The Value of Radiographic Standardization in the Medico-Legal Setting

Kathryn Frazee, M.S., Kyra Stull, M.S., Stephen Ousley, Ph.D
Mercyhurst College, Erie, PA
The Biological Profile

Adults:
• Sex
• Ancestry
• Stature
• Age

Subadults (<20 years)
• Age
Inadequacies of Available Methods

Based on considerably antiquated samples

- Scheuer and Black (2000) published reference data for long bone age at death estimates
  - Reference Maresh (1970)

- Original data source: Maresh (1939)
Modern populations show significantly:
- earlier childhood growth
- greater adult stature
- earlier maturation
Inadequacies

Previous data limited to European-Americans

Differences in age of epiphyseal union

- Mexican-Americans 15
- African-Americans 16
- European-Americans 17

(Crowder and Austin 2005)
Inadequacies

Statistical Issues

• Historically
  – normal growth for known age
  – failure to meet *Daubert* standards

• Currently
  – predict age from bone length
  – apply appropriate statistics
Lack of Modern Samples

- Few known modern skeletal collections
- Collections almost exclusively adults
- Donations by parents of deceased children - exceedingly rare
Radiographs

- Problems with clinical radiographs
- Extensive radiographs routinely collected by medical examiners and coroners
- Most comprehensive source of modern subadult osteological information
- Demographic information available
NIJ Grant

• Creation of digital database

• Sample selection
  – Individuals under the age of 20
  – Year of death after 2000
  – Geographically diverse

• Goals:
  – Scan radiographs
  – Link to demographic information
  – Make available for research
Data Collected

- **Demographic**
  - Sex
  - Ancestry/Race/Nationality
  - Height
  - Weight
  - DOB/DOD
  - COD/MOD

- **Metric**
  - Crown-Heel
  - Crown-Rump
  - Head Circumference
  - Chest Circumference
  - Abdominal Circumference
  - Foot Length
  - Anterior/Posterior Fontanelle - Closed/Open

- **Medical History**
Research Progress

- 13 offices
- 11,612 radiographs
- 2,466 individuals
Value of Radiographic Data

• General impression
  – Not used to form “diagnoses”
  – Used to locate artifacts and image trauma

• Another perspective
  – Significant research potential
  – Need high quality forensic evidence
  – Can impact determination of COD/MOD
  – Possibility of subpoena
X-Ray Equipment

• Financial obstacles to modernization

• Less expensive options
  – Use digital processor with original source
  – Refurbished equipment
  – Regular service and maintenance
Recommendations

Standardize Radiographic Content

• Permanently embedded information
  – Office name
  – Case number
  – Scale
  – Side Identifier
Recommendations

Standardize Technique

- Maintain 40” source to image distance (SID)
Recommendations

Standardize Positioning

• Straighten or flatten limbs
• Avoid crossing appendages
• Record maximum amount of data
Recommendations

Standardize Training

• Autopsy tech radiology training to include:
  – Concepts and principles applied
  – Radiation exposure and safety
  – Basic functions of the machinery

• Appropriate training programs seldom available

• Development of national standards as framework for in-house training and certification
Recommendations

Archival Standards (film)
• Protected and organized storage
• Cool and dry environment
• In boxes (consider weight)
• Acid-free folders

Archival Standards (digital)
• Consider saved file resolution
Current and Future Applications

Age Estimation
• epiphyseal appearance, fusion
• bone appearance (wrist/ankle)
• bone measurements (corrected)

Further Research
• Similar to Anthropological Research Facility and Forensic Data Bank (UT-Knoxville)
Valid Age Estimates

- Modern data
- From diverse ethnic groups
- Better statistical methods for discrete data
  - Logistic regression
    - provides explicit confidence intervals for age prediction
Distal Epiphysis of the Radius

Scheuer and Black (2000)
- Cite older radiographic and skeletal studies
- Appears at 1 to 2 years

Schaefer, Black, and Scheur (2009)
- Appears at 1 to 2 years
  - Absent: ≤ 2.5 yo
  - Present: ≥ 4 mo
Distal Epiphysis of the Radius

Logistic Regression Curve

95% confidence interval:
• absent, \( \leq 72 \) weeks old
• present, \( \geq 36 \) weeks old

Narrower Earlier
Better Methods for Measuring from Radiographs

Adjust for size and shape distortion

Statistical methods
- Nonlinear regression
- Logistic regression
- Robust regression
- Resampling
Software

- Estimate age from specific bones ossified, measurements
- Ancestry- and sex-specific standards
- For known-age children, calculate percentiles of weights, measurements
Further Growth in Growth Data

Permanent home at Mercyhurst College

Please feel free to contact us:

  Kathryn Frazee
    kfrazee@mercyhurst.edu
  Stephen Ousley
    sousley@mercyhurst.edu
  Kyra Stull
    kstull@mercyhurst.edu
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• If you are interested in participating in this research, please contact the authors. Also, if there is a change to digital and destruction of archived xrays will be taking place, we may be able to provide on-site scanning of those films into our database.