A84 Apophyseal Ossification of the Iliac Crest in Forensic Age Estimation: New Standards for Modern Australian Subadults Using Computed Tomography

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After attending this presentation, attendees will: (1) appreciate recalibrated population-specific age standards for Australian subadults based on the Risser Sign, and the implication of idiopathic scoliosis on the derivation of age estimates; and, (2) become familiar with ontogeny of the iliac crest apophysis using 3D reconstructions of Multi-Slice Computed Tomography (MSCT) data.

This presentation will impact the forensic science community by demonstrating the potential of a contemporary MSCT database of abdomino-pelvic scans to assess the currency of methods such as the Risser Sign for clinical age assessment of maturation milestones.[1] This presentation discusses and surmounts limitations associated with conventional radiographs by utilizing MSCT Multi-Planar Reformatted (MPR) and Volume Rendered Reconstructions (VRR) to formulate Australian standards for forensic age estimation, based on excursion and fusion of the iliac crest apophysis.

Accurate age-at-death estimation of skeletal remains represents a key element in forensic anthropology, while age estimates of living individuals are of increasing importance for forensic medicine, considering the increase in transnational migratory movements. The age of criminal responsibility under Australian federal law is ten years of age, while *doli incapax*, the maximum age of presumption against criminal responsibility constitutes 14 years of age. Wittschieber et al. contend that the Risser Sign is suitable for forensic age estimation, especially the demarcation of the 14th year of life.[2] Combined with other roentgenographic indices of maturation, excursion of the iliac crest is used to estimate remaining growth potential and the likelihood of progression in patients with adolescent idiopathic scoliosis, which influences clinical intervention decisions such as bracing or surgery.

The present study seeks to determine whether the Risser Sign, used routinely for assessing iliac crest maturity in scoliosis patients, is suitable for age estimation of subadults, particularly in cases claiming *doli incapax*. The sample composes MSCT abdomino-pelvic Digital Imaging and Communications in Medicine (DICOM) data (0.5mm/0.3mm) acquired from 255 'trauma-screened' Australian individuals aged 6-25 years, admitted to Brisbane children's hospitals between 2007 and 2014. The Risser US six-stage system was employed to score ossification of the iliac crest. Transition analysis was applied to elucidate maximum likelihood estimates between maturational states; robust age parameters were established using a Bayesian statistical approach, with an MCMC sampler. Volume averaging reconstructions of DICOM datasets, using a coronal reformat were employed to create pseudoradiographs for Risser scoring of trauma-screened children. Standards for Queensland idiopathic scoliosis patients (females: 436, males: 95) aged 6 years to 23 years were derived from clinical databases comprising conventional surveillance radiographs, including the pelvis and analytic data (e.g., Risser Sign, Cobb Angle) from a scoliosis progression study performed by the Paediatric Spine Research Group between 1995 and 2007. Comparisons of maximum likelihood estimates demonstrate no significant developmental anomalies in iliac crest maturation associated with idiopathic scoliosis. Age-at-transition for apophyseal appearance corresponds to 12.99±1.3 years in females and 13.87±0.94 years in males. Posterior distributions signify complete appositional growth (Risser 4) at 15.06 (95% CI:13.5-16.7) years and 15.99 (95% CI:14.9-17.0) years in females and males, respectively, an important demarcation stage for scoliosis management. Lack of discriminant power between stages 2-4 demonstrate that the 14th-year legal demarcation cannot reliably be determined in females using this method on conventional radiographs.

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Risser grading on MPR and VRR models of Australian subadults reveals interesting anatomical deviations, highlighting flaws in the ossification progression stated by Risser. Appearance of the apophysis is witnessed 6 months to 12 months earlier in MSCT than pseudoradiographs. Circumventing radiographic limitations such as superimposition, a modified eight-stage MSCT scoring-tier was developed for appearance and fusion of the apophysis, demonstrating origins from three secondary ossification centers. Complete fusion/obliteration occurs between 18.4 years to 19.7 years in males and 19.3 years to 20.3 years in females; indicating secular change in Australian children in contrast to anthropological standards of Coimbra individuals and the 23-year demarcation by Webb and Suchey.[3,4]

The contributions of this original research are extensive. Caution in the derivation of ossification standards from conventional radiographs is advised, with conflicting timings and morphological progression to MSCT assessment. Retrospective clinical data acquisition provides the ideal catalyst for the advancement of anthropological subadult research, demonstrated by the construction of refined, Australian standards for age estimation of the current milieu. Bayesian posteriors of the MSCT scoring-tier demonstrate successful *doli incapax* age estimation for utility in criminal proceedings.

Reference(s):

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Age Estimation, Subadult, Iliac Crest Apophysis