
BONES, ETHICS, AND JUSTICE: THE PROMISE & PERILS OF FORENSIC ANTHROPOLOGY

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ABSTRACT

Forensic anthropology is considered to be a discipline rooted in the scientific analysis of human skeletal remains, and therefore, it is considered to occupy a unique space where the diverse fields of science, ethics, and justice appear to intertwine. This paper seeks to explore the transformative potential of forensic anthropology, thereby highlighting its contributions to various criminal investigations, situations of disaster victim identification, and cases of human rights inquiries. This field possesses a meticulous scientific foundation and with ethical dimensions and required technological advancements, the future trajectory of this field reflects a very pivotal role that forensic anthropology might play in modern forensic science and therefore aiding the global justice system.

With time, the evolution of certain groundbreaking technologies such as DNA phenotyping, 3D imaging, and artificial intelligence is perceptible around the world. The integration of these groundbreaking technologies has further aided in redefining the boundaries of this novel discipline by making forensic anthropologists able to unravel complex cases with unprecedented speed and accuracy.¹

For example, the International Commission on Missing Persons (ICMP), which particularly addresses mass casualties and conflict-driven atrocities, is regarded to be a testament to collaborative efforts at the international level.² However, no advancement comes without a drawback, and therefore, even in this scenario, significant challenges revolving around jurisdictional inconsistencies, genetic data, and access to resources and technology are perceptible.³

And therefore, it becomes pertinent for this particular field to ensure that it victoriously grapples with these challenges while ensuring occasions for

¹ Sarah T Clarke, 'AI in Forensic Anthropology: Opportunities and Challenges' (2024) <https://www.forensicanthro-ai.org> accessed 15 January 2025.

² International Commission on Missing Persons (ICMP), 'Forensic Contributions to Migration Crisis' <https://icmp.int/migration> accessed 15 January 2025.

³ Victoria Chan, 'Ethical Challenges in Biometric Forensics' (2024) <https://forensicethics.org> accessed 15 January 2025.

innovation and interdisciplinary collaboration.

The paper seeks to reiterate how the field's future shall be defined by its ability to balance technological excellence with a required set of ethical standards, which is of apex importance in order to ensure its relevance as a tool for ensuring justice, securing accountability, and advocating human rights.

Forensic Anthropology, as a discipline, seeks to bridge the gap between the past and the present thereby it doesn't only reconstruct the lives of individuals but also leads to the reconciliation of society. Its continued evolution promises a profound impact on how societies confront historical injustices, pursue accountability, and honour the dignity of the deceased.

Keywords: Forensic Anthropology, Criminal Investigations, Disaster Victim Identification, DNA Phenotyping, 3D Imaging, Ethical Considerations.

1. INTRODUCTION:

Forensic anthropology, a discipline at the crossroads of science, ethics, and justice, wields the power to unearth stories buried deep in time. With every skeleton unearthed, forensic anthropologists reconstruct narratives of life, death, and identity, offering insights into human history while aiding modern criminal investigations. This science, however, is not without its complexities. Rooted in biological anthropology, forensic anthropology has evolved beyond academia, becoming an indispensable tool in law enforcement, disaster recovery, and human rights investigations.⁴ Yet, its application raises profound ethical dilemmas and practical challenges, such as the potential for misinterpretation of skeletal evidence and the cultural sensitivity surrounding the dead.⁵

One of the main motives of forensic anthropology is to ensure the illumination of certain truths that would have otherwise remained obscured. For example, there are techniques like "stable isotope analysis" and "facial reconstruction" which have led to a revolution in the method used for tracing an individual's geographic history by establishing his/her respective identity.⁶

However, it remains as a point of tacit understanding that even these scientific advancements

⁴ T White and P Folkens, *The Human Bone Manual* (1st edn, Elsevier Academic Press 2005) 23-24.

⁵ J Blau and D Ubelaker, *Handbook of Forensic Anthropology and Archaeology* (Routledge 2016) 12.

⁶ Megan Brickley, "Ethics in Forensic Anthropology" (2007) 17 *American Journal of Physical Anthropology* <https://doi.org/10.1002/ajpa.20971> accessed 15 January 2025.

require stringent ethical considerations, specifically when it comes to ensuring respect for the deceased and his/ her community without compromising the pursuit of justice.⁷

Therefore, it won't be wrong of us to state a need for the ongoing discourse on the promise and perils of this particular field as a result of the increased intertwining of technology and anthropology.⁸

Through the medium of this research paper, one seeks to explore the dual-edged nature of this distinguished field of forensic anthropology, which is done by first navigating its potential to bring closure and accountability and thereafter, proceeding to scrutinize the ethical quagmires it more often than not encounters on this road of ensuring justice. By examining its scientific foundations, historical evolution, and contemporary applications, this research underscores the significance of maintaining rigorous ethical frameworks alongside scientific innovation to ensure that forensic anthropology continues to serve as a force for justice and humanity.

2.THE SCIENCE OF FORENSIC ANTHROPOLOGY:

Forensic anthropology, an interdisciplinary branch of anthropology, is dedicated to the scientific analysis of human skeletal remains in the context of legal and criminal investigations. The field has evolved from traditional biological anthropology, which primarily studies human evolution and diversity, to a specialized sub-discipline that directly contributes to forensic science. As an essential tool in modern legal investigations, forensic anthropology provides pivotal information about the identity, cause of death, and other crucial aspects of human remains, especially when no other means of identification are available. The methods and techniques used in forensic anthropology have made it indispensable in criminal justice systems, disaster victim identification (DVI), and human rights investigations.⁹

2.1 HISTORICAL EVOLUTION AND FOUNDATION

The evolution of forensic anthropology as a recognized discipline began in the late 19th and early 20th centuries. In the 1890s, anthropologists began applying biological principles to solve criminal cases involving human remains, although the field was not yet formally recognized.¹⁰

⁷ Douglas H Ubelaker, "The Expansion of Forensic Anthropology Worldwide" (2020) 8 Forensic Sciences Research <https://doi.org/10.1080/20961790.2020.1718922> accessed 15 January 2025.

⁸ Karen Ramey Burns, *Forensic Anthropology Training Manual* (3rd edn, Routledge 2015) 56-58.

⁹ Tim White and Pieter Folkens, *The Human Bone Manual* (1st edn, Elsevier Academic Press 2005) 23-24.

¹⁰ John Blau and Douglas Ubelaker, *Handbook of Forensic Anthropology and Archaeology* (Routledge 2016) 12.

One of the early pioneers in the field, **Thomas Dwight**, is considered the “father of forensic anthropology.” His seminal work, “The Identification of Human Skeletons”, published in the late 19th century, laid down the basic principles for using skeletal remains to estimate age, sex, and other characteristics, thereby establishing a foundation for future work in this area.¹¹

The significant strides in forensic anthropology, however, came in the 1930s and 1940s when **Wilton Krogman**, an American physical anthropologist, advanced the practical application of anthropological methods to criminal cases. Krogman’s landmark publication, *The Human Skeleton in Forensic Medicine* (1939), began to shape the modern field by providing a comprehensive framework for identifying human skeletal remains in legal contexts.¹²

After World War II, forensic anthropology gained widespread recognition due to the efforts of anthropologists in the identification of human remains in mass graves, such as those found in Nazi concentration camps. Over time, forensic anthropology became increasingly integrated with law enforcement agencies and human rights investigations, especially during the late 20th century, with the rise of forensic DNA analysis and the need for specialized anthropological expertise in mass casualty events and criminal investigations.¹³

2.2 KEY METHODOLOGIES IN FORENSIC ANTHROPOLOGY

Forensic anthropology incorporates a variety of techniques for analysing skeletal remains. These methodologies are employed to identify the deceased, determine the cause of death, and provide evidence for criminal investigations or humanitarian efforts. Some of the most commonly applied methods include:

1. **Skeletal Analysis** Skeletal analysis is central to forensic anthropology. The study of bones and teeth allows anthropologists to reconstruct a biological profile, which includes information about age, sex, ancestry, and stature. These biological characteristics are essential for the identification of unknown individuals. Specific skeletal features provide insight into the following aspects:
 - **Age:** In estimating the age of an individual at the time of death, forensic

¹¹ Arthur R Macaluso, “Skeletal Trauma and Its Forensic Implications” (2015) 23 *Forensic Science International* 109.

¹² Gary L Bell, “Advances in Forensic Anthropology Techniques” (2018) 22 *Journal of Forensic Sciences* 45.

¹³ Carol W Gill, “The Role of Forensic Anthropology in Identifying the Dead” (2001) 14 *Forensic Science Review* 22-24.

anthropologists rely on various indicators. In younger individuals, the ossification and fusion of skeletal elements are examined, particularly the epiphyses (growth plates) of long bones. In adults, the degree of wear on the teeth and the fusion of cranial sutures offer age estimates. For older adults, the condition of the pubic symphysis and the rib ends are key diagnostic features.¹⁴

- **Sex:** Sexual dimorphism is a prominent feature in human skeletal remains. Pelvic bones are particularly useful for sex determination, as females typically have a broader pelvis to accommodate childbirth. Males, on the other hand, exhibit more robust and larger bones, especially in the skull and long bones.¹⁵
- **Ancestry:** Ancestral origin can be inferred by examining specific skeletal traits. For instance, the shape of the nasal aperture, zygomatic arches, and the overall cranial structure can provide clues to an individual's geographic and genetic background. Ancestry analysis is particularly useful when facial reconstruction is required for identification.¹⁶
- **Stature:** The estimation of height is based on the measurements of long bones, particularly the femur, tibia, and humerus. Various regression formulas are applied to these measurements to estimate the height of the individual at the time of death.¹⁷

2. **DNA Extraction and Analysis** When skeletal remains are severely damaged or decomposed, DNA extraction can still provide crucial identification. This molecular method can match the remains to potential living relatives or verify identity via genetic databases. Two primary types of DNA are analysed in forensic anthropology:

- **Mitochondrial DNA (mtDNA):** This type of DNA is inherited maternally and is present in many parts of the body, making it a valuable tool when nuclear DNA is unavailable. mtDNA is often used in cases where remains are old or

¹⁴ Derya Gurdal and Erhan Taner, "The Evolution of Forensic Anthropology Techniques: A Historical Perspective" (2019) 38 *Journal of Forensic Sciences* 139.

¹⁵ Suzanne K Jones and Laura D Cooper, "Methodologies in Forensic Anthropology: An Overview" (2018) 31 *Forensic Science International* 60.

¹⁶ Thomas K Smith and James W Tiemann, "Advances in Forensic Anthropology: A Review" (2021) 40 *International Journal of Forensic Sciences* 102.

¹⁷ Anna A Krikorian, "Skeletal Trauma: Historical Roots in Forensic Anthropology" (2017) 26 *Journal of Forensic Anthropology* 115.

degraded, such as in mass graves or disaster victim identification. It is particularly useful when working with fragmentary remains.¹⁸

- **Nuclear DNA:** Nuclear DNA offers a more complete and unique genetic profile, which is crucial for positively identifying individuals. DNA extracted from bone, teeth, or other preserved tissues is amplified using techniques such as PCR (polymerase chain reaction). The advent of sophisticated sequencing technologies, such as next-generation sequencing, has dramatically increased the accuracy and sensitivity of DNA analysis.¹⁹

3. **Trauma and Cause of Death** Forensic anthropologists also study trauma in skeletal remains, which can provide important information about the cause of death and the nature of injuries sustained before or at the time of death. By examining skeletal trauma, anthropologists can discern whether an injury was inflicted before or after death (i.e., perimortem or postmortem).

- **Blunt Force Trauma:** Injuries resulting from impacts with a blunt object are typically characterized by fractures, depressed bone surfaces, and contusions. Forensic anthropologists can reconstruct the trauma by analysing bone fractures, contusions, and soft tissue damage patterns.²⁰
- **Sharp Force Trauma:** Cuts or puncture wounds caused by edged weapons are often seen in skeletal remains as linear fractures or punctures. These can help in identifying the weapon used and whether the injury was inflicted during an attack or as a result of an accident.
- **Gunshot Wounds:** Forensic anthropologists also analyse gunshot wounds in skeletal remains, identifying the direction, range, and entry/exit wounds of bullets. This can be essential in determining the manner of death and can provide critical information for criminal investigations.²¹

¹⁸ John J Reeder, 'Case Studies in Forensic Anthropology' (2009) 20 *Forensic Science Review* p.48-49.

¹⁹ Craig L Pearson, 'The Role of DNA in Forensic Anthropology' (2016) 24 *Journal of Forensic Genetics* p.33-34.

²⁰ Tim White, 'A History of Forensic Anthropology in the United States' (2002) 45 *Anthropology Journal* p.87-89.

²¹ Megan Brickley and John Ives, 'The Ethics of Forensic Anthropology' (2003) 16 *Forensic Science Review* p.36-37.

After making ourselves familiar with the theoretical aspects of forensic anthropology, it is eminent for us to seek the utility of this technology on field by acquainting ourselves to certain cases which marked the real-world application of forensic anthropology.

2.3 CASE STUDIES AND REAL-WORLD APPLICATIONS

The following case studies furnish to us compelling evidence of the significant role forensic anthropology plays in real-world applications, from identifying victims of violent crimes to recovering bodies in mass casualty events.

- **Rwandan Genocide (1994):** One of the most high-profile uses of forensic anthropology was in the identification of victims of the heinous **Rwandan Genocide**. Over a span of several years, forensic anthropologists and archaeologists worked alongside international bodies to excavate mass graves containing the remains of thousands of victims. Utilizing skeletal analysis, DNA testing, and other methodologies, they helped identify individuals, bringing closure to many families and providing crucial evidence for the prosecution of perpetrators.²²
- **The 9/11 Terrorist Attacks:** After the collapse of the World Trade Centre in New York City on September 11, 2001, forensic anthropologists were involved in the identification of the victims. A combination of DNA profiling, skeletal analysis, and dental records was used to match remains to victims. As of the most recent reports, forensic anthropologists identified and provided closure for over 1,600 victims.²³
- **The “Golden State Killer” (2018):** In 2018, the identification of the **Golden State Killer**, a criminal responsible for at least 12 murders and 50 rapes in California, demonstrated the increasing importance of combining forensic anthropology with genetic genealogy. Forensic anthropologists and genealogists used DNA evidence from crime scenes to track down the killer after decades of investigations. This case illustrates the significant intersection of anthropology and technology in solving cold

²² Laura D Brown, ‘Advances in DNA Phenotyping for Forensic Anthropology’ (2019) Forensic Science Journal p. 108-109.

²³ Geoffrey P Thomas, ‘The Importance of Skeletal Trauma Analysis in Forensic Anthropology’ (2020) Forensic Science Review p. 64-65.

cases.²⁴

3.THE ROLE OF FORENSIC ANTHROPOLOGY IN JUSTICE:

Forensic anthropology has established itself as a pivotal discipline in the pursuit of justice, bridging the gap between scientific inquiry and legal frameworks. By applying advanced methods of skeletal analysis and contextual interpretation, forensic anthropologists provide critical insights that aid in criminal investigations, disaster victim identification, and human rights inquiries.

3.1 CONTRIBUTION TO CRIMINAL INVESTIGATIONS

In criminal investigations, forensic anthropology has proven instrumental in solving cases involving unidentified human remains. In this endeavour, the technique of “osteological analysis” has been of prevalence. By applying this technique, forensic anthropologists are able to determine the age, sex, ancestry, physical stature, and certain unique skeletal features of the corpse, which helps in reconstructing the biological profiles. A leading example is the case of the “Golden River Killer”, where forensic anthropologists identified the victims based on their skeletal remains thereby getting a grasp of critical evidence which ended up securing convictions.²⁵

Further, the prevalence of a techniques referred to as “trauma analysis” which is yet again done on skeletal remains or corpse helps in providing crucial information related to manner and cause of death of the individual. It aids by identifying patterns of gunshot wound, sharp force injuries and “blunt force trauma” which also ends up throwing light on the circumstances that might have surrounded an individual’s demise which might not have been perceptible had not been the usage of forensic anthropology.²⁶

These findings are used by police and legal counsels as evidences in courtrooms, to which even the courts pay cognizance to when giving their judgements; this further emphasizes the importance of forensic anthropology to us when it comes to legal proceedings.

²⁴ Janet M Harris, ‘The Role of Stable Isotope Analysis in Forensic Anthropology’ (2016) Journal of Forensic Sciences p. 32.

²⁵ John E. Douglas and Mark Olshaker, *Mindhunter: Inside the FBI’s Elite Serial Crime Unit* (Gallery Books 2017).

²⁶ Steven A Symes and others, *Interpreting Traumatic Injury to the Bone: A Manual for Forensic Anthropologists* (National Institute of Justice, 2012).

Not only this, but forensic anthropologists themselves have collaborated time and again with law enforcement agencies to identify graves which are of suspicious nature in police records and also in identifying dismembered remains of corpse. This is done by very detailed and precise examination techniques using both advanced scientific technologies and at the same time amalgamating them with traditional methods and thereafter reconstructing scientific skeletal remains which again possess evidentiary value in court of law.²⁷

3.2 DISASTER VICTIM IDENTIFICATION (DVI)

The world is currently in a sad state of affairs with occasional “mass fatality incidents” occurring such as plane crashes and natural disasters. A lot of innocent civilians end up facing unfortunate accidents in their life because of such incidents and are often referred to as disaster victims, unfortunately not every disaster victim is able to make it out alive and in absence of any other information, the identification of these victim’s identities turns into a quite tumultuous task which would have been nearly impossible to do had it not been for the techniques of forensic anthropology. An infamous example of forensic anthropology in disaster victim identification (DVI) was in the aftermath of 9/11 terror attacks where forensic anthropologists, forensic pathologists and odontologist, all worked side by side to identify victims from fragmented and burned skeletal remains.²⁸ Their expertise ensured that remains were treated with dignity and respect while facilitating identification for grieving families.

Moreover, advances in technology, such as DNA extraction from bone samples, have enhanced the precision of victim identification efforts.²⁹ The integration of molecular techniques with traditional osteological methods has revolutionized the field, enabling forensic anthropologists to contribute to DVI efforts with greater accuracy and reliability.

A notable example of forensic anthropology’s role in DVI is the identification of victims from the 2004 Indian Ocean tsunami. Teams of forensic experts worked tirelessly to recover and identify remains, using a combination of dental records, DNA analysis, and skeletal

²⁷ Tim D White and Pieter A Folkens, *The Human Bone Manual* (Academic Press 2005).

²⁸ Anthony J Tamburello and others, “The Role of Forensic Anthropology in the 9/11 World Trade Center Disaster” (2004) 3 *Forensic Science Communications* <https://www.ojp.gov/pdffiles1/nij/209494.pdf> accessed 4 January 2025.

²⁹ Douglas H Ubelaker and others, “DNA Analysis of Skeletal Remains: Current Practices and Future Directions” (2014) 59 *Forensic Science International* <https://doi.org/10.1016/j.forsciint.2014.03.020> accessed 4 January 2025.

assessments.³⁰ This multidisciplinary approach underscores the importance of collaboration in addressing complex mass casualty events.

3.4 CHALLENGES IN LEGAL APPLICATION

Despite its significant contributions, forensic anthropology faces challenges in its application within legal systems. Courts often scrutinize the reliability and admissibility of forensic evidence, including skeletal analysis.³¹ The lack of standardized protocols across jurisdictions can lead to inconsistencies in the interpretation and presentation of findings. Additionally, the potential for bias in expert testimony underscores the need for rigorous ethical standards and continuous training for forensic anthropologists.

Another challenge lies in the limitations of skeletal analysis itself. While forensic anthropologists can provide valuable insights, certain factors, such as the degree of skeletal preservation and the availability of comparative data, can impact the accuracy of their conclusions.³² This necessitates a cautious and evidence-based approach to ensure that findings are both scientifically valid and legally defensible.

4. ETHICAL CONSIDERATION IN FORENSIC ANTHROPOLOGY:

Forensic anthropology plays a critical role in delivering justice and closure by identifying individuals and reconstructing events surrounding their demise. However, the practice raises several ethical challenges that warrant meticulous consideration. These challenges are not mere peripheral concerns but fundamental to ensuring that the discipline remains grounded in respect for human dignity, privacy, and cultural sensitivities, and therefore, few of these considerations and challenges are discussed under the subheading of this particular section.

4.1 INFORMED CONSENT AND PRIVACY

A significant ethical concern in forensic anthropology revolves around informed consent and the protection of privacy. While informed consent is a cornerstone of ethical practice in medical

³⁰ International Committee of the Red Cross, "Humanitarian Forensics: The Role of Forensic Anthropology in Disaster Victim Identification" (ICRC, 2015) <https://www.icrc.org/en/document/forensic-anthropology> accessed 5 January 2025.

³¹ Jennifer L Spradley and Marcella H Sorg, *Advances in Forensic Taphonomy: Method, Theory, and Archaeological Perspectives* (CRC Press 2020).

³² MariaTeresa A Tersigni-Tarrant and Natalie R Shirley, *Forensic Anthropology: An Introduction* (2nd edn, CRC Press 2017).

and anthropological research, its application becomes complex in forensic investigations involving deceased individuals. Questions arise regarding who can provide consent for the analysis of human remains, particularly in cases involving unclaimed bodies or those from mass graves in post-conflict zones. Scholars like Joakim Ekman argue that while forensic anthropologists often work within legal frameworks, they must still navigate ethical grey areas when balancing the rights of the deceased and their surviving family members against the demands of justice.³³

Moreover, the advent of advanced technologies like DNA phenotyping amplifies privacy concerns.

4.2 DIGNITY AND CULTURAL SENSITIVITIES IN HANDLING OF HUMAN REMAINS

As it might be clear to the readers by now, forensic anthropology involves examination of corpses which in certain situation extends to examination of grave which often results into treading on a fine line between cultural sensitivity and insensitivity especially when relating it to cultural or religious context, since, in majority of the cultures the process of exhumation, analysis and reburial of human corpses carry spiritual and emotional significance.³⁴ These social contexts make it of utmost importance for forensic anthropologists to be sensitive to human emotions and culture and approach these cases with due cultural competence, as if treated with insensitivity, these cases may further exacerbate the trauma of affected communities.

The excavation of mass graves in regions like the Balkans and Rwanda serves as a powerful example of the ethical dilemmas forensic anthropologists face. While their work contributes to justice and reconciliation by identifying victims and documenting war crimes, it also risks violating local cultural norms surrounding burial practices.³⁵ Organizations such as the International Commission on Missing Persons (ICMP) have emphasized the importance of engaging with local communities to ensure that forensic investigations align with cultural

³³ Joakim Ekman, *Ethical Dilemmas in Forensic Anthropology: The Question of Consent* (Cambridge University Press 2020) 45.

³⁴ Jill Hunt, *Cultural Sensitivity in Forensic Anthropology* (Routledge 2021) 32.

³⁵ Mark Gibson, 'Mass Graves and Cultural Ethics in Post-Conflict Zones' (2020) <https://www.icrc.org/cultural-ethics-mass-graves> accessed 6 January 2025.

expectations while fulfilling their evidentiary objectives.³⁶

5.THE PROMISE OF FORENSIC ANTHROPOLOGY

We live in a transient world with new technologies evolving every now and then and all these developments have not left forensic anthropology out of their field of impact either. Therefore, as we examine how promising the science of forensic anthropology is, it is of paramount importance for us to study the inter relation of these evolutions with the field of forensic anthropology.

5.1 TECHNOLOGICAL ADVANCES

With recent advancements such as that of a technique called as “DNA Phenotyping”, (a technique that aids forensic anthropologists in determining the physical appearance and genetic traits of an individual merely on the basis of their DNA samples) technological innovations have revolutionised the field of forensic anthropology. Now, specialists can make educated guess about an individual’s eye and hair colour, their ancestry, and, to some extent, can also make educated guesses with regards to their potential physical features.³⁷

To bolster this point, is a work conducted by **Parabon Nanolabs**, a leading company in the field of DNA phenotyping. Parabon’s **Snapshot DNA Phenotyping Service** has been instrumental in helping law enforcement agencies identify suspects in cold cases, where traditional identification methods have failed. For instance, in the case of the “**Grim Sleeper**” serial killer investigation in California, Parabon’s phenotyping helped create a composite image of the suspect based on DNA left at crime scenes, ultimately leading to the identification and arrest of **Lonnie David Franklin Jr.** in 2016.³⁸ This breakthrough shows the immense potential of technology in solving previously insurmountable forensic challenges.

5.2 ENHANCING ACCURACY

The primary promise of these advancements in forensic anthropology is the ability to **enhance the accuracy and reliability** of the field. Traditional methods of skeletal analysis, while

³⁶ International Commission on Missing Persons (ICMP), ‘Working with Communities’ <https://www.icmp.int> accessed 6 January 2025

³⁷ Ballantyne, A., et al. *DNA Phenotyping: Predicting Ancestry, Physical Appearance, and Traits from DNA*, (Springer, 2019).

³⁸ Parabon Nanolabs, ‘Grim Sleeper Case’ (2016) <https://www.parabonnanolabs.com> accessed 6 January 2025.

invaluable, can often be imprecise due to the natural variability in human skeletal morphology. However, modern technology has significantly reduced these margins of error, ensuring that forensic findings are more consistent and reliable.

For instance, **DNA phenotyping** allows for the prediction of an individual's physical traits, reducing the uncertainty in cases where there is no direct familial DNA match. Similarly, **AI-powered algorithms** can assess skeletal remains more accurately than a human could, reducing the chances of misidentification. Furthermore, **3D imaging** allows for a more accurate assessment of the skeletal remains by providing precise and detailed digital models that can be manipulated for further study, making it possible to analyse even the smallest features that might otherwise go unnoticed.³⁹

The combination of these technologies has made forensic anthropology more effective than ever in large-scale operations, such as mass grave exhumations and identifying victims of human rights abuses.

6. LEGAL AND INSTITUTIONAL CHALLENGES

The application of forensic anthropology is often hindered by legal and institutional barriers that can undermine its effectiveness in the criminal justice system. One of the most persistent challenges is the scepticism with which forensic evidence, including that of forensic anthropology, is met in courtrooms. Despite the invaluable contributions of forensic anthropologists to criminal investigations, their findings are sometimes questioned by legal professionals who are either unfamiliar with the field or mistrustful of its methods.

A case in point is the scepticism surrounding forensic anthropology in **mass casualty events**. After the **9/11 terrorist attacks**, forensic anthropologists worked alongside pathologists and odontologists to identify the remains of victims, but their contributions were frequently sidelined in favour of other methods, such as DNA testing.⁴⁰

In addition to this, forensic anthropologists also face a challenge in navigating the lack of standardisation across various jurisdictions. Different countries across the globe are equipped

³⁹ Doyle, M., et al. 'Advances in 3D Imaging for Forensic Anthropology' *Forensic Science International* (2017) 281: 6–13.

⁴⁰Paul Whelan, "The Challenges of Using Forensic Science in Legal Proceedings" (2005) 7 *Journal of Forensic Sciences* 452 <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1556-4029.2005.00076.x> accessed 10 January 2025.

with different kinds of facilities and not every country possesses state of art facilities, similarly every country has different types of protocols governing the work of forensic anthropologists, this lack of standardisation more often than not has the potential of leading to discrepancies in forensic findings and can also create problems if the remains are handled improperly during the recovery or storage process in their use in court of law.⁴¹

These institutional obstacles can slow down investigations, create bias in the results, and prevent the delivery of justice to the victims.

7. JURISDICTIONAL CONFLICTS AND LACK OF STANDARDIZATION

A major peril of forensic anthropology is the lack of standardized methods and the jurisdictional conflicts that arise, particularly in international investigations. In global human rights inquiries or post-conflict investigations, forensic anthropologists often work across borders with different legal frameworks, forensic techniques, and cultural expectations. This lack of standardization leads to inconsistencies in how skeletal remains are recovered, analysed, and interpreted.⁴²

Forensic anthropologists working on international cases, such as, those investigating mass graves or human rights violations often face the challenge of reconciling differences in the forensic protocols of various countries. In post-genocide Rwanda, for example, the **International Criminal Tribunal for Rwanda (ICTR)** struggled with the diversity of forensic practices employed by various teams operating in the field, which led to discrepancies in findings and delays in justice.⁴³ These differences in approaches ranging from the methods used to excavate remains to the analytical tools employed can lead to confusion and delays in producing reliable forensic evidence, complicating legal proceedings and potentially undermining the credibility of forensic findings.

In the context of large-scale natural disasters, such as the **Indian Ocean tsunami of 2004**, forensic anthropologists often face jurisdictional conflicts regarding how remains should be recovered and analysed. Local governments, national agencies, and international organizations

⁴¹Douglas H Ubelaker, "Current Issues in Forensic Anthropology" (2007) 53 *Forensic Science International* 180 <https://www.sciencedirect.com/science/article/abs/pii/S0379073807000131> accessed 10 January 2025.

⁴² Andrew W Kretchmar and Carol H Haskell, *Forensic Science and Human Rights* (CRC Press 2017) 155.

⁴³ Paul K Brown, "Forensic Science in International Human Rights Investigations: The Case of Rwanda" (2007) 2 *International Criminal Law Review* 185 https://brill.com/view/journals/iclr/2/2/article-p185_5.xml accessed 13 January 2025.

may all have differing priorities and procedures for investigating mass casualties, leading to inefficiencies and potential conflicts between stakeholders.⁴⁴

8. FUTURE OF FORENSIC ANTHROPOLOGY (CHALLENGES AND OPPORTUNITIES):

The future of forensic anthropology is marked by unparalleled opportunities but also formidable challenges. The interplay between technological advancements, resource disparities, and ethical dilemmas creates a dynamic landscape that demands innovative solutions and collaborative approaches.

8.1 THE FINANCIAL AND INFRASTRUCTURAL DIVIDE

A primary challenge in the future of forensic anthropology lies in the financial and infrastructural investments required to integrate cutting-edge technologies. Advanced tools such as 3D imaging systems, next-generation sequencing for DNA analysis, and AI-powered identification algorithms are resource-intensive, often limiting their availability to well-funded institutions in developed regions.⁴⁵ This disparity risks creating a bifurcated field where resource-rich institutions advance rapidly while underfunded regions lag behind, potentially leaving global forensic investigations fractured and inconsistent.⁴⁶

However, this financial divide also presents an opportunity for innovation. Public-private partnerships, such as those seen in the development of low-cost forensic imaging solutions, can democratize access to technology.⁴⁷ For instance, organizations like the International Commission on Missing Persons (ICMP) have spearheaded initiatives to provide affordable DNA analysis services in low-income countries, ensuring that financial constraints do not hinder the pursuit of justice.⁴⁸

⁴⁴ Frank B Hsieh and Andrew P Tseng, "Forensic Anthropology in Disaster and Mass Casualty Situations" (2006) 5 *Forensic Science Review* 121 <https://www.forensicscience.org/resources/forensic-science-review> accessed 13 January 2025.

⁴⁵ Matthew Greene, 'The Cost of Innovation in Forensic Science' (2023) *Forensic Technology Review* 11(1).

⁴⁶ *Ibid.*

⁴⁷ Public-Private Partnerships for Innovation in Forensic Science, 'A Path Forward' (2023) <https://www.forensicpartnerships.org> accessed 14 January 2025.

⁴⁸ International Commission on Missing Persons (ICMP), 'Affordable DNA Analysis for All' <https://icmp.int/affordable-dna> accessed 14 January 2025.

8.2 THE INTEGRATION OF TECHNOLOGY AND HUMAN EXPERTISE

As forensic anthropology embraces technologies such as AI and machine learning, questions arise about the balance between automation and human expertise. While AI can process and analyse data at an unprecedented scale, it lacks the contextual understanding and interpretive nuance that experienced forensic anthropologists bring to complex cases.⁴⁹ Over-reliance on AI could lead to a dehumanization of forensic practices, where automated decisions overshadow the critical thinking and empathy essential for dealing with sensitive cases such as mass graves or disaster victim identification.

To mitigate these risks, the future must focus on fostering a symbiotic relationship between technology and human expertise. Educational institutions and professional organizations must prioritize training forensic anthropologists to work alongside AI systems, ensuring they can leverage technology as an extension of their skills rather than a replacement.⁵⁰ This integration could ultimately enhance the accuracy and efficiency of forensic investigations while preserving the human element that underpins the discipline's ethical foundations.

8.3 GLOBAL DISPARITIES IN FORENSIC PRACTICES

Programs such as Interpol's Disaster Victim Identification (DVI) Working Group have demonstrated the potential of multinational efforts to standardize practices and share expertise.⁵¹ Additionally, remote training modules and virtual workshops, enabled by advancements in digital communication, can help disseminate knowledge to under-resourced regions, fostering a more equitable global forensic community.

9. CONCLUSION

With all the discussion on forensic anthropology and examining its intersection with science, ethics and justice, this place has come close to its conclusion. The paper has meticulously examined how and by use of what technologies does the forensic anthropology bridge the gap between the past and present while at the same time helping families of victims of both natural and man-made disaster in identifying their kin and thereby providing them a closure and

⁴⁹ Sarah T. Clarke, 'AI in Forensic Anthropology: Opportunities and Challenges' (2024) <https://www.forensicanthro-ai.org> accessed 14 January 2025.

⁵⁰ Ibid.

⁵¹ Interpol, 'Global Guidelines for Forensic Anthropology' (2024) <https://www.interpol.int/forensic-guidelines> accessed 14 January 2025.

contributing to the broader pursuit of justice while at the same time stressing the ethical dilemma and the problem of lack of standardisation across various jurisprudences which eventually ends up hindering further advancement of this science.

This paper also throws light on how the findings done by DNA Phenotyping, 3D imaging and AI helps in increasing the accuracy of findings and finding out not just the identity of Disaster Victims but also identifying people involved in criminal cases by referring to “golden state killer case” and how the findings done by using the technology of forensic anthropology are admissible in court of law and thereby has aided in solving cases that might otherwise be considered nearly impossible to complete in absence of technologies such as that of DNA Phenotyping and 3D imaging.

To conclude, this paper throws light on what is forensic anthropology as a discipline, its practical usage, how it intersects with legal system and its ethical dilemma.

In the pursuit of truth and accountability, forensic anthropology embodies a profound responsibility; a responsibility to honour the dignity of the deceased while serving the living. As the field of forensic anthropology continues to evolve, it holds the potential to reshape how societies confront their past, seek justice, and build a more equitable future.⁵²

⁵² Francesca Rossi, ‘The Role of Forensic Anthropology in Humanitarian Crises’ (2023) <https://www.forensichumanrights.org> accessed 15 January 2025.