Role of Forensic Anthropology in Disaster Victim Identification (DVI)

Alok Sharma [a#] and Avinash H. Waghmode [b*]

[a] *Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Sawangi (M), Wardha, Maharashtra, India.*
[b] *Department of Forensic Medicine, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Sawangi (M), Wardha, Maharashtra, India.*

Authors' contributions

Review Article

ABSTRACT

DNA profiling is one of the most dependable and well-organized methods for recognizing bodies or losing body parts in disaster victim identification (DVI). This necessitates the collection of a post-mortem DNA sample and an antemortem DNA sample from the alleged victim or a biological related people. Collecting an acceptable ante mortem sample is usually effortless, but because of the varying degree of preservation of the human remains after any disaster and very high risk of cross-contamination of DNA, obtaining an adequate standard post mortem sample under cold DVI conditions is difficult. Various post mortem DNA samples from a deceased person in DVI can be obtained from muscle, bone including femur and ribs, teeth, and bone marrow with the slightest possibility of contamination.

DVI (disaster victim identification) has been used to identify deceased people in various famous disasters like the 9/11 attack of the terrorist group al-Qaeda against the United States, Malaysia Airlines Flight 17 from Amsterdam to Kuala Lumpur that was shot down on 17 July 2014 while flying over eastern Ukraine. All 283 passengers and 15 crew members were killed; the 26/11 attack on Mumbai in 2008 led by terrorist organizations caused 166 deaths, excluding nine terrorists.

According to Interpol protocol, four steps for identification are given importance:

_____

[#] *MBBS Student;*
Corresponding author: E-mail: avinashw4@gmail.com;

1 – Site examination, which lasts for days to weeks.
2 – Post-mortem data include fingerprints, odontology, DNA profiling and physical indication.
3 – Ante-mortem data collected from victim houses.
4 – Reconciliation where specialists identify the victim from the data collected.

Keywords: Contamination; DNA sample; various attacks; steps of identification; odontology.

1. INTRODUCTION

Human remains may now be collected, sampled, preserved, and processed for DNA-based identification due to advances in forensic biology .y DNA profiling is one of the most successful methods for identifying deceased persons in DVI. DNA profiling allows for the identification of deceaspersonsson, the reallocation of different parts the of b,ody, the identification of criminals. Duelowerits lower price and high level of unfairness, DNA profiling has booked its place as a universal standard for identifying deceased people in disease tetermshere many casualties had occurred and forensic investigations where leftover parts of humans are substantially fragmented or deteriorated. The bones of victims are frequently fragmented, decomposed, and mixed due to the conditions associated with a catastrophic calamity. In deceased person remains, Because the quality of genetic material, i.e., DNA is highly modified by time since death and environmental circumstances, the level of decomposition of human remains can hinder DNA recovery [1]. Choosing the right postmortem (PM) sample can improve the odds of obtaining a DNA profile from polluted human remains. Recent recommendations suggested cocollectingamples from teeth and bones like Femur bone mainly from the aft because there is an elevated positive chance of recovering DNA than from blood and tissue sample since both teeth and bones are well known to preserve DNA, which makes them dependable sources of obtaining DNA, especially for long-term sampling [1-5].

In mass casualty disasters, identification through the visual method has been known to carry a high risk of error, and cremation should be avoided or resisted according to visual method identification given in INTERPOL guidelines [6].

1.1 Background

The DVI process strives to offer a reasonable, medical basis for every victim's identification involved in DVI, ensuring that the right person is identified have always been fascinated by forensic medicine. Having this idea in mind, this article has been made.

1.2 Aim / Objective

The role of forensic anthropology involving various methods helps identify victims in many disasters.

2. METHODS

Various methods have been involved in the examination of victims involved in disasters.

2.1 Imaging Methods

Various techniques like radiograph and Postmortem Computed Tomography (PMCT) are used. These scans are becoming more common during DVI procedures because of the advent of portable X-ray machines and portable CT scanners. As a result, there is a high chance of these scan images to be added in the Forensic anthropologist investigation in the mortuary [7-10]. These imaging methods have been shown to help identify deceased victims in various ways. It may aid in the recognition and re-assembling of body parts [11] and also help in documentation of details that can further be used in recognition, such as individual persona features [12], dental pattern [13], any operating scars, any past finding of trauma that was incompletely healed and individual personal belonging. This imaging may also be used for biological profiling in victims.

2.2 Ground Penetrating Radar

GPR is a technology that isn't often explored amid significant mortality situations, but it may be precious whenever the inquiry entails the exhumation of human residue, particularly those traces that are interred in unknown locations. Historical graves, for example, might fall under this category, specifically if the recognition of the interred residues is desired or required. The discovery of these remnants is an evident requirement of the lengthy recognition procedure.

2.3 Forensic Odontology

In major catastrophic events, forensic odontology's job is usually the same: comparing Antemortem and Postmortem dental profiles to find similarities that enable recognition. The result is based on two basic premesis: that molars can withstand disintegration and relatively harsh persisting to environment circumstances (as determined by extensive monitoring). Each individual consists of a pair of dentition that is essentially and noticeably different.

2.4 DNA Sampling

In cases when DNA is necessary for recognition, forensic anthropologists can help create DNA sampling techniques (in partnership with scientists) [14,15]. In situations of extensively disturbed human residues, such as those resulting from bombs or aircraft crashes, forensic anthropologists can make a significant contribution by selecting the most relevant specimens for DNA testing utilizing their expertise in skeletal biology [16,17].

3. MAIN TEXT

According to INTERPOL protocols, there are four steps of identification for Disaster Victim Identification

1 – Site Examination: Based on the event and where it occurred, recovering all of the deceased and personal belongings might take days or even weeks.

2 – Post-mortem data: Experts analyze human residue for forensic proof that might assist in recognizing the deceased person, which includes

Fingerprints are very trustworthy if they are accessible; however, because many people's fingerprints may not be on file, they are of little utility;

Dental inspection is referred to as odontology. Because teeth are exceedingly resilient and most individuals maintain dental records, they are one of the most reliable means of identification.

DNA profiling — direct comparisons between a deceased person's DNA and a sample acquired from their house, such as hairs, may be produced. The DNA of the parents can also be used to make secondary comparisons.

Physical marks – Tattoos, bruises, or any surgical marks/implants distinctive to the sufferer.

3 – Ante-mortem (AM) data: Oral and healthcare data, fingerprints, and DNA are obtained from the deceased's residences or given by members of the family or relative.

4 – Reconciliation: When the PM and AM statistics have been obtained, a group of experts evaluates and unifies the given two datasets to determine the deceased person.

The DVI comprises 5 phases which are

Phase 1: the calamity scene
Phase 2: data collecting from the mortuary and PM
Phase 3: Data collection from Antemortem
Phase 4: conciliation
Phase 5: Debriefing

Although forensic anthropological information was already employed in DVI for almost 100 years [18], it was not until 1971 that Thomas Dale Stewart, an American scientist, highlighted the need to use forensic anthropology in the analysis procedure [19]. Since then, many disasters have occurred, requiring the forensic anthropologist to play a more significant part in DVI.

4. AT THE CALAMITY SCENE

The urge to discover and gather remnants at the catastrophe site to permit quick recognition often struggles against a backdrop of turmoil and inadequate resources. Evidence has indicated that comprehensive charting and documenting of corpses, parts of the body, bones (whole or shattered), and related evidence is critical in such challenging circumstances. In a DVI scenario, the ability to recognize fractured and otherwise degraded remains is critical. It is self-evident that if human remnants, irrespective of their conservation condition, cannot be identified at the site, they cannot be documented and recovered.

The first assessment of the state and conservation of the remnants at the site has a considerable influence on logistical strategy for comprehensive documenting and collection of human residues and the DVI procedures that follow. To avoid additional unneeded fragmentation or disintegration, handling the situation as soon as possible is critical. Forensic

anthropologists can significantly contribute to the catastrophe location due to their skill in handling variably maintained residues. Their presence on the site will assist in avoiding the gathering of non-human remnants, limiting the number of incident numbers assigned and the amount of data generated. Furthermore, their presence at the site guarantees that certain parts of the body and pieces are recovered, reducing the need to re-analyze the site. Finally, if the corpses found were compromised, experts may decide on the appropriate storage and transportation methods to avoid harm during transportation [20-26].

5. AT THE MORTUARY

Forensic anthropologists have aided in the examination of catastrophic events in recent years by conducting a variety of studies, including:

1) Distinguishing between osseous and non-osseous materials.

2) Determining whether the remnants were humanoid (or non-humanoid – if this is not confirmed at the spot.

3) Determining which bits are recognized and which need DNA profiling.

4) Recognising and maintaining mixed remnants (that might include re-arranging dissimilar limbs.

5) Biomedical description (an estimate of a deceased person's heritage, gender, age, as well as size), with extra personal details like past bone cracks, illness, or anatomical variations if possible.

Most of the found human residues from the Malaysia Airlines Flight 17 crash in 2014 were expected of an aircraft tragedy, heavily intermixed, skeletonized, and shattered. This was finally agreed throughout the Disaster victim identification procedure that any non-oxidized humanoid bone fragment measuring well over 2.5 g would never be correlated with other skeleton components forwarded for DNA testing. Whereas the forensic anthropologist's elimination of non-human substances and re-associating more significant human skeleton pieces significantly decreased the number of samples provided for DNA analysis, hundreds of skeletal remains still needed to be examined.

Another tragedy that presents a unique difficulty for DVI groups is large fatalities during a terrorist strike like humans found in the 9/11 attack, and 26/11 were sent to forensic department for identification from DNA samples from bone, mainly femur, ribs, and teeth, along with bone marrow examination. Because officials are faced with the necessity to merge a police inspection mostly with the obligation to recognize the murdered person, the criminal character of such an occurrence frequently shifts the objectives of the supervisory, governmental entity. In these situations, the DVI investigation is frequently put on holdfavoring more pressing considerations like the hunt for the culprits and the prevention of additional assaults. Many nations created specialist 1st squads for terrorist attacks, and DVI squads must understand their position inside the more significant police case. DVI groups must be equipped for several situations, including one or many catastrophe locations that happen simultaneously or sequentially, judging by recent events. They must be ready for a variety of assaults, including gunshots, knife attacks, (suicide) bombs, automobiles colliding with humans, and Chemical, Microbiological situations. Injured, criminals and all forms of information were retrieved accurately and promptly thanks to strong coordination among federal prosecutors and the DVI squad, who might undoubtedly perform their separate investigations together. It's important to note that DVI squads were constantly bound by the limits and regulations of the nations they're operating in, and they will constantly adjust the analysis and recognition techniques appropriately.

6. RECOGNITION OF LIVING

While DVI is often focused on identifying the victims, any DVI approach must also identify individuals who survived a massive mortality incident. The recognition of the surviving does not always necessitate forensic anthropological competence, although the latest tragedies have demonstrated that forensic anthropologists might well be called in.

Including both open and closed catastrophes, identifying the alive is critical. Furthermore, during a public tragedy, the quick recognition of victims significantly influences the analysis procedure since it allows individuals to be removed from the unexplained disappearances. It may also influence those caring for victims, as health workers would be forced to provide

medication without medical background knowledge. Whenever the victim is a juvenile who cannot be recognized, the absence of permission to healthcare from responsible adults should be considered.

Surviving persons are divided into four categories. Someone who is unhurt and so anticipated to depart the scene of the mortality incident on their own comes in the first category. Someone who is wounded but yet has consciousness comes in the second category. The role of the forensic anthropologist in these categories is negligible. Persons who get emergency care must be aware that whatever distinguishing information collected by the healthcare staff may have to be submitted to the recognition squad since it includes the information needed for recognition.

Anyone that is hurt but still in an unconscious state and escapes their wounds, as well as some who are wounded, unresponsive, and die to their injuries in hospital, makes its way to the final two categories. Such persons who are so gravely damaged as they seem unable to disclose personal information might well be considered the biggest challenge to the recognition process. In such circumstances, this becomes more customary to recognize the person using the same procedures used to recognize the dead. Following terrorist strikes in numerous nations over the last few decades, this strategy has shown to be quite successful. However, the usefulness of this strategy is contingent on the assumption that the critically wounded remain part of the assumed lost group whose Antemortem data will be gathered until they are discovered.

Relatively similar data is acquired both from the unconscious person and the dead individual to complete the DVI paperwork for identifying reasons. To establish DNA data, DNA specimens are retrieved [20]. If feasible, fingerprints and tooth conditions could also be restored, albeit the overall performance is based on the severity of the damage. Medical imaging is critical for obtaining more data, and the widespread usage of radiography and Computed tomography during clinical assessment and therapy assures their accessibility. By creating DNA profiles, or commenting on the appearance of diseases or artificial organs and several data that could be used to guide recognition data gathering and to compare, the forensic anthropologist can supplement radiologists' assessment.

Information of differences in outward traits, including complexion color and hair texture, may also aid in the identifying procedure. This method of identifying the alive can be used in conjunction with that of identifying the dead, guaranteeing that the recognition procedure does not halt due to inadequate knowledge.

7. CONCLUSION

Forensic anthropologists are continually researching novel approaches and procedures to improve humanoid identity whenever conservation occurs in skeletonize or severely disturbed remnants, thanks to their expert understanding of the human morphology and variety. As a result, based on the type of the catastrophe, including a forensic anthropologist in a DVI investigation can help speed up recognition significantly, as seen by the positive effect that forensic anthropologists had performed in previous significant fatality incidents throughout the nation. Based on ongoing and prospective breakthroughs with themself and allied field of forensic science, the functioning behind the forensic anthropologist in Disaster victim identification would keep evolving. Various instances of such advancements and their impact on the Disaster victim identification procedure have been described in this study.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1.   Prinz M, Carracedo A, Mayr W, Morling N, Parsons T, Sajantila A, Scheithauer R, Schmitter H, Schneider PM. DNA Commission of the International Society for Forensic Genetics (ISFG): Recommendations regarding the role of forensic genetics for disaster victim identification (DVI). Forensic Sci. Int. Genet. 2007;1:3–12.

2. Andelinović S, Sutlović D, Ivkosić IE, Skaro V, Ivkosić A, Paic F, Rezić B, Definis-Gojanović M, Primorac D. Twelve-year experience in identification of skeletal remains from mass graves. Croat. Med. J. 2005;46:530–539.

3. Milos A, Selmanović A, Smajlović L, Huel R, Katzmarzyk C, Rizvić A, Parsons TJ. Success Rates of Nuclear Short Tandem Repeat Typing from Different Skeletal Elements. Croat. Med. J. 2007;48:486–493.

4. Montelius, K, Lindblom, B. DNA analysis in Disaster Victim Identification. Forensic Sci. Med. Pathol. 2012;8:140–147.

5. Ziętkiewicz E, Witt M, Daca P, Zebracka-Gala J Jarząb MGB. Current genetic methodologies in the identification of disaster victims and in forensic analysis. J. Appl. Genet. 2012;53:41–60.

6. Calacal GC, Apaga, DLT, Salvador JM, Jimenez JAD, Lagat LJ, Villacorta RPF, Lim MCF, Fortun RD, Datar, FA, De Ungria MCA. Comparing different post-mortem human samples as DNA sources for downstream genotyping and identification. Forensic Sci. Int. Genet. 2015;19: 212–220.

7. Tsokos M, Lessig R, Grundmann C, et al. . Experiences in tsunami victim identification. Int J Legal Med. 2006;120:185–187.

8. Dedouit F, Savall F, Mokrane F-Z, et al. . Virtual anthropology and forensic identification using multidetector CT. Br J Radiol. 2014;87:20130468.

9. Franklin D, Swift L, Flavel A. Virtual anthropology and radiographic imaging in the forensic medical sciences. Egypt J Forensic Sci. 2016;6:31–43.

10. Brough AL, Rutty GM, Black S, et al. Post-mortem computed tomography and 3D imaging: anthropological applications for juvenile remains. Forensic Sci Med Pathol. 2012;8:270–279.

11. Vallis J. The role of radiography in disaster victim identification In: Errickson D, Thompson T, editors. Human remains: another dimension. London (UK): Academic Press. 2017;57–69.

12. Blau S, Robertson S, Johnston M. Disaster victim identification: new applications for postmortem computed tomography. J Forensic Sci. 2008;53:1–6.

13. Gascho D, Philipp H, Flach PM, et al. . Standardized medical image registration for radiological identification of decedents based on paranasal sinuses. J Forensic Legal Med. 2018;54:96–101.

14. Westen AA, Gerretsen RR, Maat GJ. Femur, rib, and tooth sample collection for DNA analysis in disaster victim identification (DVI). Forensic Sci Med Pathol. 2008;4:15–21.

15. Johnston E, Stephenson M. DNA profiling success rates from degraded skeletal remains in Guatemala. J Forensic Sci. 2016;61:898–902.

16. Mundorff A, Davoren JM. Examination of DNA yield rates for different skeletal elements at increasing post mortem intervals. Forensic Sci Int Genet. 2014;8:55–63.]

17. Mundorff AZ, Davoren J, Weitz S. Developing an empirically based ranking order for bone sampling: examining the differential DNA yield rates between human skeletal elements over increasing post mortem intervals. Washington, DC: Department of Justice; 2013.

18. Mundorff AZ, Black S, Blau S, et al. Disaster Victim Management—the role of the anthropologist In: Payne-James J, Byard RW, editors. Encyclopedia of forensic and legal medicine. 2nd ed. London (UK): Elsevier; 2016;288–304.

19. Stewart TD, editor. Personal identification in mass disasters. Washington (DC): Smithsonian Institution; 1970.

20. Black SM, Walker G, Hackman L, et al. . Disaster victim identification: the practitioner's guide. Dundee: Dundee University Press; 2010.

21. Abbafati, Cristiana, Kaja M. Abbas, Mohammad Abbasi, Mitra Abbasifard, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Foad Abd-Allah, et al. Five Insights from the Global Burden of Disease Study 2019. LANCET. 2020;396(10258)1135–59.

22. Abbafati, Cristiana, Kaja M. Abbas, Mohammad Abbasi, Mitra Abbasifard, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Foad Abd-Allah, et al. "Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study 2019." LANCET 396, no. 10258(October 17, 2020):1204–22.

23. Franklin, Richard Charles, Amy E. Peden, Erin B. Hamilton, Catherine Bisignano, Chris D. Castle, Zachary Dingels V, Simon Hay I, et al. "The Burden of Unintentional Drowning: Global, Regional and National

Estimates of Mortality from the Global Burden of Disease 2017 Study." Injury Prevention. 2020;26(1):83–95. Available:https://doi.org/10.1136/injuryprev-2019-043484.

24. James, Spencer L, Chris D. Castle, Zachary Dingels V, Jack T. Fox, Erin B. Hamilton, Zichen Liu, Nicholas L. S. Roberts, et al. "Estimating Global Injuries Morbidity and Mortality: Methods and Data Used in the Global Burden of Disease 2017 Study. Injury Prevention. 2020; 26(1):125–53. Available:https://doi.org/10.1136/injuryprev-2019-043531.

25. James, Spencer L, Chris D. Castle, Zachary Dingels V, Jack T, Fox, Erin B. Hamilton, Zichen Liu, Nicholas LS.

Roberts, et al. Global Injury Morbidity and Mortality from 1990 to 2017: Results from the Global Burden of Disease Study. Injury Prevention. 2017;26(1):96–114. Available:https://doi.org/10.1136/injuryprev-2019-043494.

26. Lozano, Rafael, Nancy Fullman, John Everett Mumford, Megan Knight, Celine M. Barthelemy, Cristiana Abbafati, Hedayat Abbastabar, et al. Measuring Universal Health Coverage Based on an Index of Effective Coverage of Health Services in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study. Lancet. 2019; 396(10258):1250–84. Available:https://doi.org/10.1016/S0140-6736(20)30750-9.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/79612