***Review Article***

# Role Of Forensic Anthropology in Disaster Victim Identification (DVI)


## Abstract

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

DVI ( disaster victim identification) has been used to identify deceased people in various popular disasters like 9/11 attack of 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, 26/11 attack on Mumbai in 2008 lead by terrorist organisation caused 166 deaths excluding 9 terrorist.

According to Interpol protocol, 4 steps for identification are given importance:

1 – Site examination which last 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.


## Introduction

Human remains may now be collected, sampled, preserved, and processed for DNA-based identification due to advances in forensic biology. For identification of deceased persons in DVI,

DNA profiling is one of the most successful method. DNA profiling allows for the identification of deceased person, the reallocation of different parts of body and for the identification of criminals. Due to its less price and high level of unfairness, DNA profiling has booked its place as universal standard for identifying deceased people in disasters where large number of casualties had occurred and forensic investigations where left over parts of humans are substantially fragmented or deteriorated. The bones of victims are frequently fragmented, decomposed, and mixed together as a result of 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 recommendation suggested to collect samples from teeth and bones like Femur bone mainly from shaft because there are 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 source of obtaining DNA specially for long term sampling [1],[2],[3],[4],[5].

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

## 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 have been made.

## AIM/OBJECTIVE

Role of forensic anthropology involving various methods helps in identifying victims in many disasters.

## METHODS

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

1. IMAGING METHODS: various techniques like radiograph and Postmortem Computed Tomography (PMCT) are used. These scans are becoming more common during DVI procedures, because to the advent of transportable X-ray machines and transportable 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],[8],[9],[10]. These imaging methods have been shown to help with identifying deceased victims in a variety of ways. It may aid in the recognition and re-assembling of body parts[11] and also help in documentation of details which can further be used in recognition, such as persona individual features[12], dental pattern[13], any operating scars, any past finding of trauma that was incompletely healed and individual personal belonging. These imaging may also be used for biological profiling in victims.

2. GROUND PENETRATING RADAR: GPR is a technology that isn't often explored in the midst of major mortality situations, but it may be highly valuable whenever the inquiry entails the exhumation of human residue, particularly when those traces 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 to the lengthy procedure of recognition.

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 worth is based on 2 basic premesis: that molars can withstand disintegration and relatively harsh persisting to environment circumstances (as determined by extensive monitoring), and that each individual consist of pair of dentition that is essentially and noticeably different.

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 utilising their expertise of skeletal biology [16],[17].



**MAIN TEXT**

According to INTERPOL protocols there are 4 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 took days or even weeks.

2 – Post-mortem data: Experts analyse human residue for forensic proof that might assist in recognising the deceased person which include

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 trustworthy means of identification.

DNA profiling — direct comparisons between a deceased person DNA and a sample acquired from their house, such as a 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 that are distinctive to the sufferer.

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

4 – Reconciliation: When the PM and AM statistics has 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 a 100 years [18], it's not until 1971 that Thomas Dale Stewart, an American scientist, highlighted the need of using forensic anthropology in the analysis procedure [19]. Since then, a lot of disasters have occurred, requiring the forensic anthropologist to play a larger part in DVI.

**AT THE CALAMITY SCENE**

The urge to discover and gather remnants at the catastrophe site, in order to permit quick recognition, often struggles against a backdrop of turmoil and inadequate resources. Evidence has clearly indicates that comprehensive charting and documenting of corpses, parts of the body, bones (whole or shattered), and related evidence is critical in such tough circumstances . In a DVI scenario, the ability to recognise fractured and otherwise degraded remains is critical . It is self-evident that if human remnants, irrespective of their condition of conservation, 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, as well as the DVI procedures that follow. To avoid additional unneeded fragmentation or disintegration, it is critical to handle the situation as soon as possible. Forensic anthropologists can make a significant contribution at the catastrophe location due to their skill in handling with variably maintained residues.Their presence on the site will assist to avoid the gathering of non-human remnants, limiting the amount 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-analyse 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]

**AT THE MORTUARY**

Forensic anthropologists has 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 recognised 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.

The most of the found human residues from the Malaysia Airlines Flight 17 crash in 2014 was expected of an aircraft tragedy, that is, heavily intermixed, skeletonise and shattered. This was finally agreed throughout the Disaster victim identification procedure that any non-oxdised humanoid bone fragment measuring well over 2.5 g that would never be correlated with other skeleton component which will be forwarded for DNA testing. Whereas the forensic anthropologist's elimination of non-human substances and re-association of bigger human skeleton pieces significantly decreased the amount of samples provided for DNA analysis, hundreds of skeletal remains still needed to be examined.

Other sort of tragedy that presents a unique difficulty for DVI groups is large fatalities during a terrorist strike like humans found in 9/11 attack and 26/11 were send to forensic department for identification from DNA samples form 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 obligation to recognize the murdered person, the crime character of such an occurrence frequently shifts the objectives of the supervisory governmental entity. In these situations, the DVI investigation is frequently put on hold in favour of more pressing considerations like the hunt for the culprits and/or the prevention of additional assaults. Many nations created specialist 1st squads for terrorist attacks, and DVI squads must understand their position inside the larger police case. DVI groups must be equipped for a number of 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 in an accurate and prompt manner 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 always adjust the analysis and recognition techniques appropriately.

**RECOGNITION OF LIVING**

While DVI is often focused on identifying the victims, any DVI approach must also address identifying individuals who survived a massive mortality incident. The recognition of the surviving does not always necessitate forensic anthropological competence, although 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 an public tragedy, the quick recognition of victims has a significant influence on the analysis procedure since it allows individuals to be removed as from unexplained disappearances list. It may also have an influence on those caring for victims, as health workers would be forced to provide medication in the lack of medical background knowledge. Whenever the victim is a juvenile who cannot be recognised, the absence of permission to healthcare from responsible adults should be considered.

Surviving persons are divided into 4 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 have 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 unconsciousness state and escape their wounds, as well as some who are wounded, unresponsive, and die to their injuries in hospital, makes its way to final two categories. Such persons, that are so gravely damaged as they seem unable to disclose personal information, might well be considered as posing the biggest challenge to the recognition process. In such circumstances, this becomes more customary to recognise the person using the same procedures that were 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 unconscious person and the dead individual in order to complete the DVI paperwork for identifying reasons. To establish a DNA data, DNA specimens are retrieved [20]. If feasible, fingerprints and tooth condition 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 a dna profiles, or commenting on the appearance of diseases or artificial organs, and several data which could be used to guide

recognition data gathering and comparing, the forensic anthropologist can supplement the assessment of radiologists. Information of differences in outward traits including complexion colour 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 owing to an inadequate knowledge.

## CONCLUSION

Forensic anthropologists are continually researching novel approaches and procedures to improve humanoid identity whenever conservation occurs in skeletonise 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 large fatality incidents throughout the nation. Based on ongoing and prospective breakthroughs with their self 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 its impact on the Disaster victim identification precedure have been described in this study.



## REFERENCES

1. Prinz, M.; Carracedo, A.; Mayr, W.; Morling, N.; Parsons, T.; Sajantila, A.; Scheithauer, R.; Schmitter, H.; Schneider, P.M. 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. [**Google Scholar**] [**CrossRef**]

2. Andelinović, S.; Sutlović, D.; Ivkosić, I.E.; 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. [**Google Scholar**] [**PubMed**]

3. Milos, A.; Selmanović, A.; Smajlović, L.; Huel, R.; Katzmarzyk, C.; Rizvić, A.; Parsons, T.J. Success Rates of Nuclear Short Tandem Repeat Typing from Different Skeletal Elements. *Croat. Med. J.* **2007**, *48*, 486–493. [**Google Scholar**] [**PubMed**]

4. Montelius, K.; Lindblom, B. DNA analysis in Disaster Victim Identification. *Forensic Sci. Med. Pathol.* **2012**, *8*, 140–147. [**Google Scholar**] [**CrossRef**] [**PubMed**]

5. Ziętkiewicz, E.; Witt, M.; Daca, P.; Zebracka-Gala, J.; Jarząb, M.G.B. Current genetic methodologies in the identification of disaster victims and in forensic analysis. *J. Appl. Genet* **2012**, *53*, 41–60. [**Google Scholar**] [**CrossRef**]

6. Calacal, G.C.; Apaga, D.L.T.; Salvador, J.M.; Jimenez, J.A.D.; Lagat, L.J.; Villacorta, R.P.F.; Lim, M.C.F.; Fortun, R.D.; Datar, F.A.; De Ungria, M.C.A. Comparing different post-mortem human samples as DNA sources for downstream genotyping and identification. *Forensic Sci. Int. Genet.* **2015**, *19*, 212–220. [**Google Scholar**] [**CrossRef**

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

8. Dedouit F, Savall F, Mokrane F-Z, et al. . Virtual anthropology and forensic identification using multidetector CT. Br J Radiol. 2014;87:20130468. [PMC free article] [PubMed] [Google Scholar]

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. [Google Scholar]

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. [PubMed] [Google Scholar]

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. p. 57–69. [Google Scholar]

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

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. [PubMed] [Google Scholar]

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. [PubMed] [Google Scholar]

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

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. [PubMed] [Google Scholar]

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 Apr.

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. p. 288–304. [Google Scholar]

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. [Google Scholar]

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 396, no. 10258 (October 17, 2020): 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 26, no. SUPP_1, 1 (October 2020): 83–95. 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 26, no. SUPP_1, 1 (October 2020): 125–53. 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 L. S. Roberts, et al. "Global Injury Morbidity and Mortality from 1990 to 2017: Results from the Global Burden of Disease Study 2017." INJURY PREVENTION 26, no. SUPP_1, 1 (October 2020): 96–114. 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 2019." LANCET 396, no. 10258 (October 17, 2020): 1250–84. https://doi.org/10.1016/S0140-6736(20)30750-9.