A7 3D Analysis of Computed Tomography (CT) -Derived Lumbar Spine Models for the Estimation of Sex

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After attending this presentation, attendees will more deeply understand the usefulness of 3D CT models of lumbar vertebrae in the estimation of sex from the spine. Attendees will also learn which measurements of the spine are most beneficial and which ones should be used with caution.

This presentation will impact the forensic science community by providing the results of a methodology to assist in forensic analysis, particularly in sex identification. This presentation will enhance existing research of osteological materials by adding data of a living, modern American sample with the spine *in situ*. This will provide insight into the natural spacing and orientation of the spinal components.

Sex identification is a crucial part of the forensic analysis of human remains. While the skull and pelvic bones are often the most ideal structures to use in sex estimation, the condition in which skeletal remains are found is frequently not ideal as bones may be damaged or missing.

Previous studies of the spine and sex estimation have examined the 1st cervical vertebra, 2nd cervical vertebrae, 12th thoracic vertebra, and the 1st lumbar vertebra with varying degrees of success. The hypothesis of this study was that CT-derived 3D models of lumbar vertebrae will be able to capture the unique morphologies used in determining sex in the human body. This study examined all five lumbar vertebrae in order to determine the most reliable and robust method for sex estimation. A series of 140 lumbar vertebrae complexes were acquired from CT and three-dimensionally reconstructed into volumetric models from living patients. The dataset was divided into 70 males and 70 females. Ages ranged from 20 years to 89 years old. Any individuals having additional or missing lumbar vertebrae were excluded from this study. The lumbar vertebrae (L1-L5) and the top of the sacrum were modeled and analyzed using 27 measurements and five aspect ratios for each vertebra. The data were then analyzed using the statistical package SPSS 22. All measurements with a $P<0.05$ were considered to be significant.

Bilateral measurements of the articular and transverse processes, pedicles, facets, and lamina were all compared using a paired t-test and no statistical significance between sides was found. Therefore, any bilateral measurements used in the discriminate function test were limited to the left side. A paired *t*-test was performed comparing males and females for each linear measurement and ratio. Measurements that were determined to be statistically significant were used for further analysis. A stepwise analysis method used these focus measurements to create discriminate equations for L1 though L5 individually.

For L1, five measurements (upper endplate width, upper endplate depth/middle depth ratio, left transverse process length, posterior vertebral height, and anterior vertebral height) predicted sex with 100% accuracy. For L2, five measurements (upper endplate depth, articular process width, spinous process height, lower endplate depth, and upper endplate width) predicted sex with 100% accuracy. For L3, four measurements (transverse process length, anterior vertebral height, spinal canal width, and spinal canal depth) predicted sex with 100% accuracy. For L4, six measurements (transverse process length, posterior vertebral body height/anterior vertebral body height ratio, articular process width, spinal canal width/spinal canal depth ratio, lower endplate width, and spinous process height) predicted sex with 100% accuracy. For L5, three measurements (lower endplate width, transverse process length, and superior articular process height) predicted sex with 100% accuracy.

Human remains in forensic cases are discovered and recovered in scattered, damaged, comingled, or partial states making identification more difficult for those establishing an unknown individual's biological profile. By having a modern living human data sample, investigators can utilize new reference data of any lumbar vertebrae in their quest for a positive identification. The accuracy of the sex estimation found in this study for all lumbar vertebrae reinforces the distinct dimorphism between sexes while also providing forensic practitioners with more options or tools for their analyses.

Lumbar Spine, Sex Estimation, CT