



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 10, October 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com



Identification of Victims of the Bhilai Steel Plant, Chhattisgarh Fire Blast in October 2018 through DNA Fingerprinting

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ABSTRACT: In the case of any mass fatality incident, victim's real identification must be undertaken instantaneously. The non-identification or incorrect identification in such cases may result in several issues at emotional and legal levels for the family members and friends. This paper describes work conducted during the identification of the victims of a fire accident that occurred on October 9, 2018 at Bhilai Steel Plant, Durg, Chhattisgarh. This accident resulted in the loss of 9 lives and 14 sustained injuries. The DNA analysis performed in the stipulated time period permitted the identification of all 09 body remains but 04 of them were swapped. The data indicates that in this fire accident, several of the original identifications of the bodies (prior to DNA testing of the remains) had been erroneous. Thus, with the help of DNA analysis the real identity of the bodies was established.

KEYWORDS: Bhilai Steel Plant, Fire accident, Original Identification, DNA profiling, Body remains.

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I. INTRODUCTION

The proper identification of a deceased is not only important for humanitarian and emotional reasons for the next-of-kin but also for legal and administrative purposes. For some the grieving process starts as soon as the family members are aware of the suspected loss but the positive identification of the decedent also may be needed and helpful with so-called "closure". Some families feel that the ambiguity is more difficult to deal with than the conclusive identification. From both legal and administrative point of view, non-identification creates additional problems. People manage as best they can, and the use of DNA fingerprinting in identification procedures is often a vital element in this.

On October 9, 2018, a fire blast (**Figure 1**) took place at 10.30 am in a gas pipe line of Coke Oven Battery Complex No. 11 during a scheduled maintenance job at the Bhilai Steel Plant situated in Durg district, Chhattisgarh. Nine persons (**Figure 2**) were killed and 14 injured in a fatal fire. The identification procedure currently followed in such cases in our country is based on recognition by kin of morphological features and personal belongings such as clothing or jewellery, but these become increasingly difficult to employ where victim remains have been charred, mutilated or decomposed ^[1, 2]. It has been suggested that DNA based identification would be more effective in these situations. Looking at the matter, two Senior Scientific Officers from State Forensic Science Laboratory (SFSL), Raipur, Chhattisgarh rushed to BSP to guide the Investigation agencies and Medical Officers for the collection of samples (bone and tissue from victims and blood from their relatives) for DNA analysis from victims and their relatives. Two of the relatives were unable to recognize features for identification with any degree of confidence. The decision was therefore taken to attempt identification based on DNA profiling of all 09 victims by comparison of their DNA profiles with their relatives, the majority of them were their parents or children. Using reference blood samples of claimant relatives, identifications were made directly using a 'paternity style' analytical approach. The paper provides details of the loci used and also deals with efforts to evaluate the applicability of STR profiling and its suitability for forensic investigations of this nature.



Figure 1: Fire blast at Bhilai Steel Plant.



Figure 2: Burnt bodies (A and B) at incident spot.

II. CASE HISTORY

At the police station, Information Register of Premature and Accidental Death for 09 victims were launched by police personhood under section 174 of The Code of Criminal Procedure (Cr.P.C.). The detailed account of the received cases and exhibits at DNA Unit of State Forensic Science Laboratory, Raipur, Chhattisgarh are given in the **Table 1** and **Table 2**.

Table 1: Summary of received BSP cases.

Sr. No.	Marg No.	DNA No.	Body Tag No.
1	42/18	94/18	15
2	43/18	95/18	16
3	44/18	96/18	17
4	45/18	97/18	18
5	46/18	98/18	19
6	47/18	99/18	20
7	48/18	100/18	21
8	49/18	101/18	22
9	50/18	102/18	23

**Table 2: Details of received exhibits.**

Marg No.	No. of Packets	Exhibit	Internal Coding	Property Seized
42/18	03	A-1	742	Tissue
		A-2	743	Bone
		A-3	744	Blood
43/18	03	B-1	745	Tissue
		B-2	746	Bone
		B-3	747	Blood
44/18	03	C-1	748	Tissue
		C-2	749	Bone
		C-3	750	Blood
45/18	03	D-1	751	Tissue
		D-2	752	Bone
		D-3	753	Blood
46/18	03	E-1	754	Tissue
		E-2	755	Bone
		E-3	756	Blood
47/18	03	F-1	757	Tissue
		F-2	758	Bone
		F-3	759	Blood
48/18	03	G-1	760	Tissue
		G-2	761	Bone
		G-3	762	Blood
49/18	03	H-1	763	Tissue
		H-2	764	Bone
		H-3	765	Blood
50/18	03	I-1	766	Tissue
		I-2	767	Bone
		I-3	768	Blood

III. METHODOLOGY

To obtain reliable final results of identification tests, the use of appropriate nucleic acid extraction methods is crucial. DNA preparations were obtained and analyzed from body samples (tissue, bone and blood) of the victims and their claimant relatives, with the aid of commercially available kits and according to the set protocols^[3]. Since, the samples obtained from the victims were burnt and in charred condition, it required screening and pre-processing. The tissue adhering to the surface of the burnt bones was removed. Samples were then cut into small pieces and washed with Nuclease Free water (NFW). The samples were left to dry overnight at room temperature. The dry bone powders were incubated for de-calcification in 5 ml of 0.5 M EDTA, pH8.0 solution for consecutively 03 days with fresh EDTA added each day at room temperature with continuous rotation at 40 rpm in rotary mixer (Tarsons Rotospin). After 03 days of de-calcification the de-calcified bone samples were submerged in Forensic Buffer, 20% SDS and Proteinase K (20 mg/ml) and incubated for 24 hrs at 56°C with periodic shaking at 700 rpm in Thermomixer (Eppendorff Thermomixer C). The lysates obtained from bone samples were brought to room temperature and subjected to Organic method³ of DNA Extraction. The extracted DNA was stored at 4°C. DNA extraction from blood samples were performed using PrepfilTM Forensic DNA Extraction Kit (Life Technologies Inc).



The extracted DNA (bone, tissue and blood) was quantified by Real Time PCR (RT-PCR) using Quantifiler[®] Duo DNA Quantification Kit (Life Technologies Inc). The amount of DNA was calculated by the RT-PCR (Applied Biosystems) instrument and software: 7500SDSV.1.1. AmpFISTRIdentifiler Plus[®] Kit was used to carry out multiplex PCR reaction for co-amplification of 15 autosomal STRs loci and a gender locus. The PCR products were then examined using electrophoresis system. Capillary electrophoresis was performed on Applied Biosystems-3130 Genetic analyzer using 36cm, 04 capillary arrays. The results of electrophoresis were analyzed using Gene Mapper IDX software V1.1.

IV. EXPERIMENTAL RESULTS

Out of the 09 cases, the questioned exhibits of 05 cases (DNA/94/18, DNA/98/18, DNA/100/18, DNA/101/18 and DNA/102/18) were found to be matching with their respective claimant relatives as shown in the **Table 3, 7, 9, 10** and **11**. The questioned exhibits of remaining 04 cases were found to be mismatch with their respective claimant relatives as given in the **Table 4, 5, 6** and **8**. The exhibits (bone and tissue) of deceased of DNA/95/18, DNA/96/18, DNA/97/18 and DNA/99/18 were found to be matched with the blood sample of claimant relatives of DNA/96/18, DNA/97/18, DNA/99/18 and DNA/95/18 respectively which is mentioned in the **Table 12.1, 12.2, 12.3, 12.4** and **13**. The above results indicated that in the latter 04 cases the identification of the deceased by the relatives on the spot was erroneous and DNA profiling revealed that the bodies were actually swapped during on- spot identification.

The allelic distribution (genotype) obtained from the studied loci in the exhibits is shown in the following tables.

Table No. 3: Allelic distribution of DNA/94/18 (Marg No. 42/18).

Genetic Markers	Article A-1 (Tissue) Exhibit 742	Article A-2 (Bone) Exhibit 743	Article A-3 (Blood) Exhibit 744
D8S1179	13,14	13,14	11, <u>14</u>
D21S11	29,32.2	29,32.2	29, <u>29</u>
D7S820	9,12	9,12	8, <u>9</u>
CSF1PO	11,12	11,12	<u>11,12</u>
D3S1358	17,18	17,18	<u>17,18</u>
TH01	7,9.3	7,9.3	6, <u>9.3</u>
D13S317	11,13	11,13	11, <u>13</u>
D16S539	10,11	10,11	9, <u>10</u>
D2S1338	19,19	19,19	<u>19,22</u>
D19S433	13,13	13,13	<u>13,13</u>
vWA	14,16	14,16	<u>16,17</u>
TPOX	8,10	8,10	<u>8,12</u>
D18S51	16,16	16,16	<u>16,20</u>
D5S818	11,13	11,13	<u>11,13</u>
FGA	20,23	20,23	<u>20,23</u>
Amelogenin	XY	XY	XY



Table No. 4: Allelic distribution of DNA/95/18 (Marg No. 43/18).

Genetic Markers	Article B-2 (Bone) Exhibit 746	Article B-3 (Blood) Exhibit 747
D8S1179	11,14	12,15
D21S11	28,29	31,33.2
D7S820	8,12	10,12
CSF1PO	10,11	11,12
D3S1358	16,16	15,18
TH01	7,9.3	6,6
D13S317	11,12	9,10
D16S539	12,13	10,12
D2S1338	17,19	20,25
D19S433	13,16.2	13.2,14.2
vWA	16,16	14,19
TPOX	11,11	8,11
D18S51	13,14	16,18
D5S818	9,12	11,12
FGA	24,25	19,24
Amelogenin	XY	XY

Table No. 5: Allelic distribution of DNA/96/18 (Marg No. 44/18).

Genetic Markers	Article C-2 (Bone) Exhibit 749	Article C-3 (Blood) Exhibit 750
D8S1179	12,15	15,16
D21S11	30,33.2	29,33.2
D7S820	10,12	10,10
CSF1PO	11,12	11,11
D3S1358	15,18	17,18
TH01	6,6	6,9
D13S317	10,12	9,11
D16S539	10,12	10,12



D2S1338	19,25	20,24
D19S433	13.2,16	14,14
vWA	18,18	15,18
TPOX	8,8	10,11
D18S51	15,15	16,16
D5S818	10,11	11,12
FGA	19,24	20,24
Amelogenin	XY	XY

Table No. 6: Allelic distribution of DNA/97/18 (Marg No. 45/18).

Genetic Markers	Article D-2 (Bone) Exhibit 752	Article D-3 (Blood) Exhibit 753
D8S1179	10,16	10,11
D21S11	29,29	29,30
D7S820	10,10	8,10
CSF1PO	10,11	11,12
D3S1358	16,17	15,18
TH01	6,9	6,9
D13S317	11,12	8,12
D16S539	10,12	10,11
D2S1338	19,20	20,23
D19S433	14,17	14.2,16
vWA	15,17	16,17
TPOX	10,11	8,8
D18S51	16,16	17,23
D5S818	10,11	11,12
FGA	20,23	23,24
Amelogenin	XY	XX



Table No. 7: Allelic distribution of DNA/98/18 (Marg No. 46/18).

Genetic Markers	Article E-2 (Bone) Exhibit 755	Article E-3 (Blood) Exhibit 756
D8S1179	10,15	<u>10,15</u>
D21S11	30,31.2	29, <u>31.2</u>
D7S820	8,10	10, <u>10</u>
CSF1PO	11,11	10, <u>11</u>
D3S1358	14,15	15, <u>15</u>
TH01	6,13.3	<u>6</u> ,9.3
D13S317	10,10	<u>10</u> ,11
D16S539	10,13	<u>10</u> ,11
D2S1338	18,24	<u>24</u> ,25
D19S433	13,14	<u>13</u> ,16
vWA	14,16	<u>14</u> ,18
TPOX	8,8	<u>8</u> ,10
D18S51	14,14	<u>14</u> , <u>14</u>
D5S818	11,13	<u>11</u> , <u>13</u>
FGA	20,20	<u>20</u> , <u>22</u>
Amelogenin	XY	XY

Table No. 8: Allelic distribution of DNA/99/18 (Marg No. 47/18).

Genetic Markers	Article F-2 (Bone) Exhibit 758	Article F-3 (Blood) Exhibit 759
D8S1179	10,13	11,15
D21S11	29,30	28,32.2
D7S820	10,11	8,12
CSF1PO	12,12	11,11
D3S1358	15,18	16,17
TH01	6,6	7,9.3
D13S317	11,12	12,14
D16S539	10,12	11,12



D2S1338	19,23	18,19
D19S433	15,2,16	13,16.2
vWA	17,19	16,19
TPOX	8,8	11,12
D18S51	17,20	13,19
D5S818	12,12	9,11
FGA	22,23	21,25
Amelogenin	XY	XX

Table No. 9: Allelic distribution of DNA100/18 (Marg No. 48/18).

Genetic Markers	Article G-1 (Tissue) Exhibit 760	Article G-2 (Bone) Exhibit 761	Article G-3 (Blood) Exhibit 762
D8S1179	10,11	10,11	<u>11,13</u>
D21S11	28,32.2	28,32.2	<u>28,30</u>
D7S820	11,12	11,12	<u>8,11</u>
CSF1PO	10,11	10,11	<u>10,11</u>
D3S1358	15,16	15,16	<u>16,17</u>
TH01	6,6	6,6	<u>6,9</u>
D13S317	10,11	10,11	<u>9,11</u>
D16S539	12,13	12,13	<u>11,13</u>
D2S1338	19,23	19,23	<u>18,19</u>
D19S433	14,14	14,14	<u>14,16</u>
vWA	17,20	17,20	<u>15,17</u>
TPOX	9,12	9,12	<u>11,12</u>
D18S51	10,12	10,12	<u>10,14</u>
D5S818	11,12	11,12	<u>11,11</u>
FGA	22,22	22,22	<u>22,24</u>
Amelogenin	XY	XY	XX



Table No. 10: Allelic distribution of DNA/101/18 (Marg No. 49/18).

Genetic Markers	Article H-1 (Tissue) Exhibit 763	Article H-2 (Bone) Exhibit 764	Article H-3 (Blood) Exhibit 765
D8S1179	10,14	10,14	<u>10</u> ,10
D21S11	29,30	29,30	<u>29</u> ,30
D7S820	9,10	9,10	8, <u>10</u>
CSF1PO	11,12	11,12	<u>11</u> , <u>12</u>
D3S1358	16,17	16,17	<u>16</u> , <u>17</u>
TH01	7,9	7,9	<u>7</u> , <u>9</u>
D13S317	13,13	13,13	9, <u>13</u>
D16S539	11,12	11,12	<u>11</u> ,13
D2S1338	18,23	18,23	<u>18</u> ,23
D19S433	14,14.2	14,14.2	<u>14.2</u> ,16
vWA	17,17	17,17	<u>17</u> ,18
TPOX	8,11	8,11	<u>11</u> ,11
D18S51	10,15	10,15	<u>10</u> ,14
D5S818	10,11	10,11	<u>11</u> ,13
FGA	22,23	22,23	21, <u>22</u>
Amelogenin	XY	XY	XX

Table No. 11: Allelic distribution of DNA/102/18 (Marg No. 50/18).

Genetic Markers	Article I-2 (Bone) Exhibit 767	Article I-3 (Blood) Exhibit 768
D8S1179	10,10	<u>10</u> ,15
D21S11	30,32.2	29, <u>32.2</u>
D7S820	10,13	<u>10</u> ,12
CSF1PO	12,13	11, <u>12</u>
D3S1358	15,18	16, <u>18</u>
TH01	6,7	<u>6</u> ,9
D13S317	12,12	11, <u>12</u>
D16S539	13,13	10, <u>13</u>



D2S1338	18,19	19, <u>19</u>
D19S433	16,16	14.2, <u>16</u>
vWA	14,14	<u>14</u> ,19
TPOX	11,11	9, <u>11</u>
D18S51	14,16	<u>14</u> ,14
D5S818	11,12	<u>11</u> ,11
FGA	22,24	<u>24</u> ,25
Amelogenin	XY	XY

Table No. 12.1: Final matching of sample after DNA profiling.

Genetic Markers	Article B-2 (Bone) Exhibit 746 Body Tag No. 16	Article B-3 (Blood) Exhibit 747	Article C-2 (Bone) Exhibit 749 Body Tag No. 17
D8S1179	11,14	12, <u>15</u>	12,15
D21S11	28,29	31, <u>33.2</u>	30,33.2
D7S820	8,12	<u>10</u> , <u>12</u>	10,12
CSF1PO	10,11	<u>11</u> , <u>12</u>	11,12
D3S1358	16,16	<u>15</u> , <u>18</u>	15,18
TH01	7,9.3	<u>6</u> , <u>6</u>	6,6
D13S317	11,12	9, <u>10</u>	10,12
D16S539	12,13	<u>10</u> , <u>12</u>	10,12
D2S1338	17,19	20, <u>25</u>	19,25
D19S433	13,16.2	<u>13.2</u> ,14.2	13.2,16
vWA	16,16	14,19	18,18
TPOX	11,11	<u>8</u> ,11	8,8
D18S51	13,14	<u>16</u> ,18	15,16
D5S818	9,12	<u>11</u> ,12	10,11
FGA	24,25	<u>19</u> , <u>24</u>	19,24
Amelogenin	XY	XY	XY



Table No. 12.2: Final matching of sample after DNA profiling.

Genetic Markers	Article C-2 (Bone) Exhibit 749 Body Tag No. 17	Article C-3 (Blood) Exhibit 750	Article D-2 (Bone) Exhibit 752 Body Tag No. 18
D8S1179	12,15	15, <u>16</u>	10,16
D21S11	30,33.2	<u>29</u> ,33.2	29,29
D7S820	10,12	<u>10</u> ,10	10,10
CSF1PO	11,12	<u>11</u> ,11	10,11
D3S1358	15,18	<u>17</u> ,18	16,17
TH01	6,6	6, <u>9</u>	6,9
D13S317	10,12	9, <u>11</u>	11,12
D16S539	10,12	10, <u>12</u>	10,12
D2S1338	19,25	<u>20</u> ,24	19,20
D19S433	13.2,16	<u>14</u> ,14	14,17
vWA	18,18	<u>15</u> ,18	15,17
TPOX	8,8	<u>10</u> ,11	10,11
D18S51	15,15	<u>16</u> ,16	16,16
D5S818	10,11	<u>11</u> ,12	10,11
FGA	19,24	<u>20</u> ,24	20,23
Amelogenin	XY	XY	XY

Table No. 12.3: Final matching of sample after DNA profiling.

Genetic Markers	Article D-2 (Bone) Exhibit 752 Body Tag No. 18	Article D-3 (Blood) Exhibit 753	Article F-2 (Bone) Exhibit 758 Body Tag No. 20
D8S1179	10,16	<u>10</u> ,11	10,13
D21S11	29,29	<u>29</u> ,30	29,30
D7S820	10,10	8, <u>10</u>	10,11
CSF1PO	10,11	11, <u>12</u>	12,12
D3S1358	16,17	<u>15</u> ,18	15,18
TH01	6,9	<u>6</u> ,9	6,6
D13S317	11,12	8, <u>12</u>	11,12
D16S539	10,12	<u>10</u> ,11	10,12



D2S1338	19,20	20, <u>23</u>	19,23
D19S433	14,17	14.2, <u>16</u>	15.2,16
vWA	15,17	16, <u>17</u>	17,19
TPOX	10,11	<u>8,8</u>	8,8
D18S51	16,16	<u>17,23</u>	17,20
D5S818	10,11	11, <u>12</u>	12,12
FGA	20,23	<u>23,24</u>	22,23
Amelogenin	XY	XX	XY

Table No. 12.4: Final matching of sample after DNA profiling.

Genetic Markers	Article F-2 (Bone) Exhibit 758 Body Tag No. 20	Article F-3 (Blood) Exhibit 759	Article B-2 (Bone) Exhibit 746 Body Tag No. 16
D8S1179	10,13	<u>11,15</u>	11,14
D21S11	29,30	<u>28,32.2</u>	28,29
D7S820	10,11	<u>8,12</u>	8,12
CSF1PO	12,12	<u>11,11</u>	10,11
D3S1358	15,18	<u>16,17</u>	16,16
TH01	6,6	<u>7,9.3</u>	7,9.3
D13S317	11,12	<u>12,14</u>	11,12
D16S539	10,12	11, <u>12</u>	12,13
D2S1338	19,23	18, <u>19</u>	17,19
D19S433	15.2,16	<u>13,16.2</u>	13,16.2
vWA	17,19	<u>16,19</u>	16,16
TPOX	8,8	<u>11,12</u>	11,11
D18S51	17,20	<u>13,19</u>	13,14
D5S818	12,12	<u>9,11</u>	9,12
FGA	22,23	21, <u>25</u>	24,25
Amelogenin	XY	XX	XY



Table No. 13: Analysis Summary.

Sr. No.	DNA No. (Before Examination)	Body Tag No.	Final Matching After DNA Profiling (Body Tag No.)	DNA No. (After Examination)
1.	94/18	15	15	94/18
2.	95/18	16	17	96/18
3.	96/18	17	18	97/18
4.	97/18	18	20	99/18
5.	98/18	19	19	98/18
6.	99/18	20	16	95/18
7.	100/18	21	21	100/18
8.	101/18	22	22	101/18
9.	102/18	23	23	102/18

Burnt bones show considerable modifications both in physical and chemical properties, and these could be hindrances to DNA profiling. Exposure to high temperature increases the difficulties of bone identification. The degree of modification increases with rising temperature and includes degradation of DNA, which compromises forensic identification techniques^[4].

Recognition of accident victims based on morphological features or clothes and ornaments is unreliable as is evident from the results presented in this paper. DNA profiling serves as a relevant tool to unambiguously identify the deceased in case the body has been mutilated to an extent that mere physical observation of the body, clothes or other belongings are not relevant to establish the actual identity of the deceased. DNA is the hereditary material that is transmitted from parents to offsprings and therefore DNA fingerprinting provides a cue to trace biological relationship between individuals.

Modern molecular technologies like PCR, Capillary electrophoresis and Nucleic acid sequencing have made it possible to carry out DNA fingerprinting accurately within a reasonably short time frame so as to resolve cases otherwise not liable to unwavering elucidation by any other means^[5]. In cases of burnt bones where the chances of finding nuclear DNA is meager, sequencing and SNP typing of mitochondrial DNA can provide the cue to identification of the deceased^[6].

V. CONCLUSION

Social management after mass casualty incident is very difficult. Moreover, in a country like India the cremation of deceased is very important as it provides a structure for honouring the deceased and offering comfort for the devastated family during the time of loss. That's why it is essential to have the real identity of the decedent. DNA fingerprinting is considered to be one of the most reliable and effective means to identify bodies or separated body parts. In our study we were able to correctly identify all 09 bodies through DNA profiling. Thereafter, the bodies of the victims were handed over to their relatives by the district and BSP authorities. This indicates that it might be possible to replace traditional identification methods with DNA typing. Furthermore, in such accidental cases, DNA profiling should be mandatorily undertaken through proper channel in order to establish the real identity of the deceased.

ACKNOWLEDGEMENT

DNA Unit of State Forensic Science Laboratory is acknowledges former Director ShriPawanDev (I.P.S.) as well as BSP governing body showing confidence towards the whole team. Special thanks to ShriKuldeepKujur, Senior Scientific Officer, Biology Division for his support. Last but not the least our staff members who did the meticulous work along with the team.



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