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Review Article

Victim identification through skeletal remains: A review

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ABSTRACT

Investigative authorities use forensic anthropology to examine human skeletal remains in order to identify unidentified human remnants. Anthropology alone is the study of man, but also includes culture, language, and physical remains of humans. Forensic anthropology is used to help with the recovery of human remains and to interpret trauma. Asian, African, and European people, as well as the living and the dead, are all of interest to anthropologists. Anthropologists are also fascinated with a wide range of human characteristics, such as their technology, family dynamics, cultures, and linguistic. Forensic otology is a branch of forensic anthropology. The field began in the 19th century. Mathieu or fill published a textbook on measurements of arm bones in 1835. E.A Bertillon proposed an anthropometric system for personal identification in 1885. A branch of physical anthropology is forensic anthropology. In this analysis, criminal cases are solved using skeletal analysis and other archaeology methods. Experts in forensic anthropology focus on examining hard tissues like bones. They are also skilled at locating and recovering buried bodies. In this review we are going to discuss about the ways of identification of a victim by found skeletal remains

1. Introduction

Identification is the process of confirming a person's individuality based on specific physiological characteristics. Certain facts, such as race, age, sex, size, etc., are determined in partial or incomplete identification. While nothing is known about other characters. Identification is required for recently deceased individuals, living individuals, decomposing bodies, mutilated and burned bodies, and skeletons. In criminal cases involving people who are suspected of assault, murder, rape, etc., the exchange of newborn babies in hospitals, impersonation, etc., it is necessary. The doctor should record at least two identification markers in all medical records, including those involving marriage, inheritance, passports, insurance claims, contested sex, missing persons, etc. The doctor should confirm the noted identification signs in order to identify the accused in court.

Identification is to identify an individual, and in the case of the deceased, it is to "identify the individual by giving an appropriate name such as a birth name to the human remains." Attempting to identify unknown bodies is a constant challenge for law enforcement and also requires the resources of the most experienced forensic professionals.

Identifying victims is paramount in fatal incidents, regardless of the cause or number of victims. Background investigators have the humane and legal responsibility to identify each individual, if possible, so that they can be returned to their families.

2. Literature Review

Blau et al. in their study focused on the disaster victim identification by the use of forensic anthropology. The worst bushfires Victoria has ever experienced, in southeast

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Australia, tragically claimed lives and destroyed both public and private possessions. In this work, forensic anthropology is used to understand the evolution of the identification process. Within two days of the tragedy, forensic teams comprised of pathologists, deontologists, and anthropologists assembled at the institute to begin the process of identifying the bodies. This study explains history of the identification process utilizing forensic anthropology. Forensic teams made up of pathologists, deontologists, and anthropologists gathered at the Victorian Institute of Forensic Medicine in Melbourne within two days after the catastrophe to start the process of identifying the bodies.[1]

Simultaneous vibration spectroscopic methods (invisible, Laser, and frictional neutron diffraction) have been utilised to investigate the simultaneous burning of bone fragments with and without air at temperatures ranging from 400 to 1000 °C. The examination of human skeletal remains heated in an oxygen-free environment by the INS is new.[2]

This article provides an outline of the potential contributions forensic anthropologists could provide to DVI, putting particular attention on how recent developments and experiences in the field have widened these possibilities. This paper assesses the value of forensic anthropological expertise at calamity sites and morgues as well as discusses how forensic anthropologists might use imaging in DVI projects. Techniques for DNA analysis sampling are also described, particularly in disasters with a lot of fragmented remains.[3]

With DNA profiling, victims can be recognized, their remains can be reunited, and leads for investigations may be offered at a cheap cost and with a high level of discrimination. In major disaster occurrences, DNA profiling has become the industry standard for crime investigation. Recent developments in a wide range of new genetic markers and genotyping techniques now enable the capability to extract as much genetic information as possible from a sample, making sure that recognition is not simply exact however also feasible in situations where the material is debased or constrained.[4]

Standards for identification should be based on concordance of ante mortem and post-mortem data from at least one primary identifier, according to the INTERPOL DVI Manual. Only a small percentage of pieces will give an additional (confirming) primary identifier, such as odontology or fingerprints, in the case of fragmented remains, with the majority of matches relying on DNA. Even though the majority of jurisdictions only require a single main identity, it is best practice to confirm that identification with any secondary identifiers that are accessible, such as similar material items (such as clothing, tattoos, or crime scene context).[5]

2.1. Identification of person by skeletal remains

Blau et al. and Black et al. established that giving anything a name that makes it identifiable and recognizable is the process of identification (Black 2007). Giving the correct name to human remains is necessary for identification in forensic and archaeological situations, even if it may be important in situations affecting the livelihood. It may be necessary to demonstrate the identity of a deceased individual in cases of unexpected natural death, murder, suicide, or accident. Deaths resulted from political, regional issues and situations involving large-scale disasters. Stone et al. Bogdanowicz et al. Clark established that the hunt for historical people has also received considerable attention. Unidentified human remains with questionable identification can be found in the majority in medical examiners' offices.[6]

In contemporary forensic identification, postmortem discoveries are compared to ante mortem records, such as fingerprint, X-ray, and DNA profiles. Unidentified individuals without initial identification are less frequent. In these situations, a biological profile is required to direct the medical inquiry to the preliminary list of individuals. The deceased's age at death, gender, ancestry, height, and any distinguishing characteristics that would have been obvious to family and friends, like the presence of dental braces, healed or healing fractures, amputations, skeletal deformities, and other medical and abnormal conditions in the bones and teeth, are all included in the biological profile. For an investigation to succeed in identifying a subject, an accurate biological profile produced by a qualified forensic anthropologist is essential.[7]

To determine the biological sex of the remains and whether the two sets of bones were from the same person, DNA analyses were ordered. The samples gathered included swabs of soft tissue, bone, and nails. DNA amount and quality varied depending on the kind of sample, with metacarpal bone and swab lysates producing the best results. DNA analysis revealed a male sex, indicating cognitive bias may have been present during the first sex assessment process.[8]

For both legal and humanitarian reasons, it is crucial to identify any extensively decayed or severely damaged skeletal human remains. Various tools, including anthropological and genetic investigations, can aid in the identification procedure. The effectiveness of genetic analysis of skeletal remains over the past ten years has been largely attributed to advancements in DNA extraction and posterior analytic methods. The low quantity and deterioration of DNA collected from poorly kept materials, in particular, impact the results of such analysis despite these advancements. Currently, there is still no extensive knowledge of the postmortem kinetics of DNA degradation. Taphonomic studies can therefore play a key role in the reconstruction of the postmortem transformations

undergone by skeletal remains and subsequently DNA.[9]

The postmortem dynamics of DNA breakdown are currently not well understood. Therefore, taphonomic investigations can be crucial in reconstructing the postmortem changes that skeletal remains and later DNA underwent. The idea of DNA-typing skeletal remains is of great interest in both anthropology and forensics. Even bones that are 5,500 years old can have trace amounts of DNA and the polymerase chain reaction (PCR) can frequently be used to amplify human mitochondrial DNA sequences from such DNA. However, it is quite challenging to exclude contaminated material considering the sensitivity of PCR.[10]

Skeletons whose identities and causes of death are unclear or in question are the focus of forensic anthropologists. Experts in forensic anthropology examine people whose remains have been extensively burned, decayed, mummified, or reduced to skeletonization. The primary source of information about an unidentified person is the data acquired from the skeletal elements. It may be necessary to ask forensic anthropologists to explore the area for any remains and help restore them.[11]

An investigator can frequently respond to a variety of queries using forensics, including: Are the remains human or non-human, are they the remains of one person or a combination of people, How long ago was the death, After death, was the body disturbed? What is the person's gender, age, and race what led to the fatality, Was it a homicide, suicide, accident, a natural death, or is the cause still undetermined? Was there anything unusual about the person's anatomy, any disease or old injuries, could their height, weight, and figure be estimated, and could their facial features be recreated?.[11]

2.1.1. Human or non- human

In forensic and anthropological situations, it is crucial to identify unknown skeletal remains as either human or non-human. Traditional morphological techniques for identifying bone species, however, are arbitrary or laborious. Here, we employed chemometric techniques and Fourier transform infrared spectroscopy (FTIR) to distinguish between the spectral characteristics of both human and animals bone. Fresh, cooked, and decomposing bones were used in this investigation to as closely resemble actual forensic conditions as feasible. Pig bones were shown to be more responsive to extrinsic and extrinsic variables than the other species included in this paper, according to the results of principal component analysis (PCA). In order to examine postmortem alterations, pig bone may not be an appropriate representation of human bone. More significantly, score plots of the PCA results failed to distinguish between cooked and decomposed bones while clearly separating fresh human and non-human bones with only a little overlap. The Partial Least Squares Discriminate Assessment classification accuracy was then assessed using internal and exterior validation, producing values of 99.72 and 99.53%. The inorganic component (carbonates and phosphates), which can be reasonably stable throughout numerous conditions, was the primary cause of the spectrum variation, according to PCA and PLS-DA loading plots. Therefore, our results indicate that FTIR spectroscopy has tremendous promise in true forensic cases with natural surroundings and could be a useful tool to help identify the species of bones.[12]

2.1.2. Sex

It incorporates frontal sinus dimensions as well as a constellation of six features in the anatomy of the skull and mandible. Anthropologists frequently use the physical characteristics of the skull and mandible to determine gender (Sweet, 2001). Williams and Rogers discovered that several characteristics of the skull and mandible could accurately identify sex in 96% of cases.

In forensic examinations, whether in legal issues involving living people or in the identification of mortal remains, determining the gender of a skull is crucial. The purpose of this work is to develop a skull-based gender estimation model in the Chinese population as a scientific guide for forensic anthropology and medicine applications. We selected the front bone of the skull and its upper orbital rim as the research objects, and we provided the technique for objectively estimating the gender of the skull using the wavelet transform and Fourier transform. Wavelet transform and Fourier transform were used to quantify the supraorbital rim and frontal bone, and then SVM was used to classify the retrieved features and test the model. According to the experimental findings, the accuracy rates for men and women are higher than those for morphological and measuring approaches, at 90.9% and 94.4%, respectively. The method has a better accurate rate and more theoretical support than more conventional approaches, and it is also more objective. The frontal sinuses' size the bones of the face and skull include air spaces called sinuses that are mucous membrane-lined. The frontal sinuses are located between the inner and outer layers of the frontal bone. The frontal sinuses are absent at birth and develop fully at age 8 when a person reaches puberty. The frontal sinuses are important sex identifiers because of their unique variances in size, symmetry, and structure. Frontal sinus measurements are a helpful aid in sex discrimination, according to Uthman et al., the evolvement of frontal sinuses and frontal measurements using spiral tomography of 90 patients. They also reported that including skull measurements along with frontal sinus measurements improved accuracy.

According to Belaldavar there is larger mean value for the men's frontal sinuses in terms of height, width, and area.[13]

Table 1:

Traits	Male	Female
Size	Big	Small
Architecture of skull	Rugged	Smooth
Cranial mass	Deeper	Less deeper
Temporal ridge	More prominent	Less prominent
Supraorbital margin	Round and dull	Sharper
Zygomatic bone	More pronounced	Less pronounced
Mandible	Squared	Rounded
Superciliary arch	Large and Pronounced	Smaller
Gonian	Flared	Less flared
Teeth	Larger	Smaller
Mastoid	Medium-large	Small-medium
Nasal aperture	High, thin sharp margins	Lower, Wider rounded margins
Mandible gonial angle	Less obtuse	More abtuse

According to Humphrey et al., alterations in the mandible bone were appropriate for sexual dimorphism and may be utilized to identify a person's sex. The biggest morphological changes are in the mandibular condylar and ramus, which show the gender differences. For the dimorphic portion of the bones, it is vital to locate trustworthy differential analytical techniques. Molecular, measured, and morphological factors were used by the researchers. Visual and observable morphological parameters are available. Metric parameters, on the other hand, are trustworthy, repeatable, and based on measurements of bone fragments. Skeletal measurements have been found to be helpful in identifying gender features in recent investigations. Finding trustworthy discriminative analytical techniques for dimorphic bone fragments is thus important.

Other morphological metrics, including gonial angle, shoulder length and width, were described for the mandible. Researchers have been debating the validity of these metrics at the same time. There is conflicting information in the literature regarding the dimorphic characteristics of various criteria utilized in prior jaw studies. Furthermore, it is generally recognized that different populations have diverse skeletal characteristics. This is why each population has its own distinct standards for evaluating gender.[14]

2.1.3. Stature

A person's stature is their height when they are standing straight. Figure estimate is preliminary research used to identify unidentified human remains. The most typical estimations of stature are generated from long bones in situations where identification must be performed based on skeletal remains. These are predicated on the idea that stature and various long bones are favourably connected. There are indexes linking the odontometric parameter with the cranial parameter, often cited in the field of prosthetics. According to some other authors, there is a relationship between the combined mesiodistal width of the anterior maxillary teeth and head circumference.

The practical method currently used to estimate body shape uses measurements of the long bones (humerus - humerus, shaft, ulna and leg bones - femur, tibia and fibula) because there is a linear relationship between the length of these bones and the total by growth an individual. The more long bone measurements obtained from an individual, the more accurately their stature will be estimated. Muller (1935) provided a method of reconstructing the figure from fragmentary remains long ago bones. This is mainly done by measuring the long bones and then comparing the measurements with regression equation based on a graph or using a multiplying factor. (Character = Maximum long bone length x multiplication factor).[15]

2.1.4. Age

By looking at the biological changes that happened during human life, a forensic anthropologist can fairly estimate a person's age at the time of death. The examiner can determine with the greatest degree of accuracy when teeth erupt, bones expand, and epiphyses, or growth plates, form and unify. Another sign of ageing is when the cranial sutures in the skull are closed. After this period of growth, between the ages of 25 and 30, estimating age becomes more challenging and is dependent on skeletal degeneration. Without age information, the biological profile of unknown persons cannot be fully reconstructed. The biological profile of unknown individuals cannot be properly recreated in the absence of age information. Forensic anthropologists use time-related skeletal markers for bone deposition, remodeling, and desorption to establish an individual's age.

From a military standpoint, the bulk of these people were male and in the younger age range of 17 to 25. Later, researchers looked into the age-related changes seen in female pubic syphilis. The abnormal wear and tear in the pubic bone region caused by delivery is one of the challenges women encounter. First, it is not advised to use male standards to estimate the age of the female symphysis, and vice versa. Second, anomalies on the female symphysis induced by parturition or non-parturition generated greater variability.[16]

Even though this article primarily focuses on the skeletal remains of those who have passed away, some court cases call for an estimation of the age of the living. Legal issues relating to child pornography, migration, the treatment of juveniles and adults accused of crimes, and the increasing age of missing people are all addressed in these cases. That most of these issues are related to specific notions of adult legal status as they apply to people without identification. The Study Team for Forensic Age Diagnosis, which was

founded in Berlin, Germany in 2000, has recently achieved substantial advancements in the procedure for figuring out how old a person is while they are still alive. This attentive committee considered age estimation factors, including moral considerations and the necessity of addressing the specific issue that was put out for resolution. The suggested procedure included a physical examination, a left-hand X-ray examination, and a dental examination that included X-rays or related photographs. Guo et al. highlighted that the degree of clavicle epiphysis union also provides significant information based on these recommendations. Important data was provided by Germany where 269 males and 248 females, ages 12 - 24, in a magnetic resonance imaging research. Using CT scan data, the suggested method was successfully tested in Turkey. A description of analysis techniques and associated legal difficulties is given by Schmeling.[17]

2.1.5. Race

Based on the obvious skeletal characteristics, there are three major anthropological racial groups: Negroid, which comprises individuals from Africa, Indigenous, and Melanesian descent; Mongoloid, which includes people of Asian, Native American, and Polynesian lineage; and Caucasian, which includes people from Europe, the Middle East, and East India.[18]

Metrical and morphological techniques used by forensic anthropologists to determine race are summarized. There are other studies that look at cranial morphological approaches, such as the oval inner ear window, which is more prevalent in Caucasians than Native Americans, or the form of the alveolar region, which distinguishes between Asian, African, and North American Indian groups. There is a listing of typical skull morphological characteristics. Additionally, metric methods were utilised to identify race from the skull. While multivariate discriminating functions for identifying blacks, whites, and Native Americans properly categorise 82.6% of males and 88.1% of females, regression equations developed from measurements of the skull base show accuracy of 70–90%. However, many researchers have turned to postcranial elements not only for use in support of cranial findings but also for use when cranial information is not available. Platykemia, deformation of the femur, and other morphological characteristics of the postcranial skeleton can be used to support racial determination. Consequently, a number of discriminating functions based on evaluations of the pelvis, femur, tibia, or composites of these structures, have been devised.[19]

Facial reconstruction may be crucial in cases when unidentified substances cannot be linked to a specific missing person and established methods of identification were unsuccessful. Facial reconstruction creates a new face on a skull using facial muscles and tissue of average thickness. The skull and bones provide information about gender, age, and race. The artist then constructs a new face on a skull using the information that was gathered regarding the tissue depth of v different races, ages, and genders. Although this method is not entirely precise, it has been very effective in forensic situations, aiding in the identification of the unidentified persons.

3. Conclusion

The purpose of this review paper was to identify the usage of anthropology in identifying a person by its skeletal remains. Based on the analysis conveyed, it can be concluded that there are many features of a person that can be determined by the obtained skeletal remains such as the person's sex, age, stature, race etc Identification of unknown skeletal remains, both human and non-human, is crucial in forensic and anthropological contexts. Recent developments in a wide range of novel genetic markers and genotyping procedures now provide the ability to extract as much genetic information as possible from a sample, assuring that recognition is not only precise but it's also possible in situations when the sample is deteriorated or limited.

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5. Conflicts of interest

There are no conflicts of interest.

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