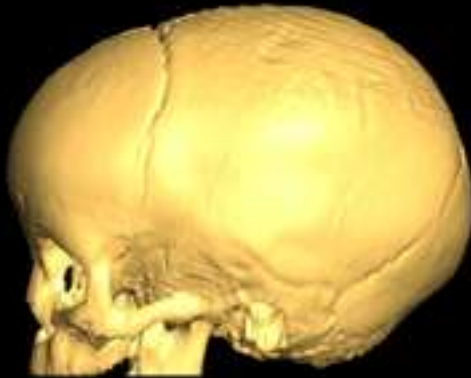


# Characterizing Neurocranial Shape in Microcephalic Children



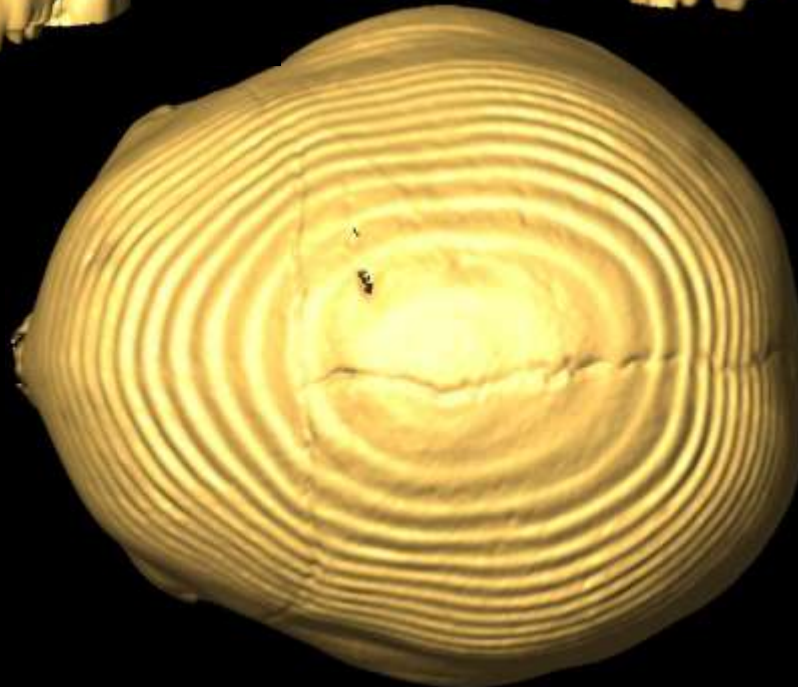
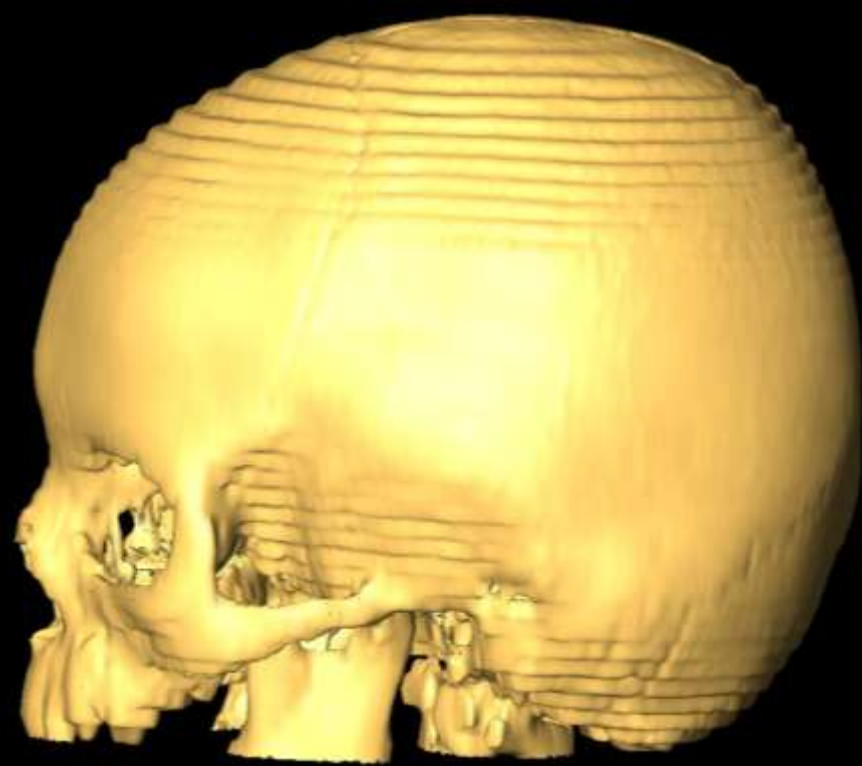
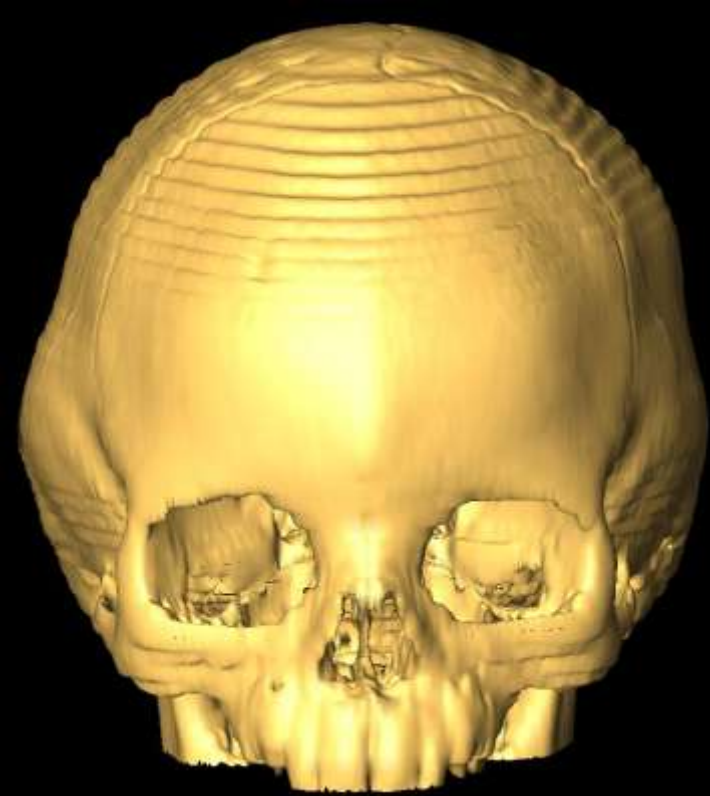
Brenda C. Frazier  
Katherine Willmore  
Joan T. Richtsmeier



Presented at the  
77<sup>th</sup> Annual Meeting of the  
American Association of Physical Anthropologists  
12 April 2008 – Columbus, Ohio

# Background

- Primary vs. secondary microcephaly
- Symptom vs. diagnosis
  - Autosomal recessive primary microcephaly (MCPH)
  - *Many* other causes possible (genetic and non-genetic)
- Discussed recently by Falk, Martin, Richards, Argue, Woods, and others
- **Are there characteristic differences in shape of the hard tissue?**



12.5-month-old  
female with  
microcephaly

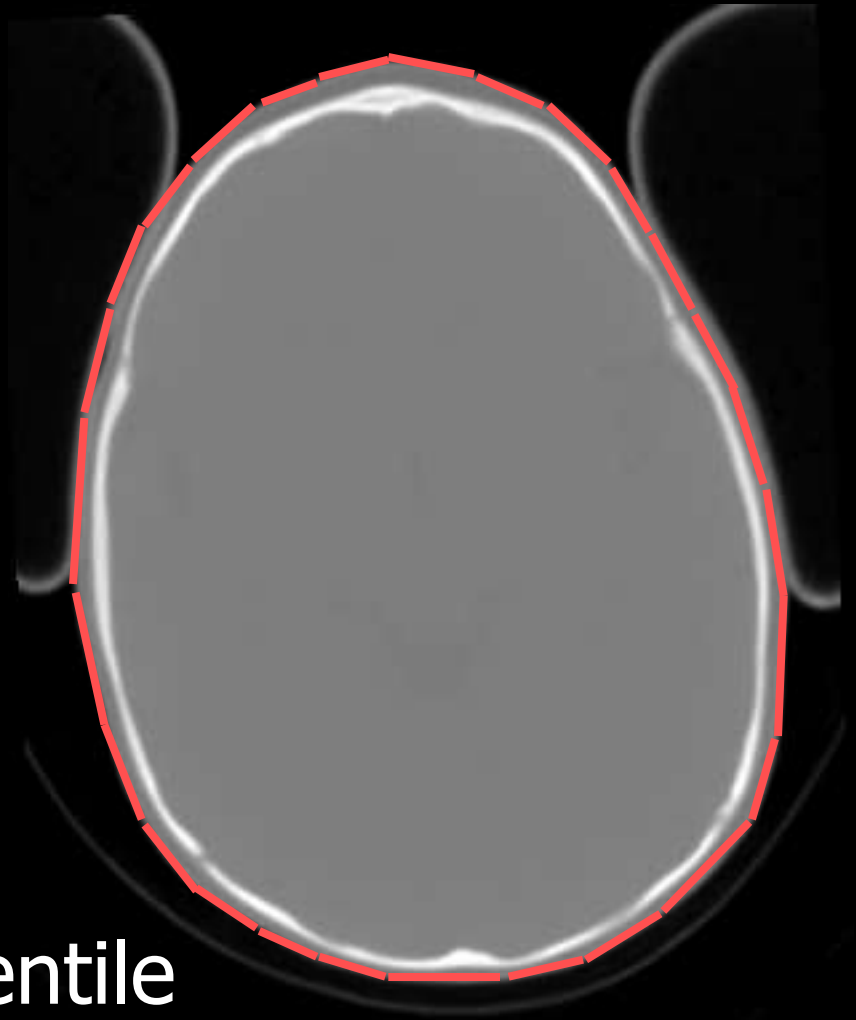
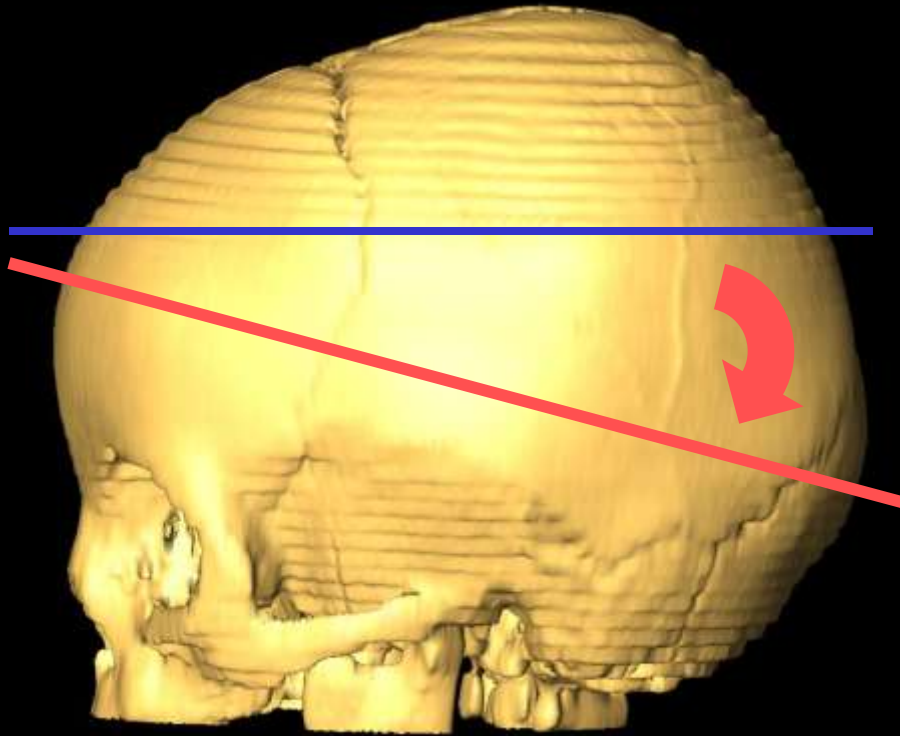
# Sample

- Medical CT scans of patients at Hopkins, Oklahoma, and Wash U
- Taken 1990 – 2002
- Clinical purposes
- Various machines, scan protocols
- Pixel size: 0.34 – 1.12 mm
- Slice thickness: 0.5 – 3.0 mm

# Sample

- Heterogeneous sample
- Unknown etiologies
- Two criteria for group assignment
  1. Reported as “microcephalic” or “normal”
  2. Observed head circumference  $< 5^{\text{th}}$  percentile,  $\geq 5^{\text{th}}$  percentile, respectively

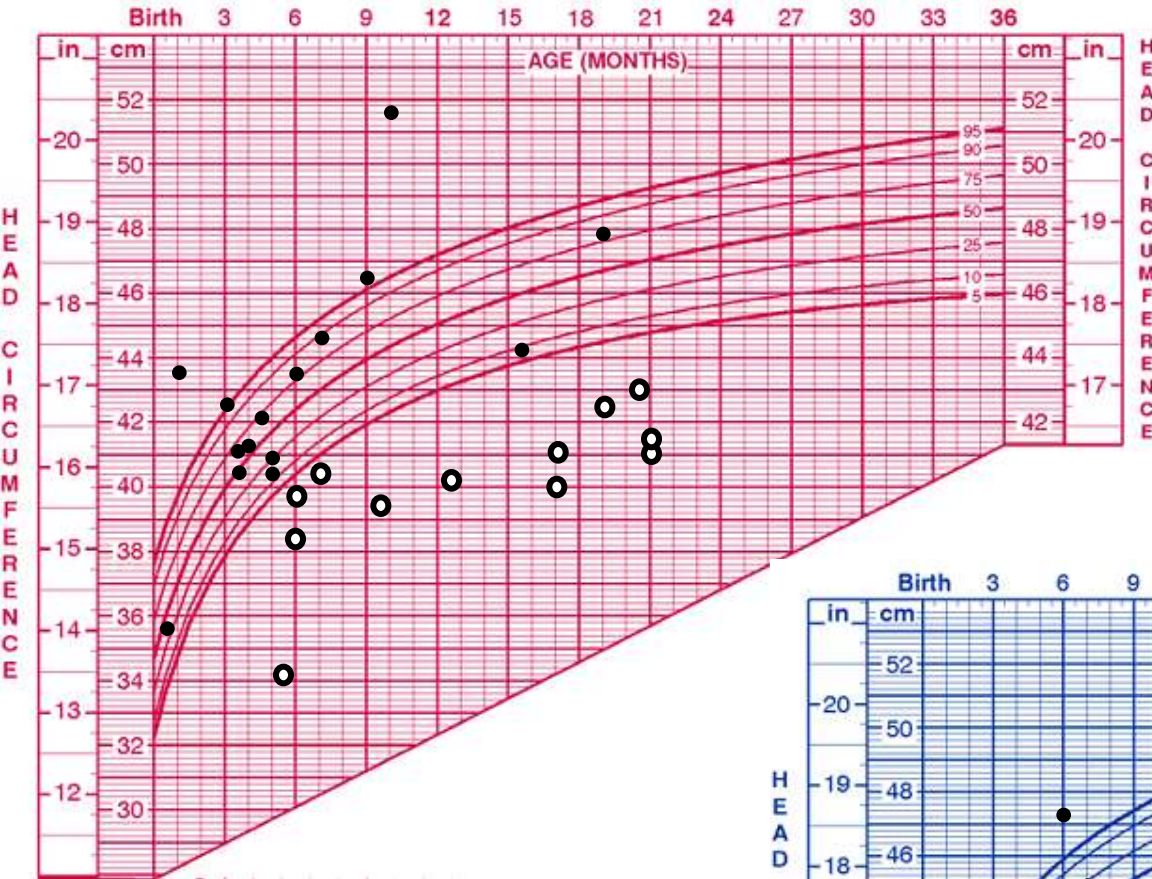
# Head Circumference



Microcephaly:  $< 5^{\text{th}}$  percentile  
Normal:  $\geq 5^{\text{th}}$  percentile

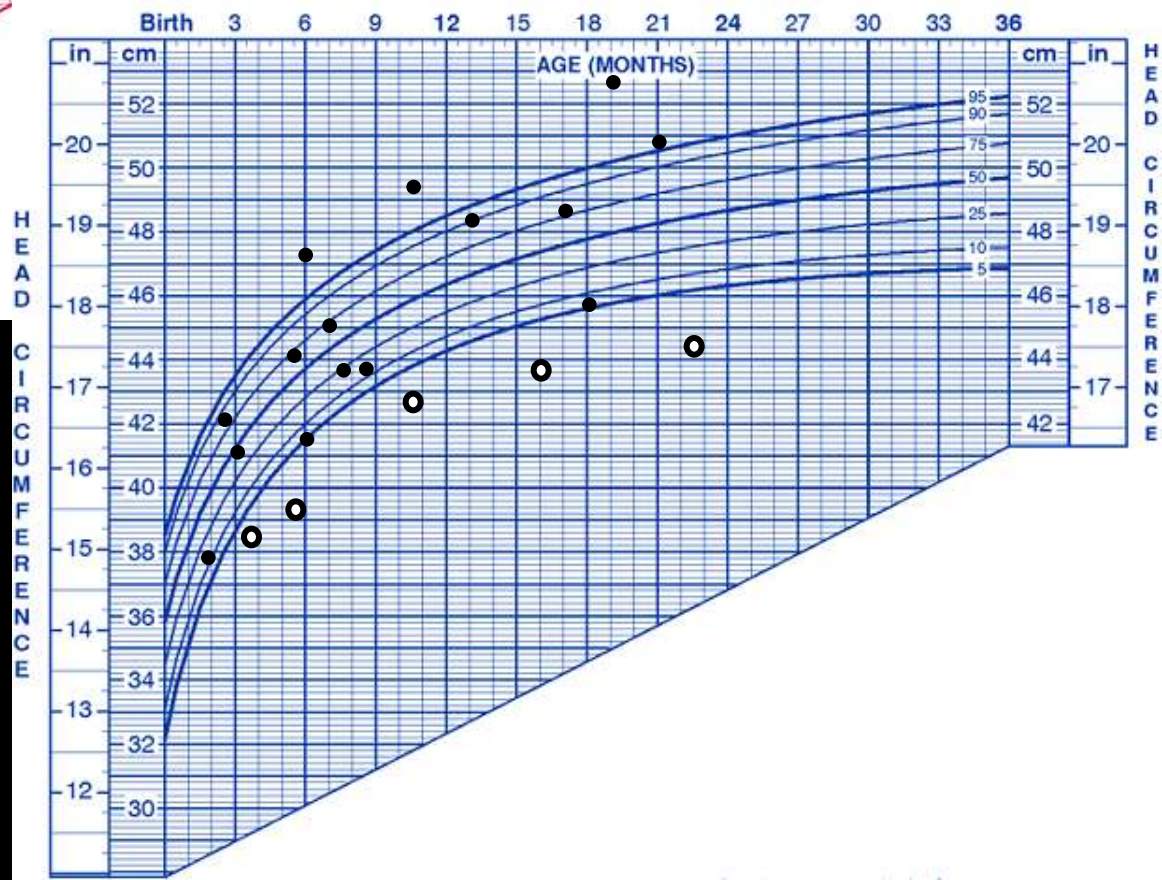
# Sample

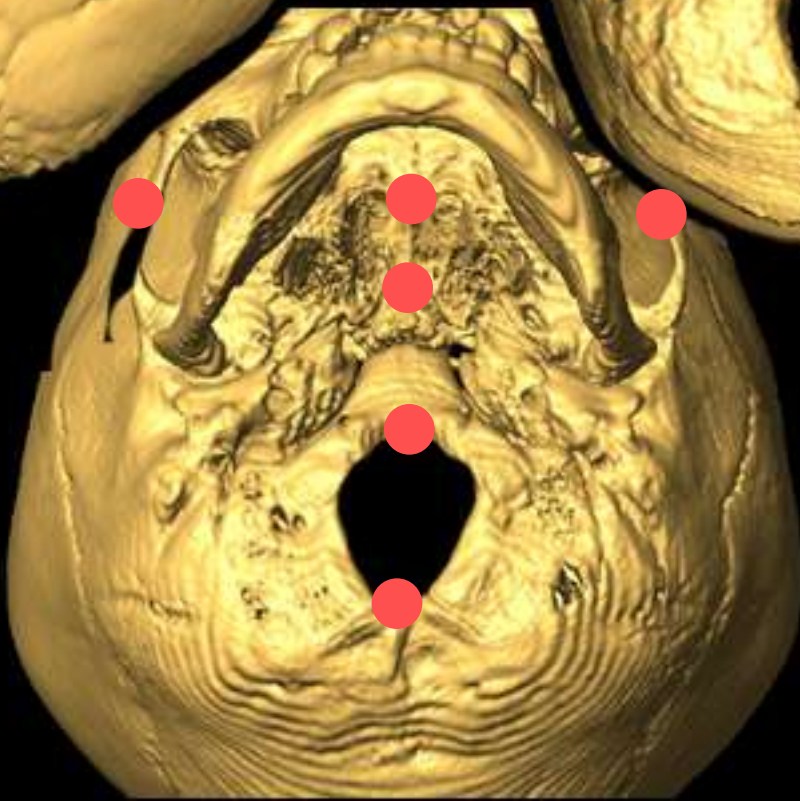
- Age range: 0.5 – 24 months
  - Mean age of Micro sample: 13 mo.
  - Mean age of Normal sample: 8 mo.
- Total of 47 scans, (41 individuals):
  - 5 M, 12 F in Microcephaly group
  - 15 M, 15 F in Normal group(sample sizes vary by analysis)



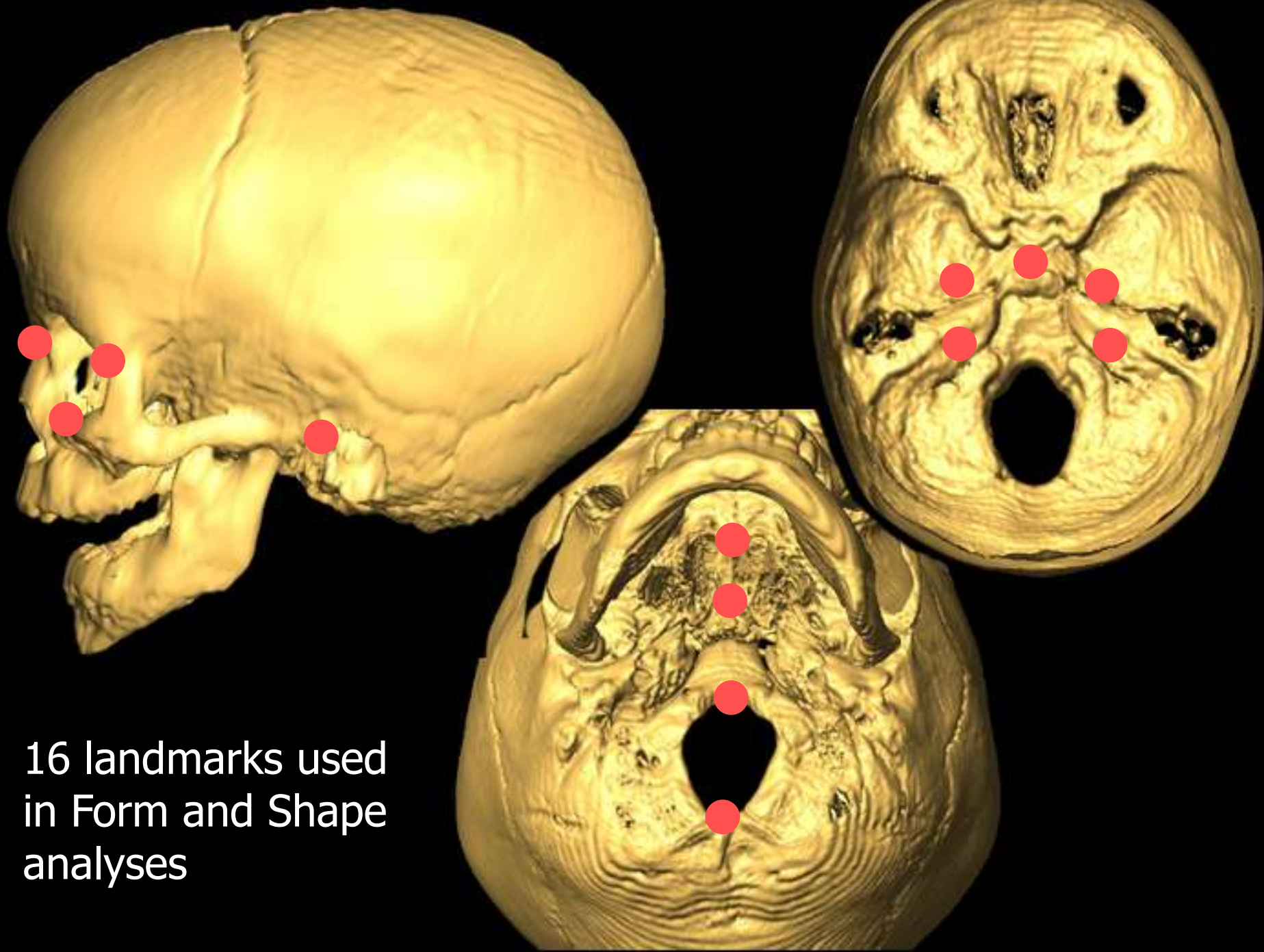
# Head Circumference

- Normal
- Microcephalic



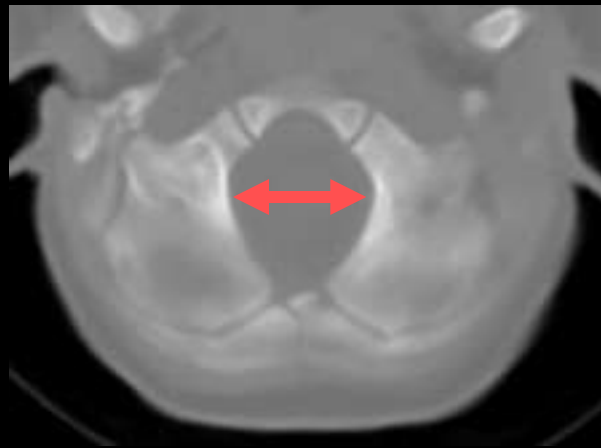
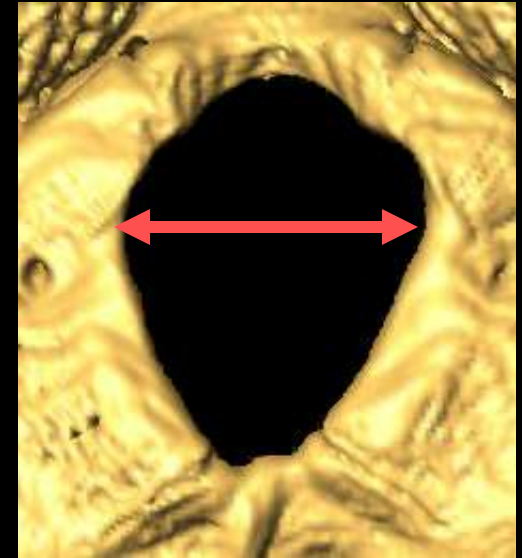
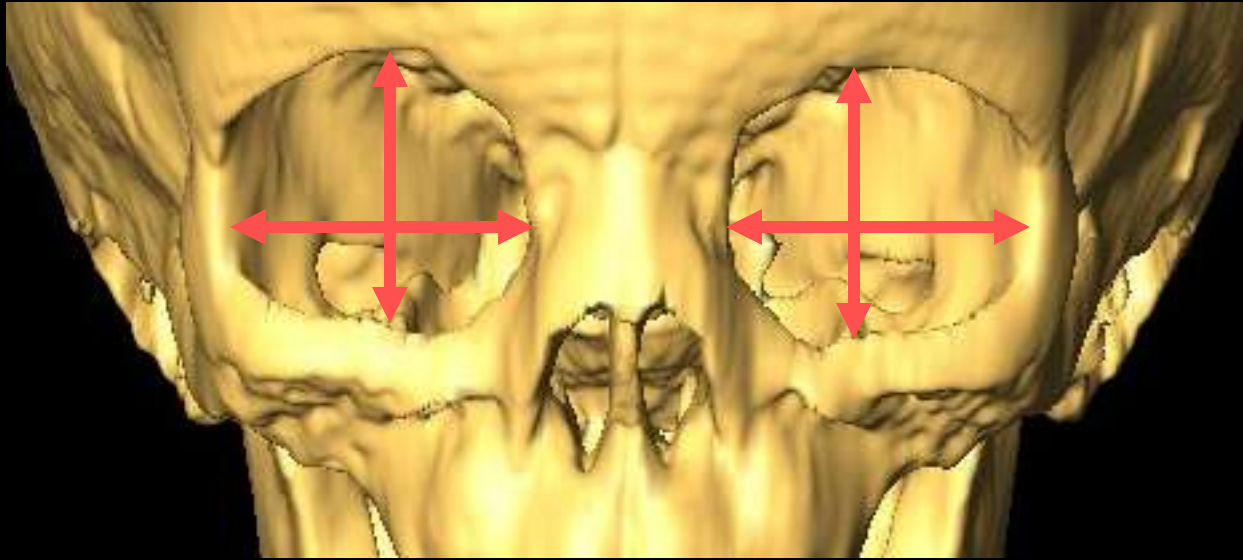


24 landmarks taken



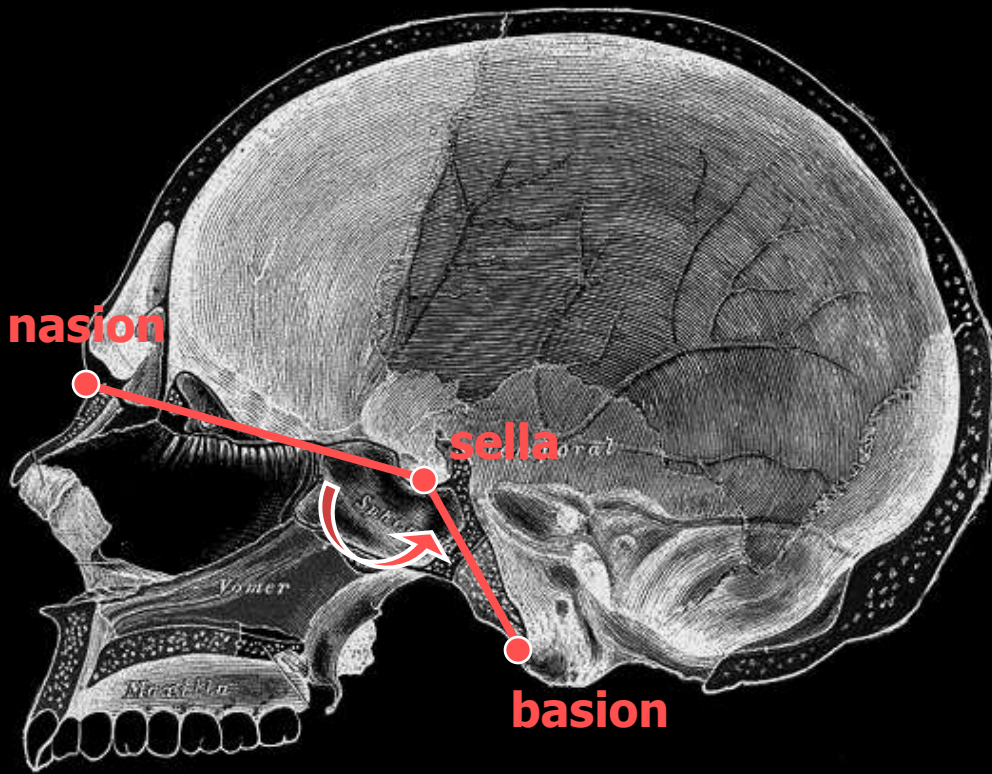
16 landmarks used  
in Form and Shape  
analyses

# Orbital & F.M. Measures

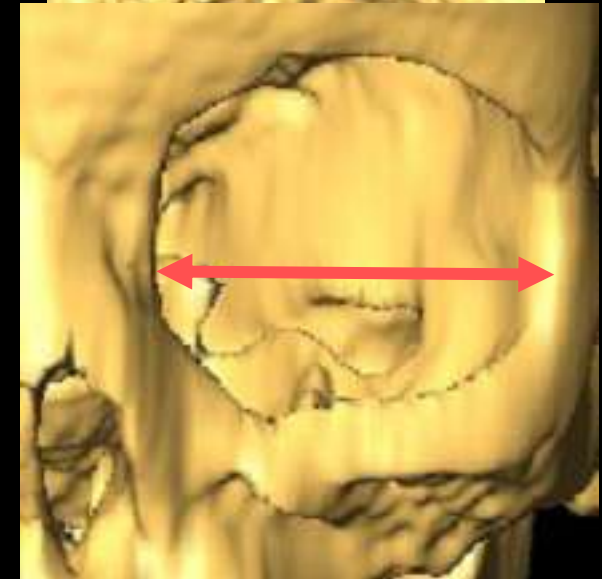
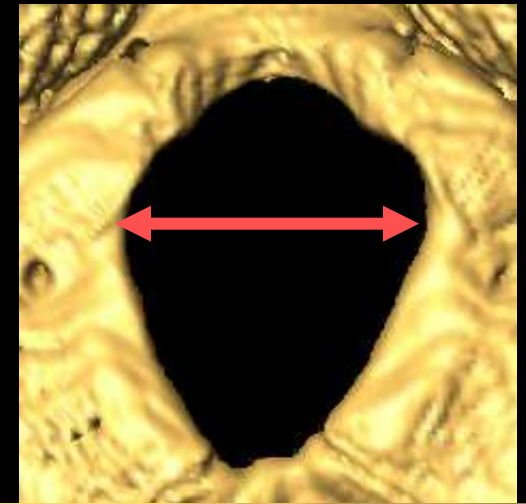
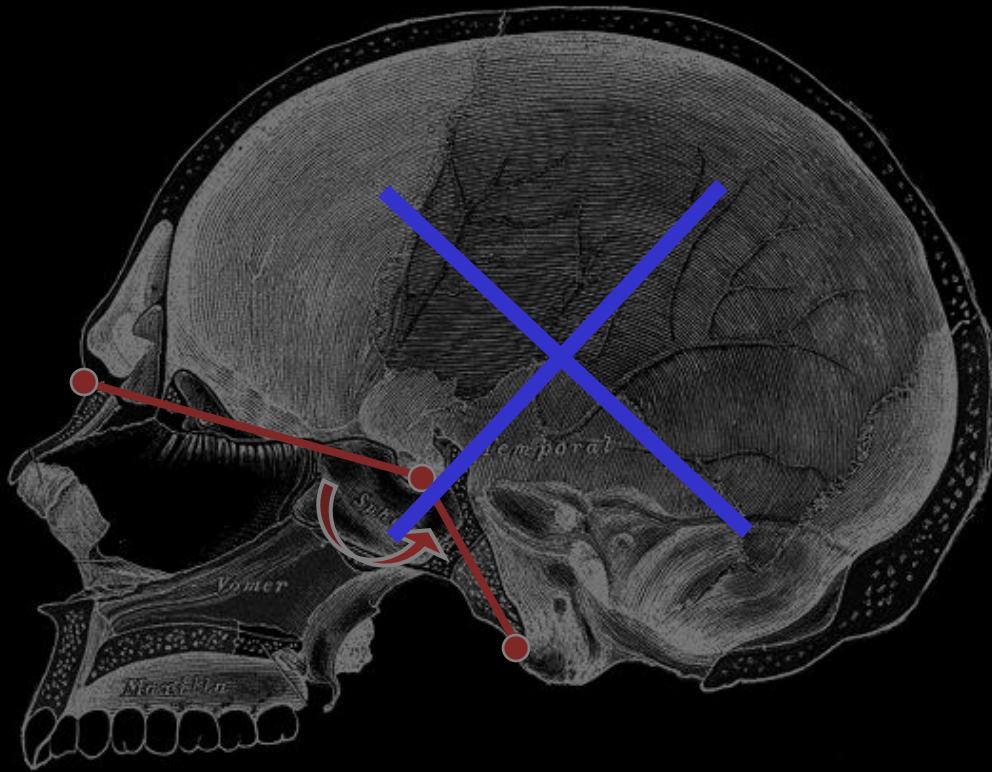


# Analyses

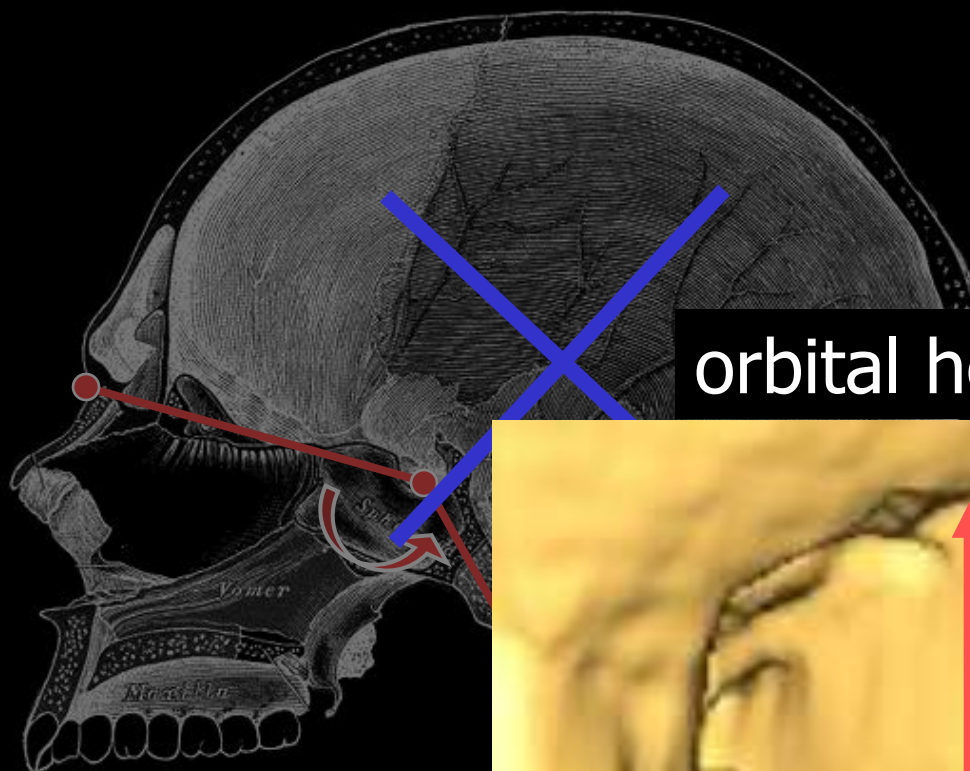
- Tests for differences in mean and variance with sex, age as covariates
  1. Cranial Base Angle (nasion-sella-basion)
  2. Foramen magnum length & width
  3. Orbital height & width
- Form, Shape tests in EDMA



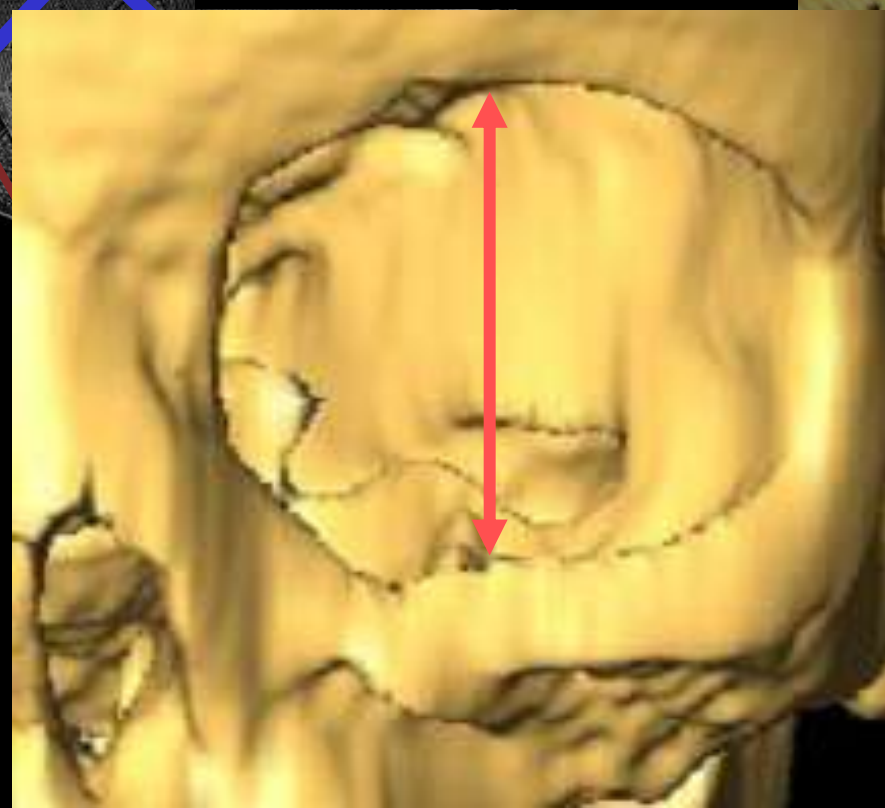
*No significant difference between groups  
in mean or variance of cranial base angle*



*No* significant difference  
between groups in mean or  
variance of foramen magnum  
or orbital width



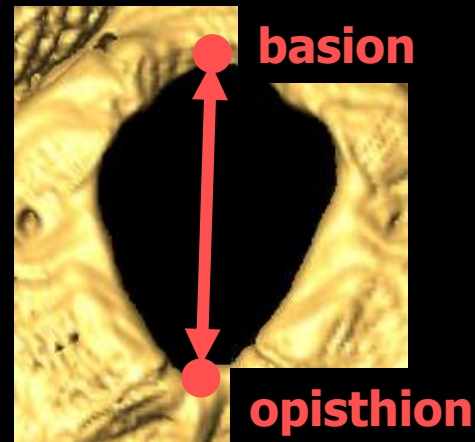
orbital height



Variance greater in microcephaly group  
( $p = 0.03$ , with sex & age as covariates)

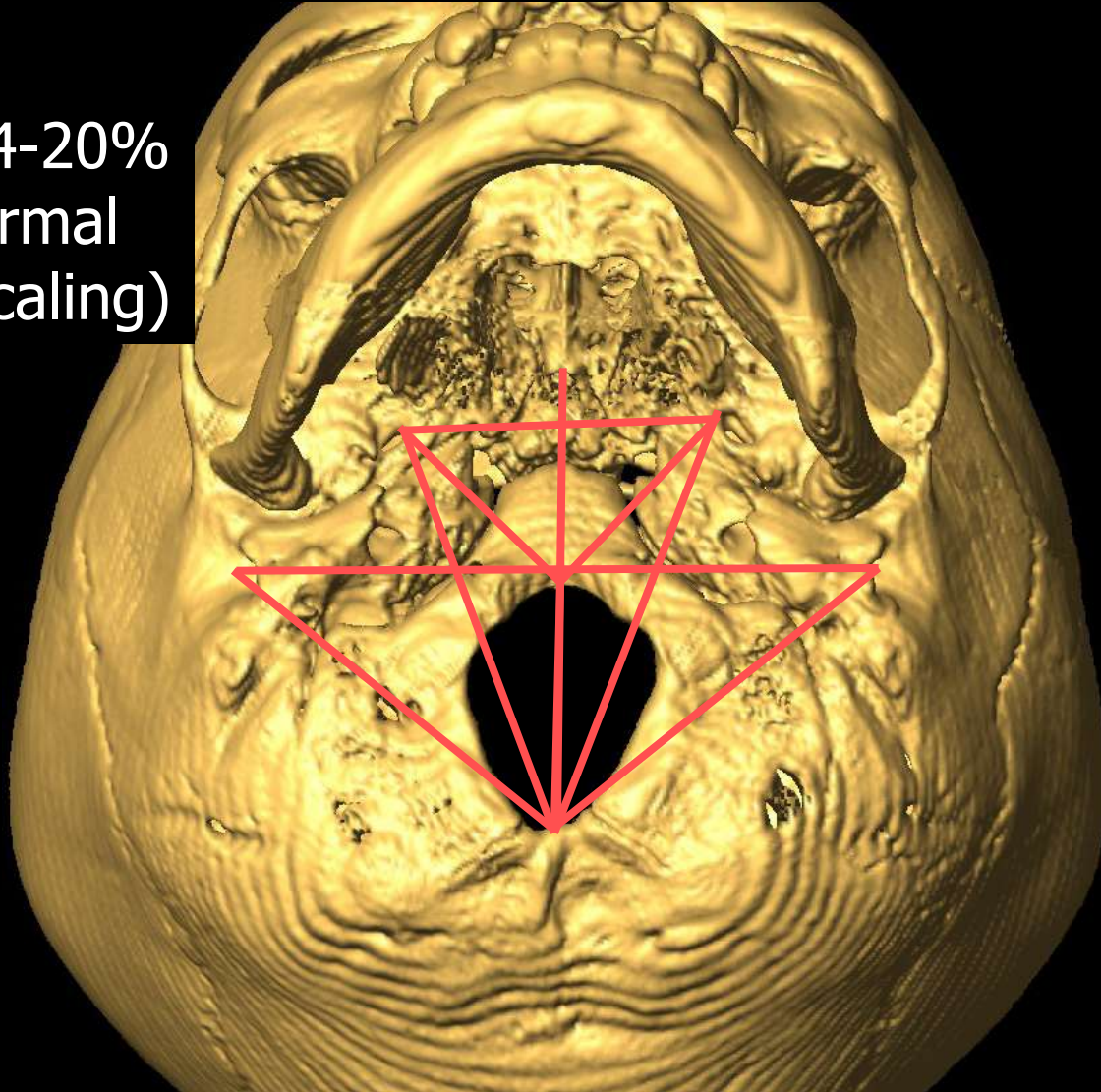
# Results: Foramen Magnum

- Mean foramen magnum length smaller in microcephalics without using age/sex covariates (by  $\sim 3$  mm)
- Alternate, nonparametric bootstrap estimates 15% difference in FM length



# Form: Normal > Microcephalic

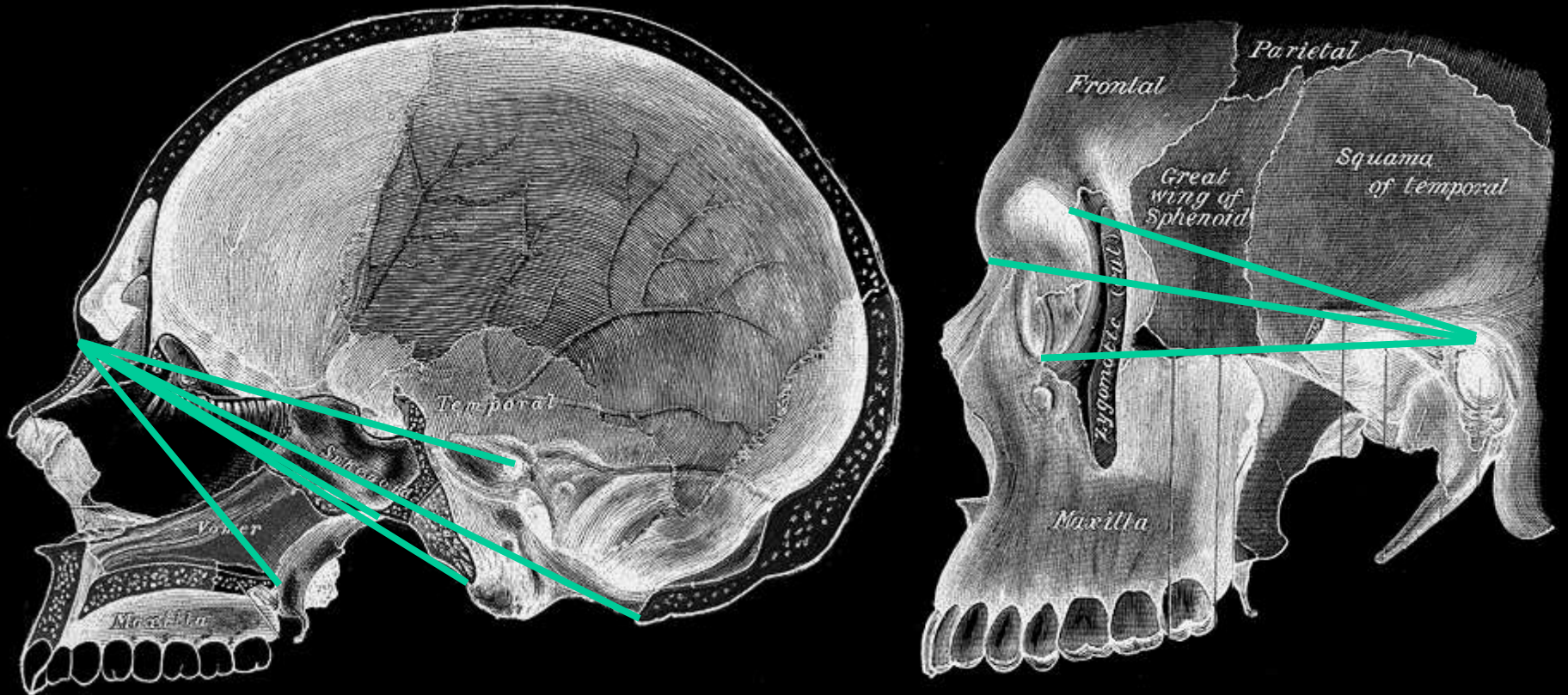
Distances 14-20%  
longer in normal  
group (no scaling)



# Shape

- All interlandmark distances scaled by foramen magnum length

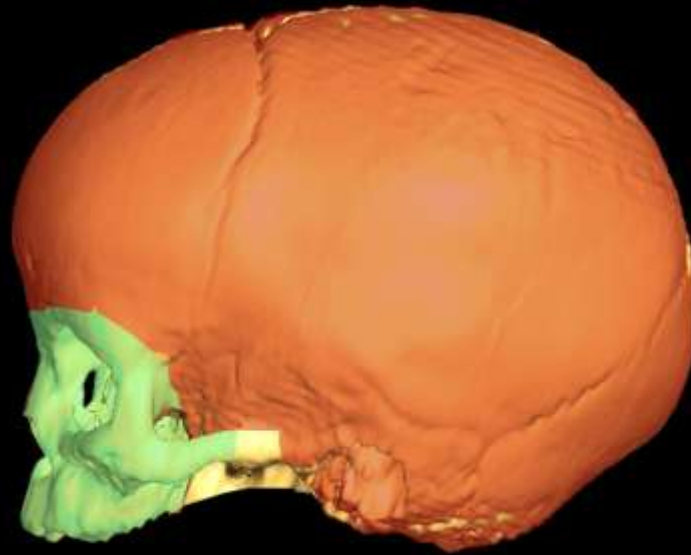
# Shape



Microcephalics *relatively* larger in many distances connecting facial to cranial base landmarks

# Conclusions

- Localized insult: cranial base shorter and narrower in microcephalics



# Conclusions

- Localized insult: cranial base shorter and narrower in microcephalics
- Upper face – cranial base connections relatively longer in microcephalics
- No evidence for facial involvement with respect to shape

# Discussion

- How about adults?
- Implications for paleoanthropology and archaeology

# Acknowledgements

- The Richtsmeier Lab
- Craniofacial surgeons at Johns Hopkins, University of Oklahoma, and WashU in St. Louis
- NIH grant P50 DE11131-01 to JTR
- NSF Graduate Research Fellowship
- The Penn State Department of Anthropology!