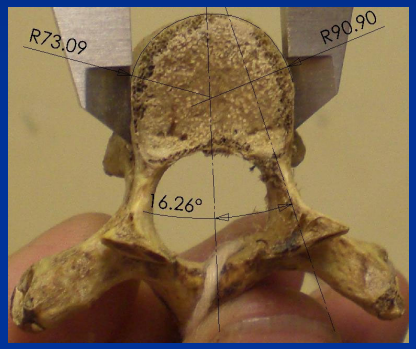
Scalar Measurements of Pediatric Spine and Ribs from the Hamann-Todd (H-T) Collection



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ComplexSpine STUDY GROUP

Disclosures

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a. Grants/Research Support
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Summary

- Hamann-Todd (H-T) Collection, Cleveland Museum of Natural History (Cleveland, OH)
  - Contains 63 pediatric skeletal specimens
  - Largest of its kind in the world

- Purpose of Study:
  - Obtain scalar measurements of spine and ribs in order to understand the growth patterns of the pediatric spine and thorax; ages 1-18

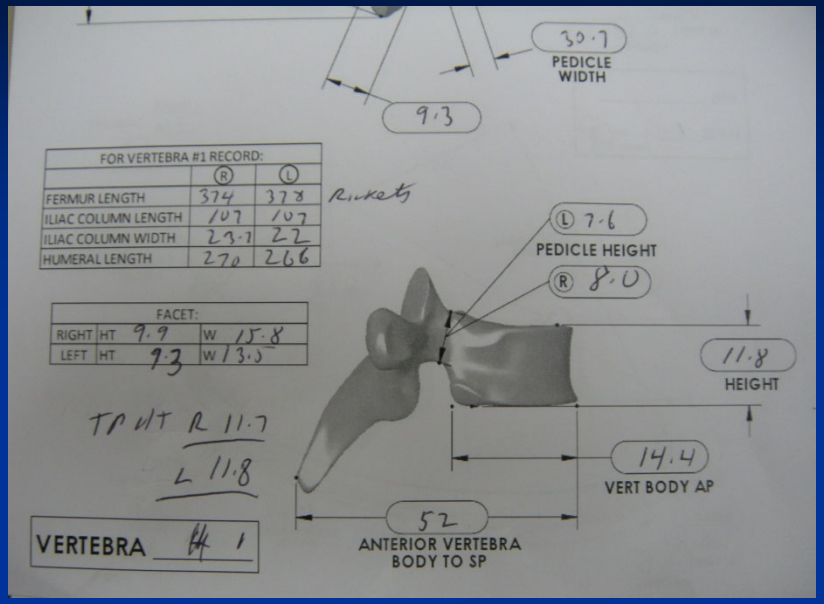
Introduction and Background

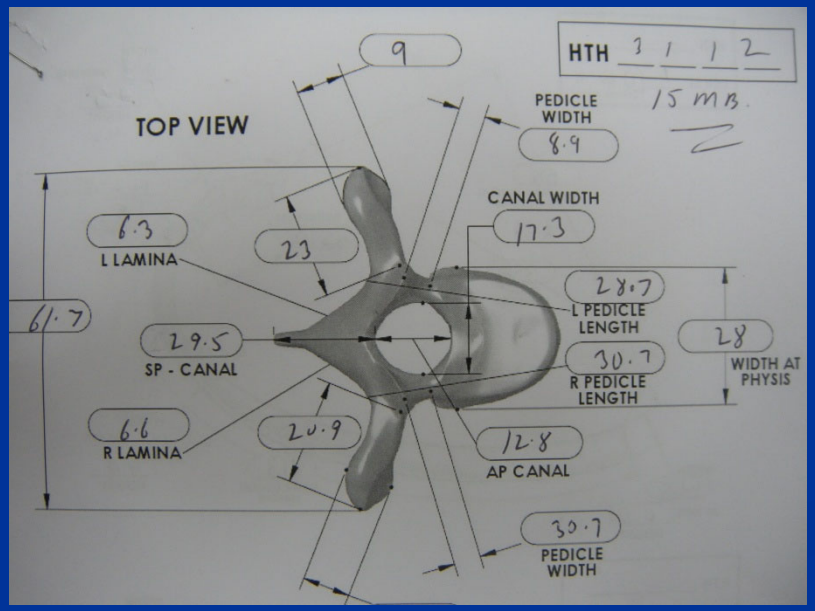
- The purpose of the study was to collect data on representative skeletons aged 1-18 years.

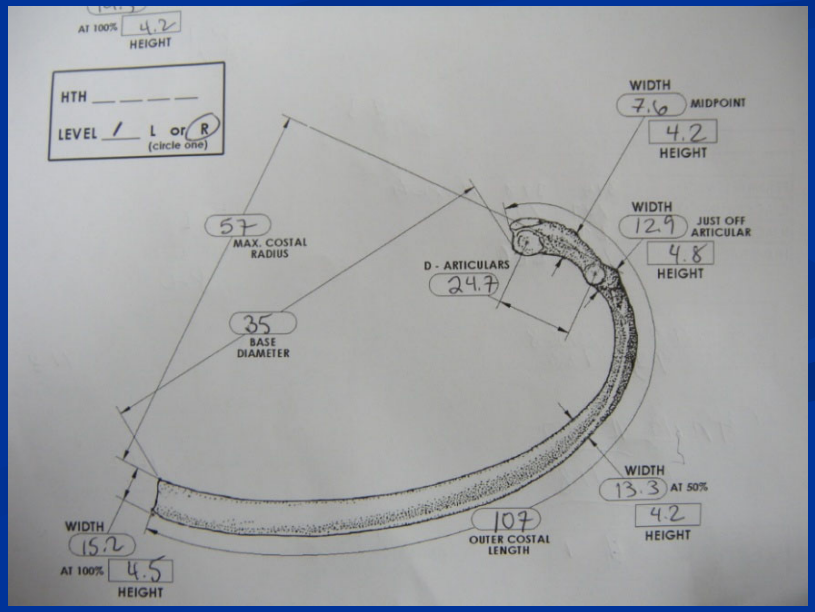
- Data Collection Methods
  - Direct measurements with calipers
  - Digital photographs analyzed with Scandium software
  - Three-dimensional scans using laser scanner

Methods and Materials

- General Demographics for each child were collected. Height, weight, or prior trauma were unknown.
- Measurements from Vertebral Bodies (VB), Ribs, and Ilium were obtained. Ages 2 and 9 were not available.
- 46 Measurements from the VBs and Ribs at T1, T4, T7, T10, and L3 was done


30.7
PEDICLE WIDTH
9.3
FOR VERTEBRA #1 RECORD:
FERMUR LENGTH 374 378
ILIAC COLUMN LENGTH 107 107
ILIAC COLUMN WIDTH 23.7 22
HUMERAL LENGTH 270 266
Rickets
FACET:
RIGHT HT 9.9 W 15.8
LEFT HT 9.3 W 13.5
TP HT R 11.7
L 11.8
L 7.6
PEDICLE HEIGHT
R 8.0
11.8
HEIGHT
14.4
VERT BODY AP
52
ANTERIOR VERTEBRA BODY TO SP
VERTEBRA #1


HTH 3 1 1 2
15 MB.
TOP VIEW
9
PEDICLE WIDTH
8.9
CANAL WIDTH
17.3
6.3
L LAMINA
23
28.7
L PEDICLE LENGTH
61.7
29.5
SP - CANAL
28
WIDTH AT PHYSIS
30.7
R PEDICLE LENGTH
6.6
R LAMINA
20.9
12.8
AP CANAL
30.7
PEDICLE WIDTH

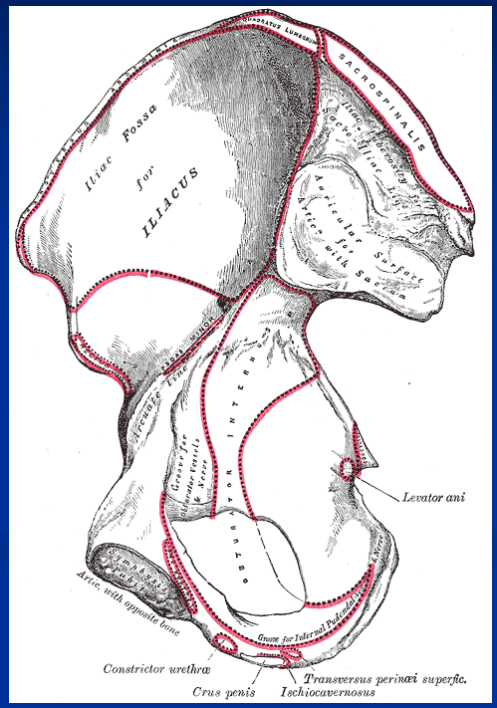

AT 100% 4.2
HEIGHT
HTH
LEVEL 1 L or R (circle one)
WIDTH 7.6 MIDPOINT
4.2
HEIGHT
WIDTH 12.9 JUST OFF ARTICULAR
4.8
HEIGHT
57
MAX. COSTAL RADIUS
D - ARTICULARS 24.7
35
BASE DIAMETER
WIDTH 13.3 AT 50%
4.2
HEIGHT
107
OUTER COSTAL LENGTH
WIDTH 15.2
AT 100% 4.5
HEIGHT

Results and Observations

- At Mid position: Rib width did not change with age but height increased
- AP Spinal canal: No Change with Age
- Neurocentral Synchondrosis: Observed
- Handedness: Iliac Column Width Left and Right is Not Equal
- Ribs follow the Golden Spiral
- VBs follow a Cardioid shape
- Transverse Process Angle changes by age and level

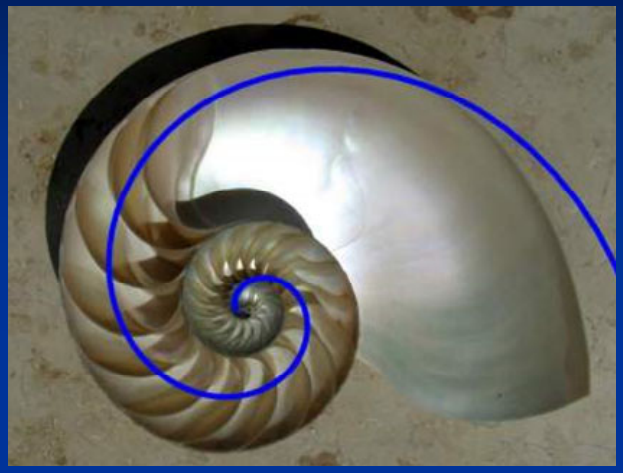
Results: Iliac Column

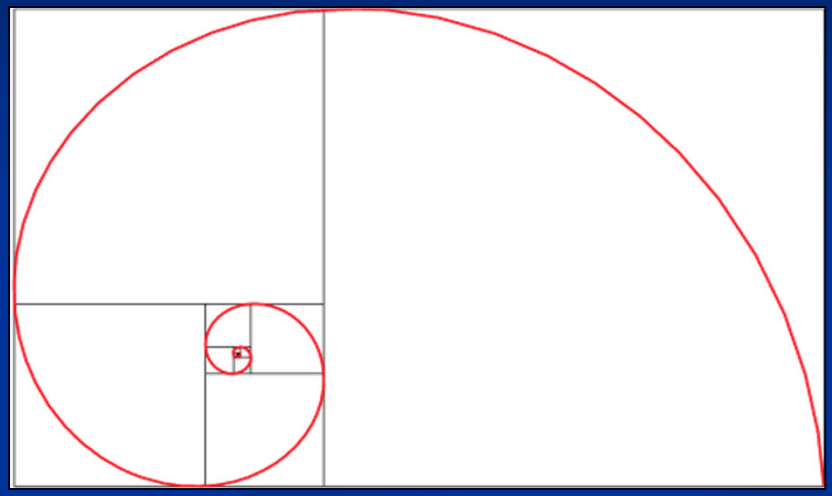
- Paired T-Test (n=16)
  - Left: 18.36 mm
  - Right: 19.33 mm
  - Mean Difference: 0.956 mm



- 81.3% Right Side Thicker than Left
- Appears to Correlate with General Population:
  - 70-90% of Humans are Right Handed

Results and Observations
Ribs: Golden Spiral

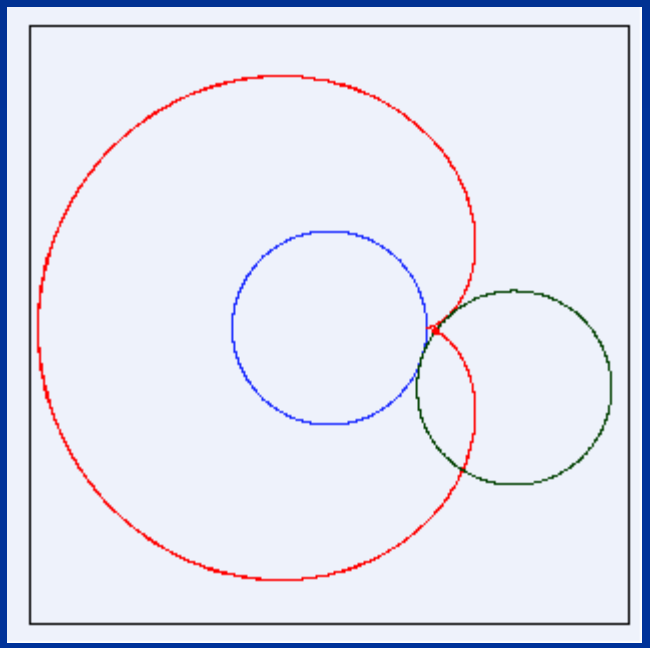


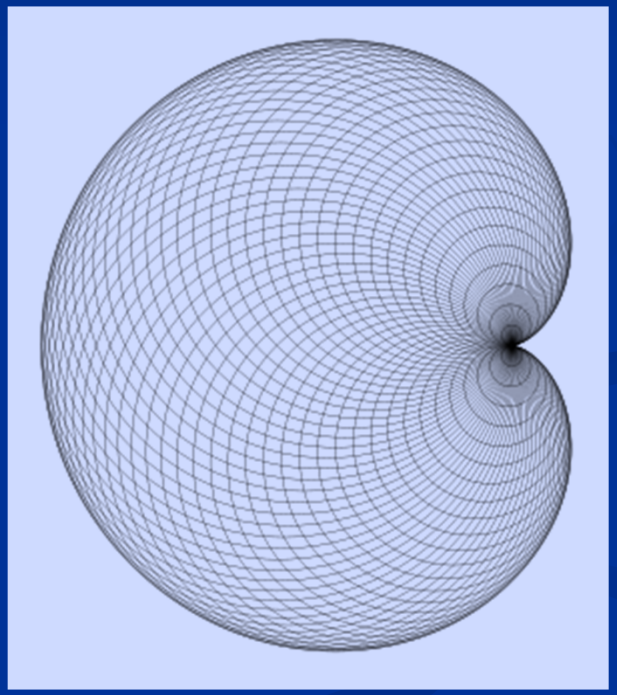


- Ratio of 1.618 to 1.0
- Found throughout nature
- Ribs follow it (<10% error)

Results and Observations
Vertebral Bodies

- VBs are shaped like Cardioids





Originally Described in 1741 by Pascal

VBs as a Cardioid

- Panjabi 1991 Estimated the area with:
  - Triangle 40% Under
  - Ellipse 10% Over

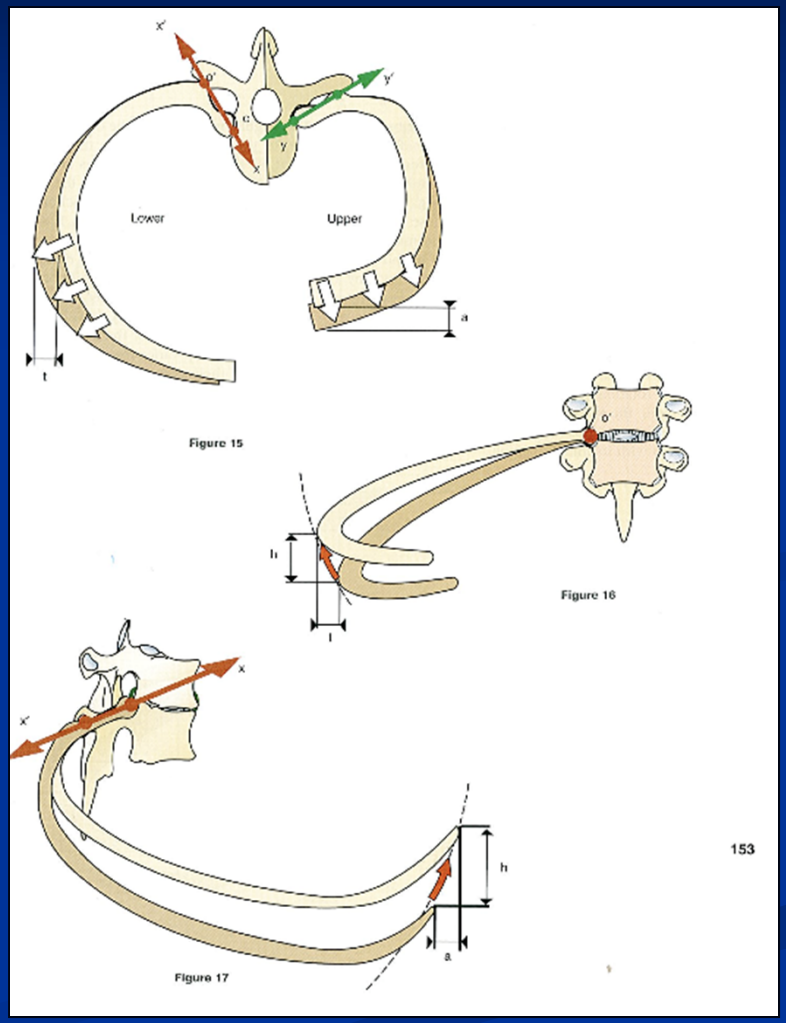
- Area Cardioid = $3/2\ \pi\ a^2$
- Perimeter Cardioid = 8a

L3 Vertebral Body

Transverse Process Angle

- Is TP Angle Linked to Respiration?

- During Respiration:
  - Rib Elevation
  - TP diameter of the lower thorax increases
  - AP diameter of the upper thorax increases



Author: A.I. Kapandji

Title: The Physiology of the Joints

Observation: Transverse Process Angle

- While no statistically relevant differences were noted the Transverse Process Angle decreased with age and with caudal progression through the spinal column.

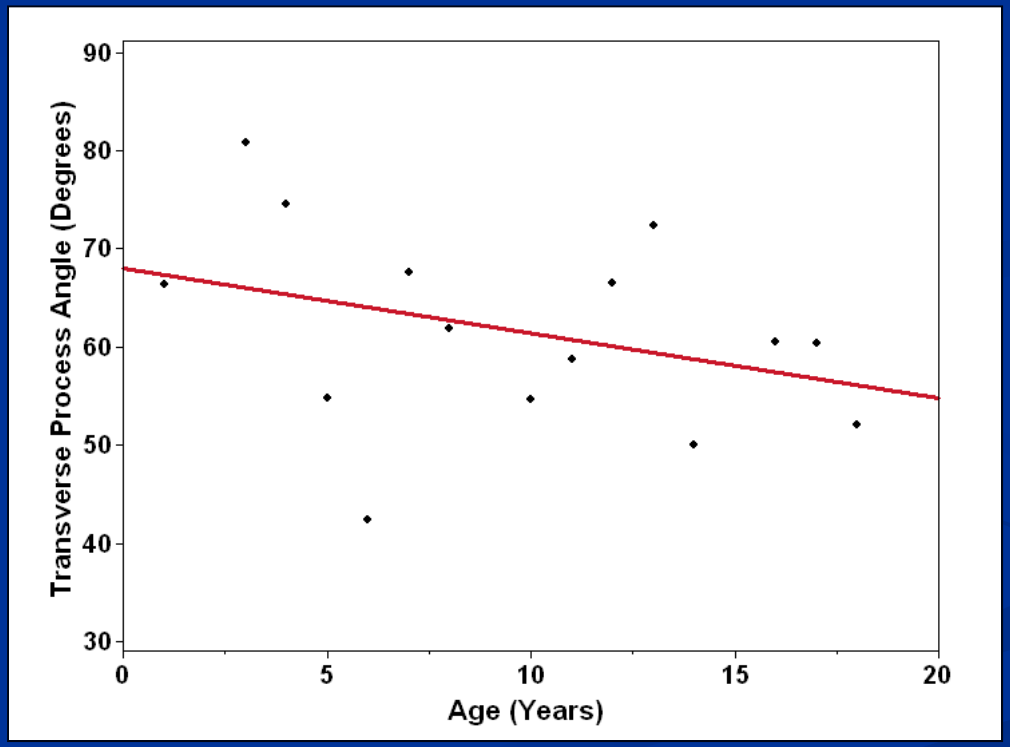


Figure 4. Left Transverse Process Angle at T7.

Conclusions

- 63 Pediatric skeletal specimens were available to study spinal and rib comparative anatomy.
- Rib height is approximately one half adult height by one year of age and increases more than width with age, indicating a preference for vertical growth and early development of the human thorax.
- The thoracic spinal canal AP diameter is established early in life to accommodate the spinal cord.

Significance

- **The Hamann-Todd collection is a valuable resource available to researchers to evaluate osteology in the growing child.**

- **With a total of 63 pediatric specimens of various ages, normative and comparative data can be obtained and used to reach a new understanding of the growing skeleton.**

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Thank you