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DNA Identification in Mass Casualty – Forensic Perspective

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Abstract

Fire related mass casualty incidents have always been difficult in terms of identification. Often the bodies recovered are in such bad shape making the process near impossible to get them identified through secondary methods of identification. Extremely charred bodies having remnant burnt soft tissue and bones are most difficult to get identified. It is exactly where Primary method of identification i.e. DNA Analysis comes into play.

One such incident occurred at a Sanitizer manufacturing factory where tragic massive fire broke out engulfing lives of seventeen adult humans. The victims were trapped because of ongoing fire making it inescapable. On autopsy, necessary samples were preserved and sent for DNA Analysis to Forensic Science Laboratory. Blood samples of all claiming relatives were also sent to the laboratory for cross matching of the DNA. Identity of all victims was thus ascertained, once again proving how DNA Analysis has been a scientific boon to the humans.

Key words: Body identification, DNA Fingerprinting, Mass Casualty, STR Profiling.

Introduction

Human generated disasters in form of fire related mass casualty are frequently encountered by the medical professionals. Establishment of identity of a victim is necessary on humanitarian grounds for all the grieving relatives and for legal purpose to achieve closure for that case. Human body consists of about six thousand billion cells which constitute organ systems. Every living cell has got some genetic material having chromosomes located inside the nucleus. DNA - Deoxyribonucleic acid, being only present in nucleated cells is made of chemical molecules, which codes for a particular protein called gene. Gene is further located on each segment of a chromosome. DNA resists variations in temperature and pH. It also doesn't lose its characteristics on contamination with adulterants

The primary and most reliable means of identification are visual identification, fingerprint analysis, comparative dental analysis, DNA analysis and personal belongings.[1] DNA identification is a technique which involves chemical division of DNA into small fragments forming a unique pattern and matching that 'identity profile' with the pattern

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obtained from the test's sample. Loci is a specific region within DNA which is short and repeats itself. Short tandem repeat loci are a class of highly polymorphic DNA markers which consist of simple, tandemly-repeated sequences of l-6 bp in length.[2] These loci often exhibit length variation (polymorphism) due to differences in number of repeat units present, making them ideal markers for use in human identification.[3,4]

The present autopsy study highlights the establishment of identity of seventeen charred and completely burnt bodies through DNA Identification by Polymerase Chain Reaction Technique involving Short Tandem Repeats (STR) Analysis.

Material and Methods

The present study was carried out at Byramjee Jeejeebhoy Government Medical College and Sassoon General Hospital, Pune in the year 2021. The autopsy series comprised of Seventeen extremely charred and burnt bodies which were brought at the mortuary in fibre jute sacks. All the bodies were recovered from a mass casualty site at a sanitizer manufacturing factory where a sudden tragic fire had occurred. They were in such bad shape that it had become impossible to get them identified by personal effects and other secondary methods of identification. The fire rendered all the bodies in a crumpled deformed shape. The complete autopsy was carried out on all deceased and for identification by DNA profiling.

All the bodies were assigned a serial number for labelling. Piece of sternum bone was preserved in 09 cases, part of humerus bone preserved in 02 cases, part of femur bone preserved in 04 cases, part of tibia bone preserved in 01 case, part of fibula preserved in 02 cases and teeth were preserved in 08 cases and sent to Regional Forensic Science Laboratory. The blood samples of next of kin were sent for comparative DNA analysis. The data obtained was tabulated and analysed systematically and is shown in Table 1. All the samples were typed at 15 STR Loci and gender specific amelogenin locus using PCR Amplification technique.

Observations

On autopsy during the external examination, all the bodies showed 100 percent superficial to deep burn injuries with complete blackening, charring and heat ruptures exposing internal organs to the exterior. Heat ruptures of skull exposing underlying cooked brain matter were observed in 15 cases. Sex could be only determined in 04 bodies out of 17 where two male bodies and two female bodies were identified. On internal examination, all the organs were cooked and hardened. Uterus and ovaries were observed and identifiable in 14 cases and prostate was identifiable in 02 cases. Preliminary sex allocation to all the bodies was done based on autopsy findings.

DNA from bone and tooth samples was analysed at 15 autosomal STR markers (D7S820, D19S433, CSF1PO, D13S317, D8S1179, VWA, TPOX, D3S1358, D19S43, D5S818, TH01, FGA, D16S539, D2S1338 and D18S51), to determine the owner of these samples. For sex determination of the victims we included the X/Y specific amelogenin gene marker. The DNA profiling conclusively established the identity of all sixteen victims and for the seventeenth case as no parental relatives were available, the identity was established by exclusion.

Table 1: DNA profiling of victims and cross matching through DNA (Autosomal and Y STR Typing) Methods

CASE NO.	STR LOCUS	GENOTYPE		SEX ON EXTERNAL EXAMINATION	SEX ON INTERNAL EXAMINATION
		DNA OF VICTIM	DNA OF ALLEGED FATHER/MOTHER /SON/DAUGHTER/ HUSBAND		
UNKNOWN FEMALE	D7S820	8,11	8,11	NON IDENTIFIABLE	UTERUS AND OVARIES
	D19S433	13,13	13,1		
	AMEL	X,X	X,Y SON		
2. UNKNOWN FEMALE	CSF1PO	12,12	12,12	FEMALE	UTERUS AND OVARIES
	AMEL	X,X	X,X DAUGHTER		

CASE NO.	STR LOCUS	GENOTYPE		SEX ON EXTERNAL EXAMINATION	SEX ON INTERNAL EXAMINATION
		DNA OF VICTIM	DNA OF ALLEGED FATHER/MOTHER /SON/DAUGHTER/ HUSBAND		
3. UNKNOWN FEMALE	D7S820	8,12	8,12	NON IDENTIFIABLE	UTERUS AND OVARIES
	D13S317	10,11	10,11		
	AMEL	X,X	X,Y SON		
4. UNKNOWN FEMALE	D8S1179	14,14	14,14	NON IDENTIFIABLE	UTERUS AND OVARIES
	CSF1PO	12,12	12,12		
	VWA	17,17	17,17		
	TPOX	8,9	8,9		
	AMEL	X,X	X,Y FATHER		
5. UNKNOWN FEMALE	D3S1358	15,16	15,16	NON IDENTIFIABLE	UTERUS AND OVARIES
	D19S433	12,13	12,13		
	TPOX	11,11	11,11		
	D5S818	11,12	11,12		
	D18S51	12,13	12,13		
	AMEL	X,X	X,X MOTHER		
6. UNKNOWN FEMALE	D19S433	13,14.2	13,14	NON IDENTIFIABLE	UTERUS AND OVARIES
	AMEL	X,X	X,Y FATHER		
7. UNKNOWN FEMALE	NO PARENTAL DNA SAMPLE AVAILABLE		HUSBAND	NON IDENTIFIABLE	UTERUS AND OVARIES
8. UNKNOWN FEMALE	CSF1PO	10,12	10,12	NON IDENTIFIABLE	UTERUS AND OVARIES
	D3S1358	16,18	16,18		
	AMEL	X,X	X,X MOTHER		
9. UNKNOWN FEMALE	D3S1358	15,16	15,16	NON IDENTIFIABLE	UTERUS AND OVARIES
	AMEL	X,X	X,X MOTHER		
10. UNKNOWN FEMALE	CSF1PO	12,12	12,12	NON IDENTIFIABLE	UTERUS AND OVARIES
	AMEL	X,X	X,Y FATHER		
11. UNKNOWN FEMALE	D7S820	8,10	8,10	FEMALE	UTERUS AND OVARIES
	TPOX	11,11	11,11		
	TH01	9,9	9,9		
	D16S539	9,12	9,12		
	AMEL	X,X	X,Y SON		
12. UNKNOWN MALE	CSF1PO	10,11	10,11	MALE	PROSTATE
	D3S1358	15,16	15,16		
	TPOX	11,11	11,11		
	AMEL	X,Y	X,Y FATHER		

CASE NO.	STR LOCUS	GENOTYPE		SEX ON EXTERNAL EXAMINATION	SEX ON INTERNAL EXAMINATION
		DNA OF VICTIM	DNA OF ALLEGED FATHER/MOTHER /SON/DAUGHTER/ HUSBAND		
13. UNKNOWN HUMAN BODY-MALE	D8S1179	13,16	13,16	NON IDENTIFIABLE	NON IDENTIFIABLE
	D7S820	11,11	11,11		
	D3S1358	15,17	15,17		
	D13S317	12,12	12,12		
	AMEL	X,Y	X,X MOTHER		
14. UNKNOWN FEMALE	D7S820	8,8	8,8	NON IDENTIFIABLE	UTERUS AND OVARIES
	AMEL	X,X	X,Y SON		
15. UNKNOWN FEMALE	D3S1358	15,15	15,15	NON IDENTIFIABLE	UTERUS AND OVARIES
	D13S317	9,12	9,12		
	VWA	16,17	16,17		
	TPOX	11,11	11,11		
	D5S818	12,13	12,13		
	FGA	21,23	21,23		
	AMEL	X,X	X,X MOTHER		
16. UNKNOWN FEMALE	D5S818	11,11	11,11	NON IDENTIFIABLE	UTERUS AND OVARIES
	D2S1338	18,23	18,23		
	AMEL	X,X	X,Y FATHER		
17. UNKNOWN MALE	D3S1358	15,17	15,17	MALE	PROSTATE
	TH01	7,9	7,9		
	AMEL	X,Y	X,Y FATHER		

Discussion

Establishment of identity in mass casualty is an extremely challenging task which demands a careful planning and execution involving a team of life savers, police personnel and medical experts including forensic pathologists and forensic odontologists. In the present autopsy study, all the bodies were completely charred and unidentifiable by other means where DNA profiling helped to establish the identity of victims.

In charred fire victims, both autolytic changes as well as deleterious effects of heat will cause degradation of the DNA.[5] The advantage of using STR technology is that polyacrylamide gels can resolve DNA fragments differing by as little as one nucleotide in length, allowing precise allele designation and thus removing the need for continuous allele distribution models and match guidelines required for conventional DNA profiling methods.[6] Thus, the applicability of Restriction Fragment Length Polymorphism (RFLP) analysis can be limited. PCR provides greater sensitivity and specificity for genotyping/phenotyping techniques. It obviates the need for radio isotopic detection, and it also reduces the time and laboratory work required. Moreover it enables the analysis of extensively degraded samples.[7,8]

For forensic purposes, a study of at least 08 loci is recommended in STR typing. Teeth being resistive to incineration, decomposition, microbial action, temperature and weather changes is an excellent source for DNA collection.[9,10] Pulp tissue is used commonly to extract DNA because it is least likely to get contaminated and remains protected by dentin

and highly mineralised enamel- hardest structure in human body.[11]

DNA can be usually extracted from canines and molars where molars being more preferred.[12,13] Raimann P.E. et al. in their study proposed that molars and premolars were good samples to obtain DNA profiles irrespective of the type of laboratory procedure used or if body was decomposed.[14] Chances of any two individuals having same 08 Loci DNA profile are one in one billion. In the present study as well, teeth were preserved for DNA identification.

On August 29, 1996, a Russian Airliner crashed while landing resulting in death of all 141 passengers and crew members on board. 257 body parts recovered from the disaster site were reconstructed into 141 individuals by STR analysis at 8 loci. Individual victim identification of 139 persons was successfully established while reference DNA samples were not available for 2 persons demonstrating a 100% success rate for DNA typing.[15]

Soares-Vieira J.A. et al. solved a police chase following a kidnapping where a car crashed and burnt completely. On autopsy, blood from the corpse's cardiac chamber was preserved which was compared to DNA obtained from corpse's alleged biological parents. Blood collected from the carbonized corpse, even with highly degraded DNA, could be analysed by the PCR technique and positively identify the victim.[5]

A raging fire broke out on 19 April,1993 near Waco, Texas, USA in a compound where a large stockpile of armaments and ammunitions were kept leading to unabated fire because of continuous explosion of these munitions. 61 extremely charred remains were recovered. Analysis of specimens from 61 bodies with parental samples predicted the genotype of 26 victims and identifications were made using the STR quadruplex.[16]

In the present autopsy study, external examination could not establish sex for all the victims except 04. Internal examination findings helped in sex allocation to 16 victims. Victim's body identifications were successfully established using the results from reference DNA samples in form of blood to predict the genotype of the deceased family member, in a paternity-style analysis. All the seventeen victims were identified using DNA analysis typing at 15 STR Loci for each victim.

Conclusions

DNA profiling serves as an irrefutable evidence of unjustified convictions and establishes a vital link to the actual executioners of crimes. It also dissuades some offenders from committing more serious offenses in future. Criminals can be convicted by the evidence provided through DNA profiling. It has become the gold standard for identification of victims in both mass casualty incidents and forensic cases where human remains are highly fragmented and / or degraded, due to a relatively low cost and high degree of discrimination.[4]

This present study has demonstrated the utility of PCR amplification of STR loci when applied to forensic investigations, especially when involved in identification of extremely charred and unidentifiable bodies in fire related mass casualty. This study also illustrates the vital role that DNA typing plays for individualization of extremely damaged human remains. PCR based techniques can provide a means for typing DNA derived from samples of fire victims. The technology is simple and provides data in an expeditious manner. When reference DNA samples are readily available, this approach may be extremely useful for rapid potential identification of human remains.

Statements and Declarations

Conflict of interest: The authors declare that they have no conflict of interest

Funding- The authors did not receive support from any organisation for the submitted work.

Ethics approval - All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was granted exemption from requiring institutional ethics approval, because the deceased victims were charred and burnt lacked the possibility

of their identification by personal effects or facial recognition, required a quick identification by DNA profiling so as to be handed over to their respective relatives or family for cremation and closure of case.

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