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SIGNIFICANCE OF RADIOLOGY FORENSIC IDENTIFICATION

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ABSTRACT

This article reviews different important and useful aspects of radiology in relation with forensic medicine. Radiological imaging plays a vital role in forensic medicine in many intersections identity, injury and postmortem examination. This Article describes areas where radiology plays its role in identification.

KEYWORDS: Radiology, Identification, Sex Determination, Human Remains, Forensic Medicine

INTRODUCTION

The importance of radiographic techniques in clinical forensic medicine is widely recognized. Radiographs are taken on post-mortem examinations to locate foreign bodies or document fractures and other types of injuries**.** Common methods of identifying human remains — facial features, scars, birthmarks, tattoos, fingerprints, palm prints, and footprints — depend on preservation of the soft tissue components of the body in question. These methods are wanted when the remains are so decomposed, burned, mutilated, skeletonized, or fragmented that the surface topography is unrecognizable or featureless. It is then that medical and dental radiological methods may be required[1].Radiological examinations play a significant role in diagnosing non-accidental injuries of children, in medical negligence and in establishing biological aging in disputed cases[2].

Role of Radiographs in Identification

Radiographs are commonly used to establish identity when antemortem radiographs are available for comparison. In such cases, unique structures (e.g., cranial sinuses, sellaturcica) can be compared. Identifying characteristics, such as a broken bone resulting in a malunion or varus/valgus deformity of a long bone, can also be used. Radiographs may reveal the presence of foreign material, such as old bullets or shrapnel, or surgical hardware, which can often be traced by a serial number on the device through the manufacturer to the recipient. The presence or absence of growth plates or the extent of osteophyte formation may establish whether the remains are those of a younger or older individual, though forensic anthropology can often be more specific[3]. Radiology played its role in the following identification purposes.

Age Determination

Determination of age at time of death is an important step toward identification of unknown remains. Age can be established with considerable accuracy by roentgenography of the skeleton from the time of its appearance about the 20th week of gestation until early adulthood. This is possible due to the complex but dependable system by which the osseous framework of the body develops, grows, and matures[1]. Most of the 206 bones of the human adult skeleton develop in cartilage precursors or anlagen from one or more primary centers of ossification (which make up the shaft or diaphysis of a long bone, the centrum of an axial or round bone) and secondary centers which develop the articular ends of the bones (epiphyses) or nonarticular processes (apophyses) for attachment of muscles, ligaments, and tendons. The appearance of these centers, and the fusion of secondary centers with the primary, follows a timetable allowing rather precise aging if appropriate skeletal parts are available for evaluation. Fetal age can be measured by crown-rump measurements, fetal length, femoral length, biparietal diameter, or skeletal maturation. Fetal parts and soft tissues, if extrauterine, are small enough that radiological magnification will not be a major problem in view of the rather wide range of standard deviations for the various fetal measurements, most of which now a days are based on real-time intrauterine measurements by ultrasonography. Intrauterine feotus imaged roentgenographically will be magnified[1.]

Sex Determination

It has been pointed out already that skeletal development maturation in females is accelerated over that of males after the third or fourth year of life. However, differentiation of sexes by skeletal radiology is unreliable until after puberty. It is then that the sexual characteristics discernible by radiography begin to appear. In general, the male skeleton is more robust and heavier, with more prominent attachment for muscles and tendons. With aging, there is a tendency for more degenerative and hyperostotic changes in the male skeleton. Male long bones are about 110% the length of female long bones. The male femoral head is larger in all dimensions. All of these general findings are helpful but not definitive in establishing the sex of unidentified human remains. There are certain skeletal components such as pelvis and sternum and both skeletal and extra skeletal findings, which are more useful in determining sex[1]

Pelvis[1]

- The bony pelvis often survives the onslaught of factors which diminish or destroy the usefulness of other body parts. This is fortunate since the pelvis offers the most definitive traits of sexual differentiation.
- The *subpubic arch* (subpubic concavity) is narrow and triangular with an inverted V-shape in the male and broad and with an inverted U-shape in the female.
- The *pubic bone* tends to be long and narrow in the male and broad and rectangular in the female.s
- The *sciatic notch* is deep and narrow in the male, and is wide and shallow in the female.
- The *preauricular sulcus* (paraglenoid sulcus) when present is one of the most dependable indicators of femaleness. This variable groove in the ilium at the inferior end of the sacroiliac joint is missing or manifest very rarely as a thin groove in the male and a deep groove is found only in females. The groove or sulcus is believed to represent resorption of bone at the insertion of the anterior sacroiliac ligament, much as the costoclavicular ligament produces the rhomboid *fossa* in the antero-inferior end of the clavicle. Deep grooves are found only in subjects in the mid-fourth decade of life or beyond and only in parous women. The depth of the groove is influenced by multiple pregnancies, genetic differences, level of physical activity, and perhaps, the degree of lumbar lordosis. While a deep groove denotes a female, not all women have a preauricular sulcus. Among the bodies recovered from the Air India disaster, a small notch was found in a 14-yearold female pelvis, and the oldest female without a periglenoid sulcus was 51 at time of death.
- The *obturator foramina* are large and oval or round in the male, but small and triangular in the female.
- The *acetabular fossae* are large and directed laterally in the male, and are smaller and directed anterolaterally in the female.

- The *ilialalae* are high and vertical in the male, and broad and laterally divergent in the female.
- The *sacrum* in the male is narrow, has a relatively flattened curve and has five or more segments. The female sacrum is broad and short with five segments and an anterior concavity.
- The *pelvic inlet* is triangular or heart-shaped in the male, ovoid in the female.
- The *muscle markings* are more prominent and rugged in the male. The female bony pelvis tends to be smooth and gracile.
- *Osteitiscondensansilii* is a triangular area of increased bony density on the ilial side of the sacroiliac joint, usually bilateral, found almost exclusively in parous women in the child-bearing years. The joint, per se, is unaffected. It may becaused by the stress of pregnancy and childbirth. There is correlation with the presence of deep preauricular sulci. The condition is self-limited and disappears; consequently, it is not to be found in the elderly female[1].

Sternum

The gender-predictive value of sternal length is not often used radiographically because it requires cross-table radiographs of the chest with a partially radiopaque ruler in place. With “chest plate” preparations direct measurements can be obtained. A combined length of manubrium and gladiolus of 17.3 cm includes only males; a combined length of manubrium and glandulous of less than 12.1 cm includes only females. Sternal lengths of 14.3 to 15.7 cm were indeterminate[1].

Other Areas

Bi-partite patella is a common anatomical variant in adolescents, and is nine times more common in boys than girls. It is seen as a separate ossicle (or ossicles) occupying the upper outer quadrant of the patella. It occurs in approximately 2% of the population and is bilateral in 40 to 80% of cases[1].Krogman states that the chance of correctly sexing bones is 100% if the entire skeleton is available, 95% with the skull and pelvis or with the long bone and pelvis, and 90% with the skull alone or with the long bones and skull. *Costalcartilage* mineralization patterns as a distinctive finding between sexes was first reported by Sanders. He noted that the typical male pattern is that of continuous parallel ossification of the upper and lower borders of the cartilage as it extends from the rib end.

The typical female pattern is a tongue-like or triangular mineralization extending from the rib end into the centrum of the cartilage. An uncommon pattern, more common in females, is that of two parallel lines extending from the center of the rib and into the adjacent cartilage. A pitfall is that the male pattern tends to first appear on the inferior images of the costal cartilage and may be mistaken for the female “tongue” which is always central to the cartilage. Finally, the pattern of a central rounded mineral collection in costal cartilage, sometimes with a more lucent center, is believed specific for elderly females[1]. Navani et al believe the predictive value of the parallel marginal male pattern to be 95%, the predictive value of the tongue-like central female-type mineralization to be 93%, and mixtures or combinations of those two patterns to be more likely found in females (predictive value 57%). *Calcification of trachea bronchial cartilage* is found in only a small percentage of the people but with an overwhelming female predominance. *Calcification or ossification of the thyroid cartilage* anteriorly is more common in males while *arytenoid cartilage* calcification is four times more common in women. Perhaps the only *absolute roentgenographic indicator of sex* was present in one of the victims of the Air India catastrophe. Many of the recovered bodies had abdominal viscera displaced into the chest. One young female chest contained a foetal skeleton estimated at 18 to 22 weeks[1].

Determination of Race or Population Ancestry

The physical anthropologists have many elaborate methods of evaluating race or population ancestry if bare bones are available. Some fleshed or partially fleshed remains can be evaluated radiographically

- **Intercondylar Shelf Angle**

A method of determining race from the intercondylar shelf angle can be used with skeletal or fleshed remains. It requires only true lateral positioning of the distal femur. The measurement of the angle between there of the intercondylar notch (or intercondylar shelf) and the long axis of the femora lshaft is independent of magnification.

- **Long Bones**

In Blacks, the tibia is long relative to the femur and the radius is long relative to the humerus, but the ratios are variable and overlap in the U.S. population, probably due to racial mixing. Compared to Blacks, the femoral shafts are bowed anteriorly in Whites and Mongoloid populations. Again there is considerable variability, but a markedly bowed femur is unlikely to belong to a Black.

Estimation of Stature

Estimation of stature from measurements of long bones has been the province of anatomists and physical anthropologists for many years. Most have been based on extensive research on World War II and Korean War casualties. The length of the femur is the most reliable basis for calculation of stature. Controversy has arisen recently concerning the accuracy of tibial measurements in Trotter and Gleser's data. The equations furnished for stature estimation from long bone measurements are based on direct measurement of the unfleshed bones.

Fleshed remains can be measured radiographically, but correction for magnification is essential. There are four ways in which this correction can be accomplished.

- Formula to determine correction factor for magnification.
- Use of an excessively long tube-to-specimen distance (72 in. or more) with minimal specimen-to-film distance (table-top grid cassette) will essentially negate magnification and was used in Maresh's seminal studies on long bone growth in children.
- Direct measurement by computed tomography. This is quick and easy if a CT scanner is readily available.
- Use of an old technique for measuring long bone to determine correct sizes for intramedullary nails in trauma cases or to measure leg length discrepancies in patients with gait disturbance or scoliosis. This technique depends on carefully collimated x-ray beams at conventional tube-object distances so that only the non-divergent central x-rays are used to expose the end of the bones. A partially radiopaque ruler included in the field of exposure can be used for direct measurement.

CONCLUSIONS

Radiology plays a very significant role in identification of livings as well as deads. In this way it is very significant in the field of forensic medicine.

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