A22 Age Estimation Using a Radiation-Free Medical Method: An Analysis of Carpal Bones by Magnetic Resonance Imaging (MRI)

Roberto Scendoni, PhD, MD, Petriolo 62100, ITALY; Mariano Cingolani, MD, University of Macerata, Macerata 62100, ITALY; Francesco De Micco, MBBS*, Università degli Studi del Molise, Campobasso, CB, ITALY; Roberto Cameriere, Cingoli, ITALY*

Learning Overview: The goal of this presentation is to verify the applicability of a new radiation-free medical method for age estimation in a sample of 57 individuals between 12 and 20 years of age.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting a new method for age estimation based on hand and wrist bone analyses by MRI.

In age estimation of living individuals, there is growing interest in using MRI to avoid exposure to ionizing radiation. Moreover, MRI compared to radiography has more details because it is able to define the individual ossification nuclei and the cartilage that surrounds single bones. Based on Bo/Ca method by Cameriere et al., the purpose of this study is to investigate the possibility of using MRI on carpal bones for age estimation.[1]

A retrospective study was performed analyzing 57 MRI scans of Italian subjects aged between 12 and 20 years, without growth diseases, endocrine disorders, or osteodystrophy. MRIs have been extrapolated and subsequently processed using a computer-aided drafting program (ImageJ). For each carpal bone, the ratio (NOSG) between the area occupied by the Nucleus of Ossification (NO) and the Surface of Growth (SG) was calculated; the latter was derived by adding the NO to the area of cartilage-bone interface. This procedure was carried out using a polygonal selection tool, capable of delimiting an area through a series of linear segments.

For age estimation, this study obtained the following multiple linear regression formula:

$$Age = -20.1743 + 0.2644 \cdot g + 3.0206 \cdot Td + 4.1685 \cdot Tm + 3.9135 \cdot S + 13.3617 \cdot P + 20.9222 \cdot C$$

where:

g = 1 for male and 0 for female

Td is $NOSG_{Trapezoid}$

Tm is $NOSG_{Trapezium}$

S is $NOSG_{Scaphoid}$

P is $NOSG_{Pisiform}$

C is $NOSG_{Capitate}$

The median of the residuals (observed age minus predicted age) was -0.025 years, with an Interquartile Range (IQR) of 0.19 years. The results demonstrated that the best model, with the lowest Root Mean Square Error (RMSE) and the highest coefficient of determination (R^2), was obtained with six predictors (Nvmax=6): Gender, and the NOSG of the trapezoid, trapezium, scaphoid, pisiform, and capitate.

According to this study, thanks to the improved resolution of MRI on carpal bones, the new method could allow one to define the age of minors with an extremely low margin of error and to obtain more accurate results for subjects over 18 years of age. In fact, the sample contained nine individuals over the age of 19, which is a not negligible number given the age range of the sample population (i.e., 12–20 years). However, to verify the applicability of the method in the forensic field, studies on larger samples and populations of different ethnic origin will be needed in the future.

Furthermore, a use of the new method on skeletal remains is also envisaged through the realization of specific regression models for each of the five carpal bones considered in the formula, for which a coefficient of determination $R^2 > 0.9$ was found. This could be useful for identification/age estimation purposes in dead bodies or in the event of the discovery of portions of the hand (as a result, for example, of mass disaster or fragmentation due to the action of macrofauna).

Reference(s):

1. Roberto Cameriere, Luigi Ferrante, Dora Mirtella, and Mariano Cingolani. Carpals and epiphyses of radius and ulna as age indicators. *International Journal of Legal Medicine* 120, no. 3 (May 2006): 143-146.

Age Estimation, Magnetic Resonance Imaging, Carpal Bones

*Presenting Author