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ANTHROPOLOGICAL ANALYSIS OF HUMAN SKELETAL REMAINS IN FORENSIC CASES

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Abstract

Anthropological analysis of skeletal human remains is an important aspect in determining the identity of the deceased, time of death and eventually the cause and manner of death. Given the fact that bones and teeth survive much longer in comparison to soft tissue, analysis of skeletal and dental characteristics is quite often a material in forensic investigation and is of substantial value in forensic casework.

Through interpreting the shape and size of the skeletal remains, four basic biological criteria such as skeletal age, biological sex, living stature and ancestry or racial affiliation could be determined, individualizing the deceased. Describing the unknown human remains in such a way becomes a feasible way to create a biological profile of the individual studied, and to enable law enforcement to narrow the range of possible missing identities. In the investigation of mass graves and identification of victims of mass disasters, forensic anthropology investigation is crucial.

In this article, some of the forensic cases of human skeletal remains anthropological investigation in our practice, are presented. A case where through analysis of the morphological and metric characteristics of the skeletal remains, biological sex, age, and stature of the deceased were estimated and a case where with analysis of bone fragments more than one individual present within the remains was determined. These analyses are important in medicolegal aspect.

Key words: forensic anthropology, human skeletal remains, biological profile.

Introduction

Forensic anthropology is the application of science of physical anthropology to the legal process. Its task is to identify human remains estimating age, sex, ancestry, stature, cause and manner of death within the medicolegal domain. In this branch of anthropology there are subdivisions such as forensic odontology and forensic radiology as well as forensic genetics.

Once the remains have been determined as human, it is important to define their identity. Skeletal remains are with medicolegal importance if the time of death can be estimated to be within 60-70 years. Very old archeological skeletal remains are not of forensic concern. Making difference between archeological bones and recent bones is quite easy as they have different appearance and morphology.

When analyzing human bones, forensic expert determines whether the bones belong to one individual, or the bones come from a number of individuals. Knowing the number of skeletal bones in a human, presence of extra set or any bone indicate that there are more than one individual present. In such cases the minimal number of individuals present within remains should be determined.

When identifying one person, the anthropological profile of the person entails estimation of age, sex, ancestry and stature of the particular individual through interpretation of skeletal shape and size of the bones. Unique characteristics such as congenital malformations or medical interventions previously recorded or known to the relatives of the deceased are of significant help in achieving a positive identification. Likewise, exclusion of the identity can be easily done if the antemortem information is contradicted by the profile of the remains.

Age estimation is usually more accurate in a younger individual and decreases as the individual gets older. In adult remains, age determination includes analyses of biological changes that take place throughout life.

Analysis of the obliterations of the cranial sutures are helpful when considered together with other age indicators. The sutures between cranial bones ossify at separate times during life, but there is an individual variation. This age determination method is not reliable, and it can provide approximate estimation in decades. The spheno-occipital suture on the skull base is useful for aging young adults as fusion is completed between the age of 20 and 25. According to published data, fusion of sagittal suture occurs at the age of 35, followed by coronal suture at the age of 38-41, while lambdoid suture closure occurs at the age of 47-50 [1]. According to other authors, closure of lambdoid suture is by the age of 37-44 (2). Closure of the occipital-mastoid and parieto-mastoid suture begins at 60-65 and is completed by the age of eighty. Age in adult remains can be estimated from the dentition based on pattern of occlusion wear and attrition, but it is an unreliable method [3,4].

Assessment of changes in the spongy bone structure of the upper end of the humerus is one of the commonly used methods of age estimation. It is based on the estimated correlation between atrophy of the spongy structure within the upper end of the humerus and the chronological age [5].

Sex-distinguishing characteristics of the skeleton are dependent on the existence of sexual dimorphism. In sexual dimorphism, from a morphological point of view the most dimorphic characteristics are identified in the pelvis and skull [6,7].

Metrical features of the hip bone also assist in sex assessment [8].

The pelvis in general, particularly pubic bones have been considered the best source of information for determining the sex of an unknown individual [9]. The modifications that occur in the pelvis at puberty provide a more reliable estimate of sex than cranial measurements.

Female pelvis is wide and shallow, gracile and smooth with wide and rectangular body of pubis and wide subpubic angle, while in male pelvis, it is high and narrow, rugged with marked muscle attachments with narrow subpubic angle. Factors that contribute to sexual dimorphism in the cranium are many. Some of them are as follows: general size of the cranium which in female is small, architecture of the bones is smooth, supraorbital ridges and mastoid processes are small to medium, frontal eminences large, parietal eminences large and in male all these characteristics are opposite to the described ones in female cranium. Orbits in female are round with sharp margins, but in male are square with round margins. In males, the nasal aperture is higher and nasal bones are larger. Some authors in their research found that glabellar and supraciliary regions, and mastoid process and the nasal region are the most sexually dimorphic traits of the cranium [10].

The mandible in males is robust, larger and thicker with greater body height and broad ramus, and gonial angle is less obtuse (less than 125°), the condyles are larger and the chin is square, in contrast to V-shaped chin in females [11].

Estimating living height of an individual from skeletal remains is a routine practice in forensic anthropology.

Different principles have been applied for stature estimation from the skeleton. Due to the fact that skeletons found at the crime scene in most of the cases are not complete, forensic experts use mathematical models or formula to calculate the stature. In this model the height of the body is estimated by using equations originally developed for this purpose by measuring the length of long bones of the lower limb with osteometric board, since they are the most important component of the height. It is observed that the relationship between the mean stature and the mean length of the femur appear to be pretty stable around the world. The reversed relationship is used to estimate the stature from the length of the femur, based on the stature/femur relationship of 3,78 for males and 3,74 for females (multiplication factor) [12].

It is worth mentioning that the prediction of the stature is affected by sex and racial factor. When the preferred skeletal element (femur or tibia) is not present within the remains, stature could be estimated from other long bones but with less accuracy. Except for this mathematical model, there is an anatomical model for stature estimation and as it is summarized in some review articles [13], the anatomical method provides better estimate of the stature, but a complete skeleton needs to be available.

Analyzing signs of bone trauma i.e. gunshot wounds, sharp wounds or fractures is in the scope of forensic anthropology [14].

Trauma seen on the skeletal remains falls into three categories: antemortem, perimortem and postmortem. Antemortem includes injuries obtained during life and evidence of healing usually exist. Perimortem trauma are injuries acquired around the time of death and often contribute to the cause of death. Postmortem trauma is the one sustained after death, usually by environmental or animal action. Usually, the remains analyzed have an extended postmortem interval in which carnivore activity or geological processes should be distinguished from perimortem trauma. Antemortem injuries or surgical implants may assist in identifying an individual.

Important question that needs to be addressed in forensic investigation is the time since death [15]. By estimating the time since death of the unknown victim, the number of missing persons that could be considered for comparison is narrowed.

Taphonomy, the study of postmortem processes which affect the condition of death organism, such as the effect of scavenging, natural dispersion, and the physicochemical influence of the environment on the bones, play a crucial role in estimating the time since death. As soft tissue decomposes and is lost into the environment, the body will skeletonize, exposing cartilage and bone tissues. The subsequent loss of organic substance within the bone has a much longer timeframe on average than soft tissues loss. The state of preservation of human remains and development of postmortem processes is in correlation to postmortem interval, but it is also influenced by environmental factors, and the place where the remains are found, on the surface or buried.

Forensic anthropology examination through practice

Case 1*:* After a man has reported to have found a human skull near his house, together with the inspectors from the department for missing persons, we went at the crime scene and after detailed examination of the place and the surrounding, many bones from human skeleton were found and collected. While examining the bones in the autopsy room (Figure 1), on the long bones of the lower limbs we found some remains of soft tissue with saponification. Also, there were dry residues of muscles on the base of the skull and in the left orbital cavity (Figure 4).

Part of the right hip bone that joints with the pelvis was replaced with metal surgical implant (Figure 2). There were no perimortem injuries on the skeleton except on the eleventh and twelfth right ribs. Through the anthropological analysis after reconstructing the skeleton with present bones, the main task was to make a biological profile of the dead person by estimating age, stature and biological sex. Age was estimated by obliteration of the sutures of the skull and analysis of the degree of atrophy of spongy material in the upper part of the humerus, which was almost absent, suggesting older age, above 70. All sutures except for the sutures of the mastoid were obliterated. So, the estimated age was around 80 ±10 years. Biological sex was determined using morphological characteristic of the skull (small, smooth bones, supraorbital ridges and mastoid processes were small, frontal eminences large, orbits were round with sharp margins, nasal bones were small (Figure 3 and 4). Gonial angle of the mandible was obtuse 135°. All these morphologic and metric characteristics indicated a female. Stature was calculated by multiplying the length of the long bones with multiplication factor 3,74 for female and the calculated height was 163 cm. Presence of the soft tissue with saponification on some parts of the bones indicated postmortem interval od 4-6 months if the body had not been buried and was under environmental influences.

Figure 1 and 2. Human skeleton with some bones missing. A surgical implant is noticeable on the right hip.

Figure 3 and 4. Lateral and frontal view of female skull where the most important factors that contribute to sexual dimorphism in the cranium may be seen. The presence of remains of soft tissues in the orbits suggest recent time since death

Case 2: In the second case, forensic anthropology analysis of multiple bone fragments was carried out. These bone fragments were excavated from a grave in the house yard while digging in the yard for construction purpose. In this expertise, first of all we determined that bone fragments recovered are human. All bone fragments (fragments of long bones, fragment from the skull, two mandibles with few teeth, part of one upper jaw with teeth, vertebre, ribs, sternum, scapula, few small fragments from the pelvic girdle bones and from clavicle) were recorded and anlyzed (Figure 5).

Figure 5. Human bone fragments.

According to the number of even bones from the same side of the body, and two mandibles, it was determined that the minimal number of present individuals in remains are two. In the estimation of biological sex, only characteristics from the mandible were used as bones from the pelvis were missing (only few small fragments). Gonial angle of both mandibles were obtuse 125° and 126°; chin of the both lower jaws was V shaped, and the bodies of the bones were small, suggesting female mandibles (Figure 6).

Figure 6. Parts of two different mandibles.

Concerning the age determination in this case, due to presence of only bone fragments it was not possible to determine the skeletal age of the individuals, but we aproximately estimated dental age. On both mandibles there were seven alveolar fossa. Teeth on one mandible were abraded with flat occlusal surface suggesting that this person was middle-aged, but on the other mandible and on the upper jaw teeth were with pit and fissure morphology, suggesting a young individual. Stature was not possible to be determined because not a single intact long bone was present within the remains. Perimortem injuries were not found. All bone fragments were without soft tissue, dry and light, morphologicaly changed, suggesting post mortem interval of more than 70 years.

Discussion

Human remains especially those skeletonized, burned, buried, disarticulated and scattered are quite difficult to recognize, and are complicated to recover. In such cases, forensic expert activities encompass many outdoor tasks such as locating remains to maximase recovery if possible, differentiate ante-, peri- and postmortem trauma or other modification of remains, and resolve taphonomic issues in context of events of death and subsequent fate of the remains.

Antrophologic analysis of the skeletal remains entails estimating the age, sex, ancestry and stature of the particular individual through interpreting the skeletal shape and size of the remains. Particular characteristics such as deformations or surgical intervention, or unique anatomic characteristics can help in achieving a positive identification.

In the first case anthropological profile of the individual by determining age, stature, and biological sex from the remains, and determining the time since death narrowed down the number of missing persons for comparison. Positive identification was achieved based on surgical implant and was approved with DNA analysis.

In the second case minimal number of present individuals in skeletal remains was determined. This is of great importance not only in mass disaster situations, but also in common graves and criminal investigations, as well as in civil claims. Estimating that skeletal remains are older than 70 years, this skeletal material was not of medicolegal significance and was not a subject of further investigation.

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