Section A -Research paper

Gender Determination by Three Dimensional Computed Tomography

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Abstract:

One of the main steps of identification process defining the individual in forensic medicine practice is age and sex determination. CT imaging technology was widely used in forensic anthropology since 1980s. it was proved that CT may be used as a valuable tool in disaster victim identification after a mass fatality incident because of the high efficiency of the technology**.**

Keywords: Gender Determination, Three Dimensional, Computed Tomography.

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Introduction:

The postmortem imaging, x-ray, computed tomography (CT), CT angiography, magnetic resonance imaging (MRI), and various surface scanning methods are utilized to investigate the circumstances of death of a deceased and to document the findings (**1).**

In such instances, postmortem CT (PMCT) is the preferred modality; it permits assessment of most forensically relevant conditions such as bone fractures, hemorrhage, parenchymal lacerations, free intracorporal gas accumulation, and the presence of foreign bodies. PMCT scanning protocols can be optimized for use in forensic cases to increase image quality by using higher energies, thus lowering image noise **(2).**

In addition, clinical CT scans can be reevaluated forensically for potential use in criminal proceedings. CT scans can also help in 3D documenting objects **(3).**

PMCT generates volumetric data that can be used in a variety of applications in forensic sciences:

➢ First, the data can be used as a triage tool for autopsy, to thoroughly plan a subsequent autopsy and to assist in determining cause and manner of death **(4).**

➢ Second, PMCT can be utilized to reconstruct the course of events, to create comprehensible visualizations for presentation to state attorneys and judges, and to add information on the internal body state of the deceased, such as the presence of underlying medical conditions or gunshot trajectories, to 3D-surface scanning. This mix of different image modalities adds resolution and color information to the CT scan, which would otherwise be insufficient for the assessment of would surface morphology (**5).**

➢ Third, it can be used to identify bodies, i.e., in cases of mass disasters, thus potentially speeding up disaster victim identification scenarios. Other fields of application include anthropological analyses such as sex or age estimation and identification and medical training **(6).**

Various forensic disciplines, including forensic medicine, forensic anthropology, and forensic crime scene reconstruction, routinely work with postmortem image data. Forensic radiologists analyze the images for initial diagnosis, and forensic pathologists are able to plan autopsies based on those findings (**2).**

Development of C.T. uses of forensic anthropology

By the end of the 20th century, forensic imaging application in forensic anthropology was elevated to a new level. The Flat-Panel-CT eXplore Locus Ultra (eLU) system was applied in determining the correlation between age and the stages of skull suture closure. The research team appraised that this method is useful in conjunction with other methods in age estimation **(7).** In **2014**, **López-Alcaraz et al. (8)** applied CT on the pubic symphysis surface and the pubic body to relate them with age and suggested that the image analysis of pubic bone offers a valid and alternative method for age estimation **(8).**

In 2017, Ikeda used Bayesian statistics in combination with CT imaging and suggested that they together can be used to estimate age at death based on costal cartilage calcification **(9).** Recently, Fan et al. developed the CT image reconstruction of laryngeal cartilage and hyoid bone in adult age estimation using data mining methods **(10).**

Three-dimensional pelvic CT scan in sex determination:

Sex identification on remaining human bone is the first step to do in helping forensic anthropologists to identify a person. The accuracy of sex identification depends on bone components that are analyzed, and the technique used **(11, 12).**

In adults, the coxa is the most reliable indicator of sex because of its sexual dimorphism. Each population must have a specific identification standard. Os coxae shows a broadly common pattern of sexual dimorphism across many regions in the world, and this pattern of pelvic sexual dimorphism appeared in early modern humans, approximately 100–150 years ago **(13).**

Accurate estimation of sex for adults is affected by the state of the individual preservation of bones, their degree of expression of sexual dimorphism, and methods employed. In some instances, metric methods are better than morphological ones. For these reasons, a study which demonstrates the importance of an objective method by utilizing radiology technology in sex determination is needed **(14).**

Over the past decade, modern cross-sectional imaging techniques have revolutionized forensic medicine. Virtual anthropology obtained by the 3D imaging techniques such as computer tomography (CT) allows us to visualize almost every anatomical and pathological bone structure with high resolution and quality. Multi-slice computed tomography (MSCT) is becoming more and more widely used for post-mortem examinations. CT provides data sources to examine modern human variation quantitatively when expanding the resources for osteological assessment to researchers. These studies have shown significant improvements in accuracy and reproducibility over conventional linear methods of constructing a person's biological profile **(15).**

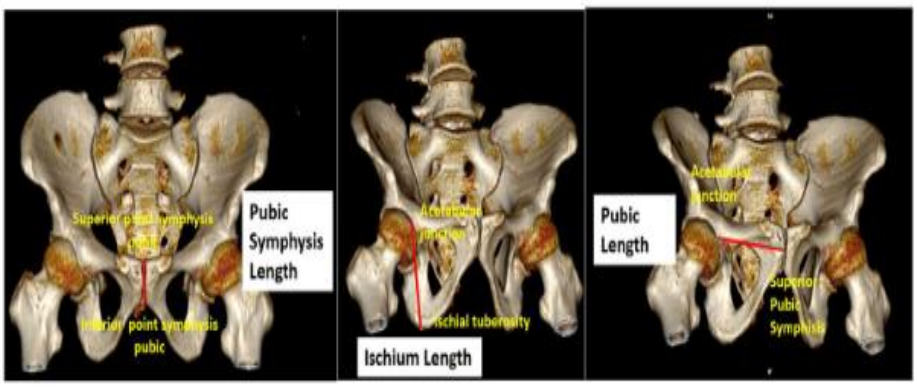

Figure (1): Illustration of measuring the pubic symphysis length, ischium length, pubic length on 3D model of pelvic CT. Pubic symphysis length (PSL) is measured by distance between the most superior and inferior points, ischium length (IL) is measured by distance between the innermost point of ischial tuberosity and acetabular junction, as well as pubic length (PL) is measured by distance between the superior point at pubic symphysis and acetabular junction **(16).**

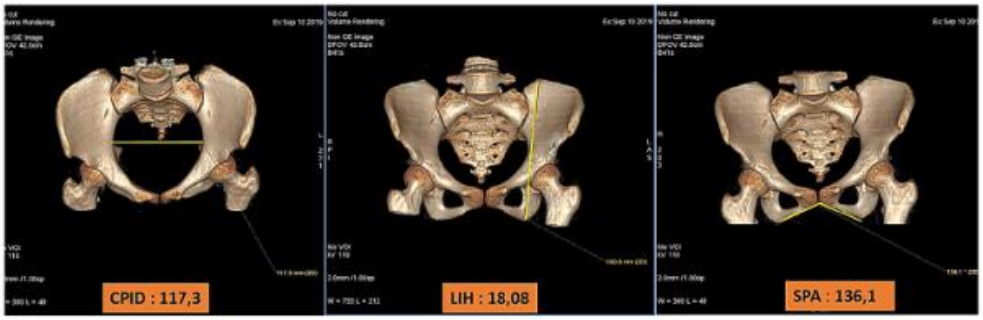

Figure (2): A case illustration of applying the regression formula using 3D pelvic CT anthropometric parameters in 43-year-old female patient. A total calculated value is 30.9, consistent with the sex of female pelvic **(16).**

A sex determination method based on a worldwide hip bone metrical database was developed. CT scans of bones were then analyzed to obtain three-dimensional (3D) virtual models then importing the models into a customized software program. CT scan imaging of the above dry bones was performed to obtain three-dimensional (3D) virtual models. 3D models were obtained using a commercial software allowing semi-automatic segmentation **(17).**

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