
FORENSIC ANTHROPOLOGY AND ESTABLISHMENT OF HUMAN IDENTITY: DETERMINATION OF AGE, SEX, STATURE AND OTHER PHYSICAL CHARACTERISTICS

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ABSTRACT

Identification of a person through examination of physical, biological, and skeletal features is what forensic anthropology is all about, and this is one of the important cross-disciplinary branches of forensic sciences. Age, sex, height, and other characteristic features should be determined in order to identify deceased, decomposed, fragmented, burnt, or skeletal bodies. This data is useful for conducting crime investigations and identification procedure by law enforcement agencies and courts. The scientific methods of identifying age, sex, and stature in particular will be explored in this paper to explain the role and significance of forensic anthropology in human identification.

Technological advances of forensic identification such as DNA profiling, radiological scanning, three-dimensional visualization, facial reconstruction, and artificial intelligence techniques are considered in the paper as well. It examines the enhancement provided by modern technologies to classical anthropological methods and raises concerns regarding the admissibility, accuracy, and scientific reliability of these methods. Also with regards to Bharatiya Sakshya Adhiniyam, 2023, Bharatiya Nagarik Suraksha Sanhita, 2023, constitutional guarantees, and forensic evidence as ruled by the Indian courts, the legal and judicial framework of forensic anthropology in India is considered in this paper.

The methodological limitations, population-dependent variation, error margin, inadequate forensic infrastructure, lack of standardized protocols, and misidentification are some of the challenges that are discussed in the paper. The paper also considers human rights and ethical implications of biological, genetic, and biometric data. Finally, it makes certain recommendations related to standardization, population-specific databases, expert certification and training, better forensic infrastructure, court guidelines, and technological regulation.

Keywords: Forensic Anthropology; Human Identification; Age, Sex and Stature Estimation; Forensic Evidence; Legal and Institutional Reforms.

Introduction

An essential requirement for criminal investigations and judicial proceedings is the process of establishing human identity, particularly in instances where the human remains are unidentified, burnt, fragmented, decomposed, or skeletonised. In situations where the condition of the remains makes it impossible to make a proper identification, traditional identification methods such as ocular and documentation identification may be ineffective. This is where forensic anthropology comes in to help with providing a scientific means through analysing the skeletal and biological aspects.

Biological anthropology, forensic science, and the law are linked together by forensic anthropology, which is useful in making identifications of victims of disasters, identification of living people, age determination and analysis of distinctive skeletal characteristics. Forensic anthropological techniques supplement the fingerprinting, dental identification, and DNA profiling techniques and provide useful investigative and corroborative evidence even if they are not conclusive on their own. The condition of the remains, methods used, population variance and expertise of the investigator affect their reliability.

Advancements in technology have further changed the field of forensic identification. Identification evidence collection, analysis and comparison have been enhanced by technologies such as DNA profiling, radiographic imaging, three-dimensional reconstruction, biometric systems and artificial intelligence. Scientific validity, accuracy, expert interpretation and proper use of biological and biometric data are some of the concerns posed by their increasing use.

The field of forensic anthropology in India needs to be considered within the context of the greater system governing scientific and forensic evidence. The modern Indian laws governing evidence and criminal investigations are contained in the Bharatiya Sakshya Adhiniyam, 2023¹ and the Bharatiya Nagarik Suraksha Sanhita, 2023². Hence, scientific methods, expert investigators, appropriate institutional framework and constitutional provisions are necessary for the effective use of forensic anthropological evidence.

Considering all this, this essay considers forensic anthropology in relation to human

¹ Bharatiya Sakshya Adhiniyam, No. 47 of 2023, India Code (2023)

² Bharatiya Nagarik Suraksha Sanhita, No. 46 of 2023, India Code (2023).

identification, technological advances, Indian law and judiciary, scientific and ethical issues and the institutional and legislative changes required.

Forensic Anthropology in the Establishment of Human Identity

Among other important fields of study of forensic science, forensic anthropology is a science, which examines and determines the identity of human remains through their skeletal and biological characteristics. In case remains are skeletonized, charred, broken, decayed, or unsuitable for traditional identification, the field becomes especially relevant. The forensic anthropologist makes a biological profile of the unknown individual based on the careful examination of his/her available remains by evaluating age, sex, and stature of the person, as well as particular skeletal and biological characteristics. This process assists in the identification of an unidentified individual³.

The main basis of forensic anthropological identification is the determination of age, sex, and stature. While the sex is usually determined based on the presence of sexually dimorphic features in pelvis and skull, the age is estimated according to development and degenerative changes in bones as well as other biological clues. Anthropometric and statistical methods allow estimating stature based on measurements of long bones and other parts of the skeleton. However, the reliability of these estimations depends on the condition of remains, examined skeletal part, population of reference standards and the methods used.

In addition, besides age, sex, and stature, forensic anthropology may consider peculiarities of the skeleton, including healed fractures, pathological disorders, and rare anatomical characteristics. If they may be compared to ante-mortem medical or radiologic records, such characteristics may provide additional information. Therefore, anthropological analysis may provide important confirmation of identity, especially in case the traditional means of identification are unavailable or uncertain⁴.

In the context of India, where the identification of unidentified human remains may arise in cases of criminal investigations, natural disasters and other situations, where the identity of the

³ Hans H. de Boer et al., Strengthening the Role of Forensic Anthropology in Personal Identification: Position Statement by the Board of the Forensic Anthropology Society of Europe (FASE), 315 Forensic Sci. Int'l 110456 (2020), <https://doi.org/10.1016/j.forsciint.2020.110456>.

⁴ Niels Lynnerup, Forensic Anthropology and Human Identification, 19 Scandinavian J. Forensic Sci. 16 (2013), <https://doi.org/10.2478/sjfs-2013-0005>.

deceased person is not known, the importance of forensic anthropology becomes especially topical. The application of biological profile, age determination, estimation of sex and stature, disaster victim identification and other methods of anthropological analysis is demonstrated by the studies on forensic anthropology in India. However, scientific validation, trained forensic specialists, and appropriate population-specific reference standards are needed in order to make these methods efficient. Forensic anthropology's contribution to the human identification will become stronger due to the creation of reliable Indian population databases⁵.

Therefore, the forensic anthropology cannot be seen as an independent tool, but rather as an important part of multidisciplinary approach to the human identification. While taking into account limitations in methodological aspect and population diversity, the results of forensic anthropology can complement other identification approaches and provide important leads for the investigation. Therefore, scientifically validated methods, appropriate reference standards, and professional interpretation of anthropological evidence are required for the efficient usage of forensic anthropology.

Technological Developments in Forensic Identification

The evolution of technologies that improve the processes of gathering, collecting, analyzing, and interpreting evidence resulted in a revolutionary change in forensic identification. Modern forensic research uses many technologies, including digital technologies, artificial intelligence, biometric systems, 3D scanning, radiology, genetic identification, and extended reality. Such technologies are helpful for conducting scientific research on crimes due to the possibility to create more detailed descriptions of the crime scene and process of evidence and increasing the level of accuracy of identification⁶.

Nowadays 3D scanning and modelling are extremely important technology in the field of forensic inquiry. It is possible to reveal spatial relations and save information for further analysis by creating digital 3D models of the crime scene and evidence with the help of 3D laser scanning. At the same time, in order to create a picture of large and complicated crime

⁵ Neha Baryah, Kewal Krishan & Tanuj Kanchan, The Development and Status of Forensic Anthropology in India: A Review of the Literature and Future Directions, 59 Med. Sci. & L. 61 (2019), <https://doi.org/10.1177/0025802418824834>.

⁶ Xavier Chango, Omar Flor-Unda, Pedro Gil-Jiménez & Hilario Gómez-Moreno, Technology in Forensic Sciences: Innovation and Precision, 12 Technologies 120 (2024), <https://doi.org/10.3390/technologies12080120w>

scenes, drones and other imaging technologies are extremely helpful, which decreases the necessity of repeated handling of evidence and increases the level of accuracy of documentation.

By creating the possibility to identify individuals based on physiological and behavioural characteristics, biometric technologies contributed to the development of forensic identification greatly. It is possible to analyse fingerprints, iris prints, voice, handwriting, geometric parameters of fingers and hands, locomotion, and other features with the help of computational systems. Thanks to such technologies as feature extraction, robustness evaluation, and feature matching, it is possible to process large amount of identifying data more effectively than using conventional methods⁷.

Due to the evolution of specialized technologies in the field of forensic medicine, the opportunities for identification and analysis became broader. To investigate evidence and human remains in a non-invasive way and in more details, modern forensic practice started using imaging and other technologies. Such developments improve conventional forensic practices because they allow extracting more information from evidence and improving the ability of forensic specialists to document and analyse the results.

Artificial intelligence, machine learning, and data-driven technologies are another important development in the area of forensic identification. These technologies are helpful for biometric identification, pattern recognition, and analysis of large data sets. By combining these technologies with forensic ones (biometric systems, digital evidence analysis, and automatic processing), it is possible to increase the speed and effectiveness of investigations. However, in order to guarantee that outputs of such technologies will be analysed by forensic specialists, their appropriate validation and scientific supervision is necessary⁸.

Modern forensic science in the Indian criminal justice system includes a number of scientific areas, including digital forensics, ballistics, toxicology, DNA analysis, and fingerprint testing. These areas support scientific analysis, evidence collection, crime scene investigation, and forensic evidence presentation. Consequently, technological development can contribute to the improvement of the evidentiary base of criminal investigations, but the successful implementation of these technologies requires appropriate infrastructure, standardisation,

⁷ *Id*

⁸ *Id*

qualification of specialists, and trustworthy protocols⁹.

To conclude, forensic identification became more digital, automated, and data-driven because of technological development, moving from mostly manual analysis. Biometric systems help with automatic identification, 3D technologies improve documentation and reconstruction, advanced analysis tools and artificial intelligence increase the capability of managing complex forensic data. Therefore, while keeping the significance of professional scientific interpretation, the implementation of these technologies may increase the level of precision, effectiveness, and reliability of forensic identification.

Legal and Judicial Framework Governing Forensic Anthropological Evidence in India

From the perspective of human identification in the legal process, forensic anthropology assists law enforcement agencies and medico-legal investigators in the evaluation of human skeletal remains as well as identification of biological characteristics of unidentified individuals. Notably, the discipline proves to be helpful not only in the identification of deceased individuals but also of live individuals, disaster victims, superimposition of photographs, face reconstruction, gait analysis, and age estimation when the required documents are unavailable. Thus, discoveries in the field of forensic anthropology may become relevant to criminal proceedings and other legal processes when identification of an individual or his/her biological characteristics is needed¹⁰.

However, the progress of forensic anthropology in India was quite slow. It follows from the literature that certified specialized programs and career opportunities for forensic anthropologists are still rare, and only a few Indian educational establishments incorporate forensic anthropology into forensic science curricula. From the legal point of view, the institutional position is quite crucial since the effective use of anthropological evidence in the legal system is possible not only due to scientific methods but also the existence of properly trained specialists who could apply and interpret those methods¹¹.

Thus, the bigger picture regulating scientific and expert testimonies becomes relevant to the

⁹ Prapti Kothari, *Exploring the Role of Forensic Science in Indian Criminal Justice System* (Sept. 7, 2023), <https://doi.org/10.2139/ssrn.4565177>.

¹⁰ Neha Baryah, Kewal Krishan & Tanuj Kanchan, *The Development and Status of Forensic Anthropology in India: A Review of the Literature and Future Directions*, 59 Med. Sci. & L. 61 (2019), <https://doi.org/10.1177/0025802418824834>.

¹¹ *Id*

evidentiary value of forensic anthropology. The characteristics such as age, sex, stature, and other individual features may be determined with the help of anthropological analysis, and its findings may be considered along with the rest of forensic evidence. In order for anthropological findings to be effectively considered and evaluated during court procedures, the development of forensic anthropology in India requires an appropriate professional institution, institutional infrastructure, and qualified professionals.

Thus, it is necessary to understand the Indian legal system simultaneously with the development of expert testimonies and forensic technology. Besides scientific reliability, forensic anthropological evidence should be properly considered by the legal system and analysed by specialists. The low level of institutional development of forensic anthropology revealed in Indian literature highlights the need to promote the integration of forensic anthropology with forensic investigation and justice administration.

Challenges in Forensic Anthropology

There are multiple institutional and professional obstacles to forensic anthropology despite the importance of the science in human identification. There are quite a few obstacles in becoming a forensic anthropologist such as high educational requirements, lack of professional employment opportunities, financial obstacles, and a lack of practical training options. All these obstacles might negatively affect the development of a qualified and diverse forensic anthropology workforce¹².

One of the major obstacles that exist is related to the scientific limitations of the use of skeletal evidence. Variability of human populations, variability among reference samples, and the condition of the remains used for investigation impact the accuracy of age, sex, stature, and other characteristics assessment. As a result, conclusions made by anthropologists always imply some degree of uncertainty rather than certainty. Thus, population-specific standards, adequate validation, and skilled professional interpretations are necessary for the choice and implementation of proper methods¹³.

The introduction of new forensic methods is complicated by the dynamic nature of forensic

¹² Sean D. Tallman et al., *Barriers to Entry and Success in Forensic Anthropology*, 124 Am. Anthropologist 580 (2022), <https://doi.org/10.1111/aman.13752>.

¹³ Douglas H. Ubelaker, *Issues in Forensic Anthropology*, in *A Companion to Biological Anthropology* 412–426 (Clark Spencer Larsen ed., 2010).

investigations. The professionals working in forensics should develop interdisciplinary skills and adapt to rapidly developing scientific methods because of the progress of biometric and computer-aided forensic investigation, as well as more recent ones like digital evidence, trace evidence, and others. Proper training, technological infrastructure, and reliable professional standards are necessary for such development¹⁴.

Another major obstacle of modern forensic anthropology is ethics. This area works with human remains that can influence people's lives, families, and societies. In this way, ethical considerations exceed scientific precision and include questions regarding the handling and preservation of human remains, professionalism, historical injustices, and potential social implications of forensics. It is necessary to develop updated ethical standards in order to maintain the scientific and social responsibility of the discipline¹⁵.

Another problem of the professionals working with human remains is related to the diversity of human populations and the inadequacy of traditional classification systems. The simplified classification does not always cover the full spectrum of biological diversity and can be influenced by wrong assumptions regarding gender, sex, or ancestry. Consequently, the necessity of the development of methods taking human diversity into account becomes evident in order to avoid biases from the past and incorrect identification¹⁶.

Finally, there is another obstacle connected with the requirements of the practitioners and professional standards. The skills, training, and experience of the person applying the scientific method are as important for the credibility of the forensic anthropological evidence as the method itself. In this way, more precise standards regarding credentials, professional training, methodological consistency, and ethical behavior are needed for the further development of forensic anthropology.

These challenges demonstrate that the developments of identification methods alone will not be enough for the development of forensic anthropology. Institutional infrastructure, professional qualifications, ethical considerations, demographic diversity, scientific reliability,

¹⁴ gor V. Borysenko et al., *The Modern Development of New Promising Fields in Forensic Examinations*, 7 J. Forensic Sci. & Med. 137 (2021), https://doi.org/10.4103/jfsm.jfsm_66_21.

¹⁵ Donovan M. Adams et al., *A Conversation on Redefining Ethical Considerations in Forensic Anthropology*, 124 Am. Anthropologist 597 (2022), <https://doi.org/10.1111/aman.13753>.

¹⁶ Donovan M. Adams et al., *Shifting the Forensic Anthropological Paradigm to Incorporate the Transgender and Gender Diverse Community*, 3 Humans 142 (2023), <https://doi.org/10.3390/humans3030013>.

and proper training should develop simultaneously. Thus, overcoming these obstacles is crucial for the reliable assistance of forensic anthropology in human identification.

Legal and Institutional Reforms

Forensic anthropology needs to be recognised officially as a specialised branch of forensic science in order for the field to progress in India. Even though this scientific discipline has many applications in human identification, disaster victim identification, age determination, photographic superimposition, and identification of living and dead people, the development of forensic anthropology in India is quite limited. There are only a few educational establishments that incorporate forensic anthropology in their forensic science curriculum, there are not enough job opportunities, and there are also only a few specialised courses at the moment. Therefore, the implementation of specialised programmes in forensic anthropology and the official recognition of forensic anthropology as a specialised professional discipline in the sphere of forensics are critical changes¹⁷.

The enhancement of career paths, professional training, and education is also very important. Accessible educational possibilities, organised training, effective mentorship, and clear career paths for professionals and students are critical factors for the development of forensic anthropology. To make sure that there will be a professional workforce that is diverse enough, institutions and professional organisations should make more efforts in terms of creating a training structure, mentoring opportunities, and career paths¹⁸.

There is also a need to provide an extensive ethical framework for forensic anthropology in India. Inspection, handling, and storage of the human remains, professional conduct, research procedures, and presentation of forensic results should be governed by ethical standards. Besides, these standards should consider the potential social impacts of forensic anthropology. Therefore, the forensic anthropologists should have enforceable and up-to-date ethical standards that are accepted in professional associations and regulatory bodies¹⁹.

The use of state-of-the-art forensic infrastructure and technology systems is another critical factor in the process of institutional transformation. Forensic documentation, analysis, and

¹⁷ *Id*

¹⁸ *Id*

¹⁹ *Id*

identification of evidence can be significantly improved by 3D scanning and modelling, artificial intelligence, biometric technologies, genetic identification, radiological methods, and digital forensic technologies. Therefore, there should be an appropriate technological infrastructure and experts who work with it in Indian forensic institutions. New technologies should be introduced using scientific validation and proper regulatory control.

Integrated biometric and identity systems can also enhance forensic capabilities. Using computational systems for feature extraction, robustness estimation, and feature matching, biometric technologies allow identification based on physiological and behavioural characteristics such as fingerprints, face, iris, voice, and handwriting. Therefore, an increased use of biometric technologies and integration of these technologies with forensic databases and investigative organisations can reduce the necessity to use manual identification methods and make the process faster and more effective²⁰.

Finally, the establishment of national standards for methodology, training, qualifications of the experts, and quality assurance should be the aim of forensic anthropological reform. Even though accreditation and constant professional development of experts may improve the reliability of expert opinions, standardised procedures may reduce inconsistencies during forensic testing. Collaboration between forensic anthropology departments, forensic laboratories, medical establishments, law enforcement agencies, and universities can promote research, professional development, and integration of anthropological evidence into the criminal justice process. These changes will make it possible to turn forensic anthropology in India into a professionally recognised, ethically responsible, and scientifically valid field.

Conclusion

For situations where unidentified, decomposed, fragmented, burned, or skeletonized bodies are found, forensic anthropology is essential for identifying whether a body is of human origin. Identification of the age, gender, stature, and distinctive skeletal characteristics aids in formulating a biological profile. Its efficiency is amplified by the combination of forensic techniques such as DNA analysis, fingerprint examination, and dental identification.

Many improvements have been brought about to forensic identification through advancements

²⁰ Monika Saini & Anup Kumar Kapoor, *Biometrics in Forensic Identification: Applications and Challenges*, 1 J. Forensic Med. 108 (2016), <https://doi.org/10.4172/2472-1026.1000108>.

in technology that include DNA analysis, biometric technology, radiographic imaging, 3D reconstructions, and artificial intelligence. Nevertheless, scientific validation, appropriate references, expert professionals, and safeguards against errors are needed for encouraging development in technology.

Professional standards and studies on a population level are also essential to enhance consistency and reliability in forensics evaluations. Ultimately, forensic anthropology can have a great impact on human identification and the criminal justice process if combined with expertise, accountability, reliable evidence, and human rights protection.