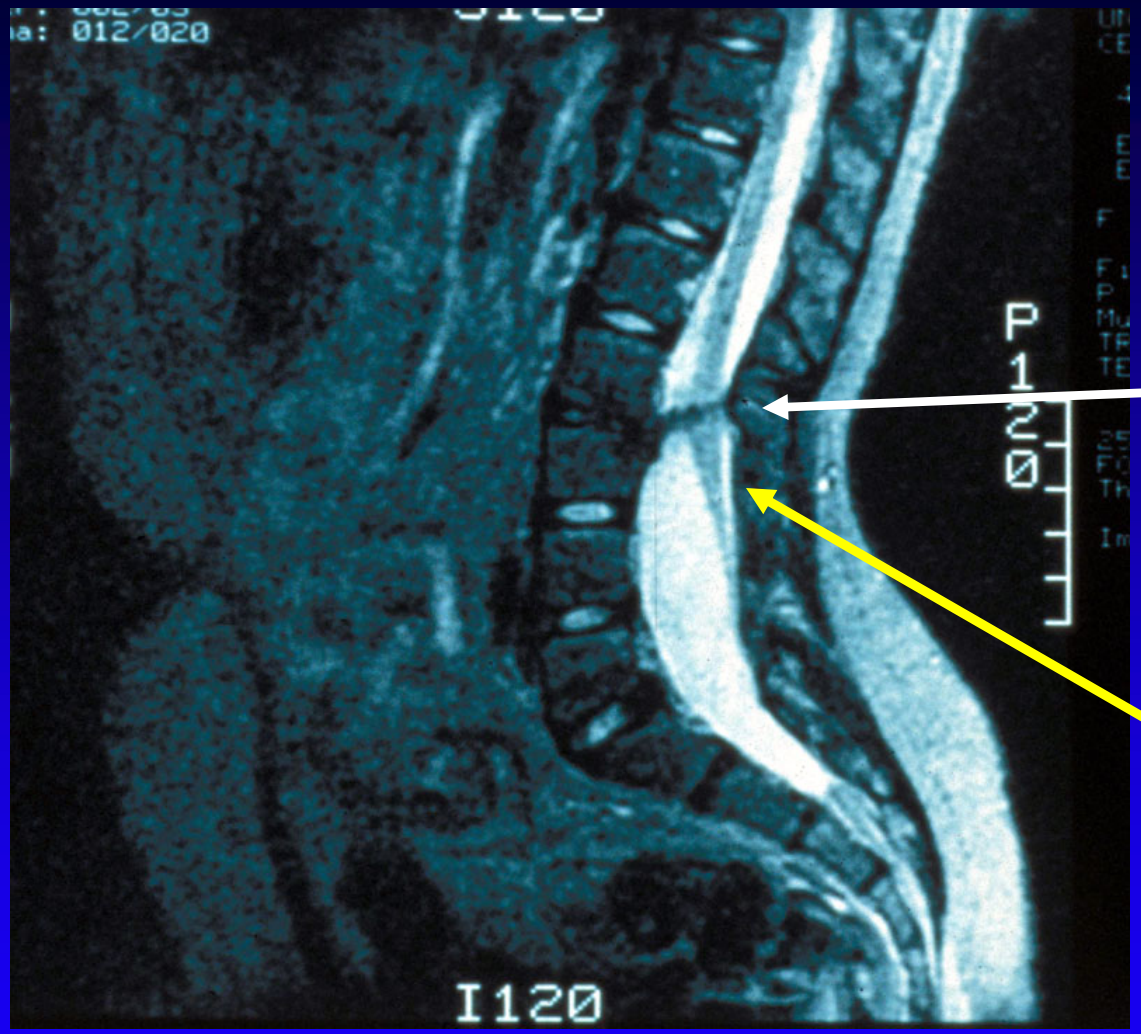
- **Congenital Scoliosis/ Kyphosis is caused by asymmetric growth of the spine associated with congenital vertebral anomalies**



# Embryology: Development of Posterior Arch

## STEP II

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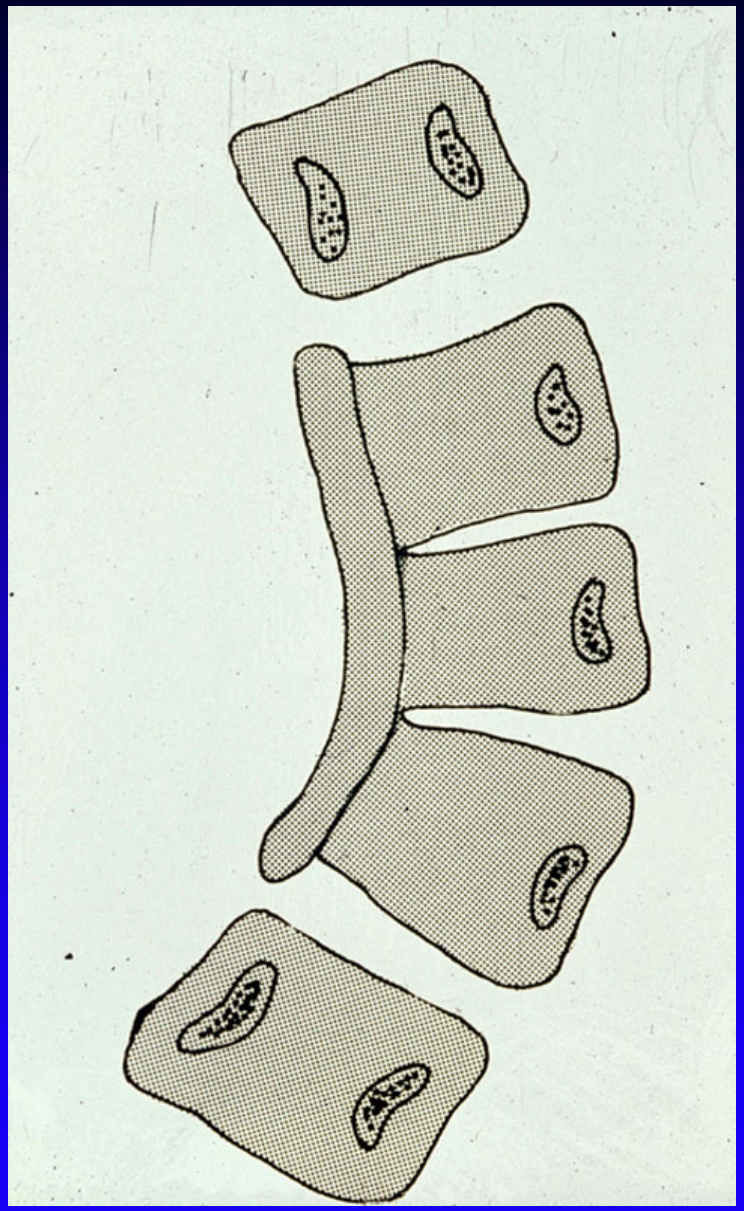

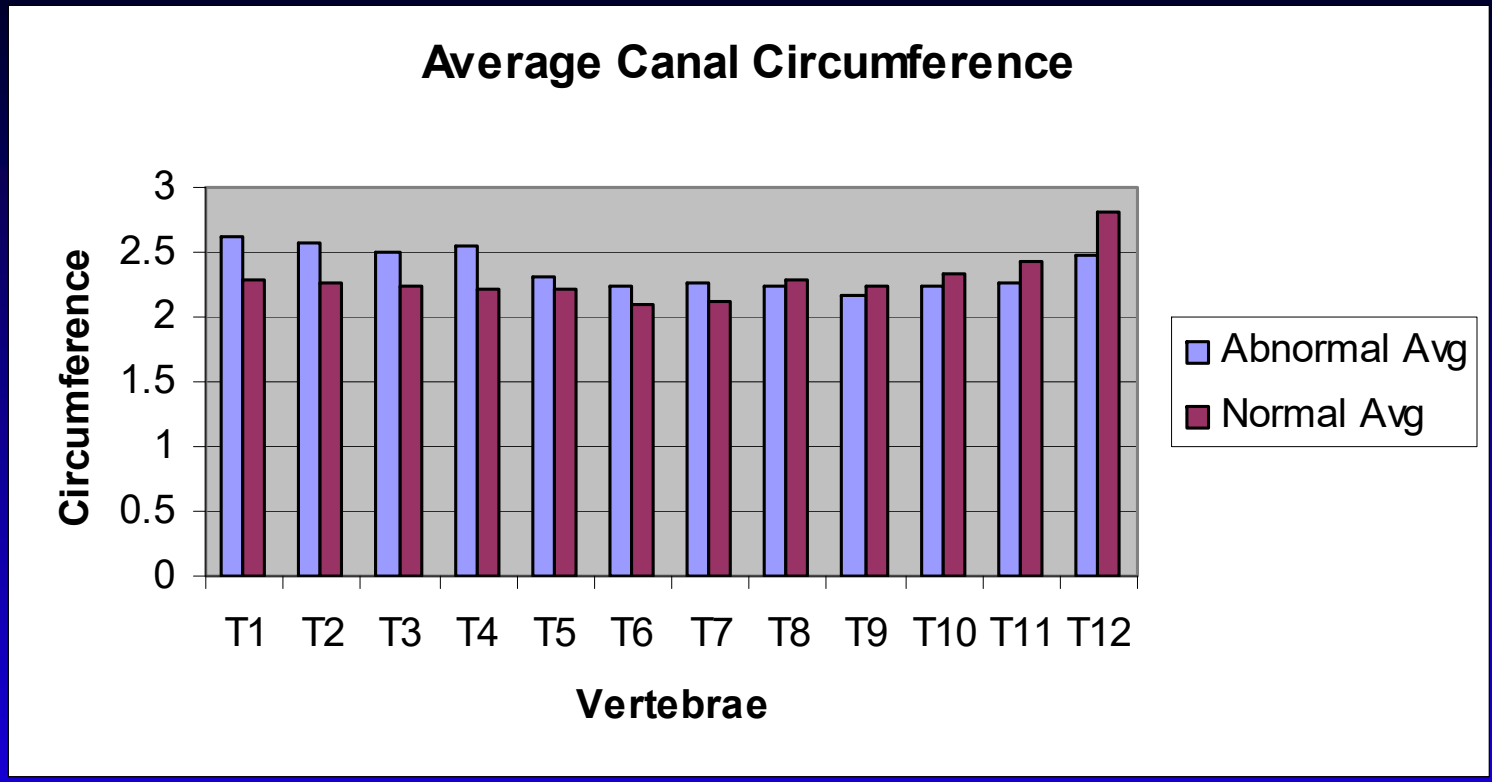
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T5
T6
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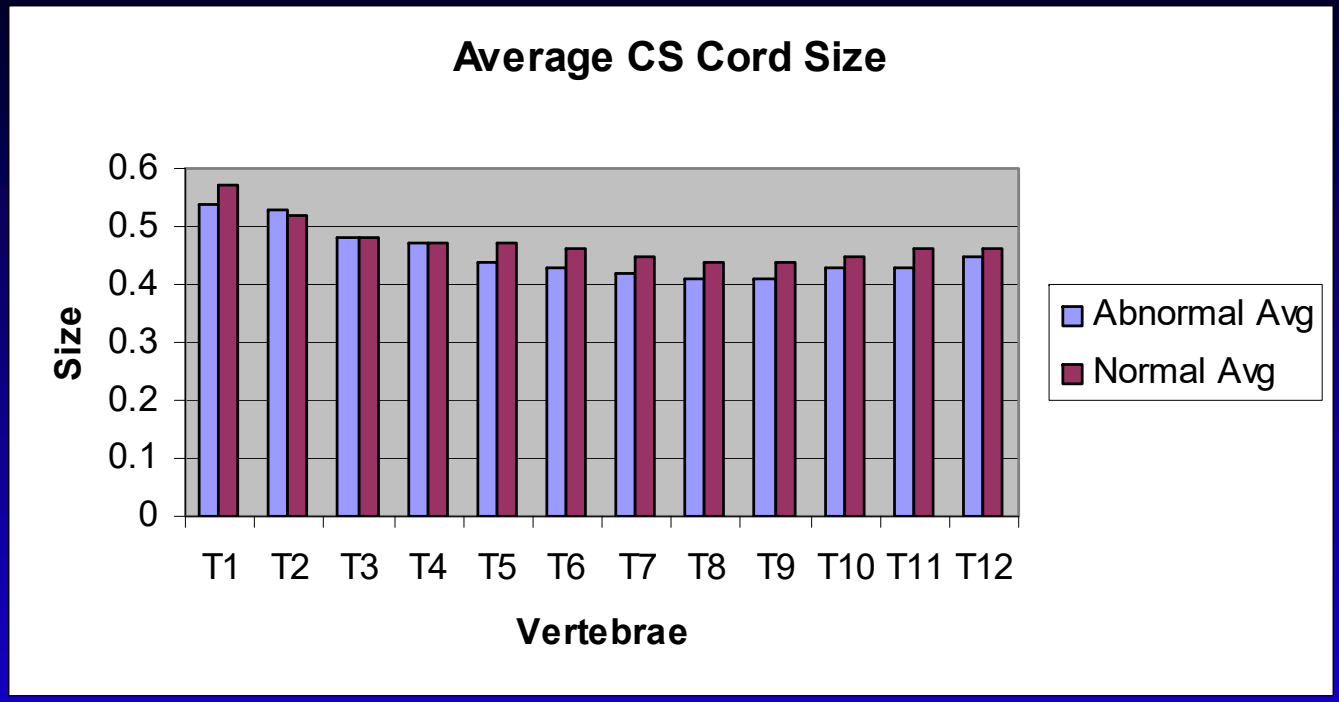
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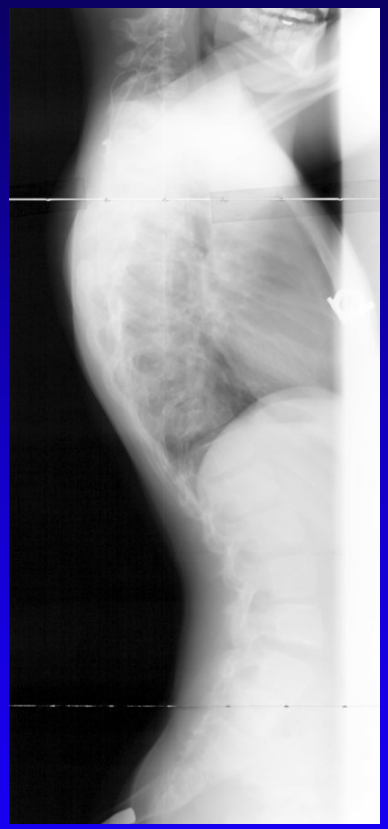
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Vertebrae
Abnormal Avg
Normal Avg

# X ray

- 22° Left thoracic scoliosis
- 25° Right lumbar scoliosis

# Pre-op



# X ray

- Congenital kyphoscoliosis (58° T9-L1)
- Congenital failure of segmentation of vertebrae (T10-T11)
- Thoracolumbar scoliosis 21 °