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Original Article

Reliability and Significance of Forensic Anthropology in Personal Identification in Comparison with DNA Profiling Technique in South Indian Population Using Case Studies

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ABSTRACT

Identification of a decomposed dead body is a universal problem for police agencies in all countries. The method of identification relied on in a country may vary based on the established identification techniques in its forensic sciences laboratories. The DNA profiling and the skull-photograph superimposition (SPS) are the two techniques employed in forensic laboratories to identify the decomposed human heads recovered from scenes of crime. While identification through DNA profiling is unambiguous and hence conclusive, SPS seem to provide only a probable opinion. Hence, SPS technique is considered only second to DNA profiling due to its inability to establish 'matchless' identity. For instance, similarities of the facial features of the victim to his/her siblings and close relatives pose a major challenge in conclusively establishing the identity of the victim. Since the Court of Law admits only conclusive evidences rather than probable opinions, experts from Forensic Anthropology Unit in forensic science laboratories often face difficult situations defending results based on SPS techniques. Though it might appear as if DNA profiling would fulfil the requirements of identification in all the cases, it is not so in many instances. In many vital cases, DNA profiling has also failed in providing corroborative evidence. This paper highlights the significance of Forensic Anthropology Unit by exploring its definite role in the identification of victims in various cases in different situations with case studies.

INTRODUCTION

The Forensic Anthropology Unit deals with identification of decomposed heads/skull, comparison of faces in two or more photographs and morphological examination for assessing origin, sex and age of bones/bone fragments. Thus, this unit plays a major role in identifying victims whose remains are decomposed beyond visual recognition. In 1935, Glaister and Brash[16] employed the SPS method for establishing the identity of two skulls recovered in a case known as Ruxton's case in England. Various improvised techniques in SPS were used for identification of skulls recovered from the scene of crime[3, 4, 6, 7, 11, 12, 13, 15, 18, 19, 20, 27, 28, 30, 32, 36]. In India, SPS is the most prevailing technique for establishing the identity of victims since the ante-mortem face photograph can be easily recovered[20, 22] and this technique is employed in South Indian Laboratories for personal identification. Although conclusive identity could also be established by using dental pattern revealing photograph or ante-mortem dental radiograph or ante-mortem radiograph of head for superimposition[20, 22, 23], the problem is that the availability of such records is rare. Despite the methodical approach involved in SPS technique, caution has been exercised by researchers with regard to 'false match' or 'mismatch' during superimposition[1, 7, 24, 34, 35]. This has been substantiated by the experimental evidence of Austin Smith and Maples[1] which proved the probability of mismatch estimated at 10% during superimposition of skull. Though some researchers enhanced the reliability of identification by establishing the anatomical relationship other than metrically correlating characters between the organs of skull and the features of the face[9, 10, 14, 20, 22, 25, 33, 38], the facial similarities among siblings and close relatives curtails

the experts from providing definite identity. The findings of SPS technique had been accepted in the Court of Law, before the advent of DNA profiling technique, as a 'definite identification method' (Shankar vs State of Tamil Nadu; Judgement in Referred Trial No. 3/1991 dated 17.7.92 High Court of Madras). However, of late, opinions of SPS are being questioned by the Court of Law as its findings are not conclusive.

AIM OF THE RESEARCH

The Forensic Sciences Department, Chennai, India has a well-equipped Forensic Anthropology Unit that has been receiving about 200 skulls and photographs every year for personal identification since 2000. However, a survey of records reveals that only 318 cases were received for a period of 15 years (from 1973 to July, 1987)[6]. This signifies the importance and increased preference of SPS over DNA profiling technique as the latter could not provide answers in some cases. Thus, SPS technique still remains a good choice. This paper intends to analyse the reliability and significance of SPS technique in comparison with DNA profiling technique in south Indian population using case studies.

MATERIALS AND METHODS

Skull-Photo Superimposition Unit

The skulls received (Table 1 and Figure 1) between the year 2005 and 2010 from various districts in south India and the corresponding face photographs that were referred for personal identification to this department were used for the present work.

Table 1: Cases received for SPS Technique

Year	No. of skulls received	No. of photographs received
2005	112	187
2006	83	157
2007	120	178
2008	105	188
2009	109	189
2010	130	291
	659	**1190**

Following are the steps involved in SPS Technique.

1. Cleaning of skull
2. Preparation of skull (if broken, reconstitution of the skull is needed)

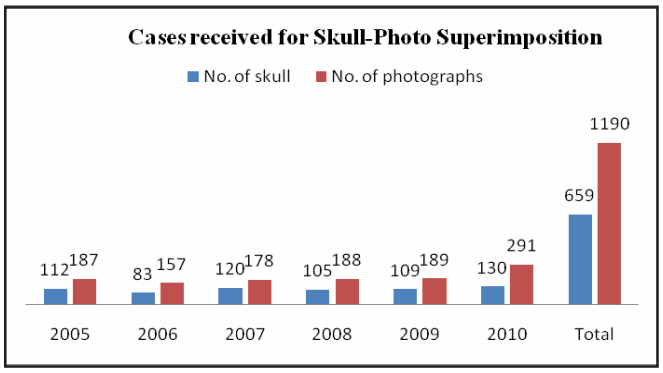

Figure 1: Number of cases received for skull-photo superimposition

Note: A case means either a skull or a photograph or photographs

3. Formulation of facial indices
4. Assessment of sex
5. Cranio-facial morphanalysis (skull-face relationships)
6. The computer Aided Video Superimposition of the skull and face, a technique improvised by Jayaprakash using computer Aided Video Superimposition Device[20, 22].

Among the cases mentioned in Table 1, the cases referred to DNA profiling, those with tentative clues indicating the identity of the suspected deceased, and the ones without controversy on identification were analysed to assess the reliability of skull-photo superimposition technique.

DNA Profiling Unit

The cases received for DNA profiling (Table 2 and Figure 2) between the year 2005 and 2010 from various districts in South India were studied.

Following is the procedure involved in DNA profiling.

1. Extraction of DNA from skull or bone.
2. Amplification for amelogenin (sex locus) and also for 15 STR loci using PCR amplified STR technique with commercially available Identifiler kit.
3. Running of the amplified products along with control on ABI prism, the automated DNA sequencer.

4. Analysis using GeneScan and Genotyper softwares with respect to standard ladder.
5. Repetition of above said procedures for the blood samples of the parents/children/spouse of the suspected deceased, received in FTA™ papers with its specific protocols.
6. Making the inference from DNA samples tested for different STR systems fix the identity.

Table 2: Cases received for DNA Profiling

Year	No. of cases received for DNA profiles
2005	121
2006	131
2007	168
2008	205
2009	234
2010	237

Note: A case means either a skull or a bone or a blood sample or blood samples

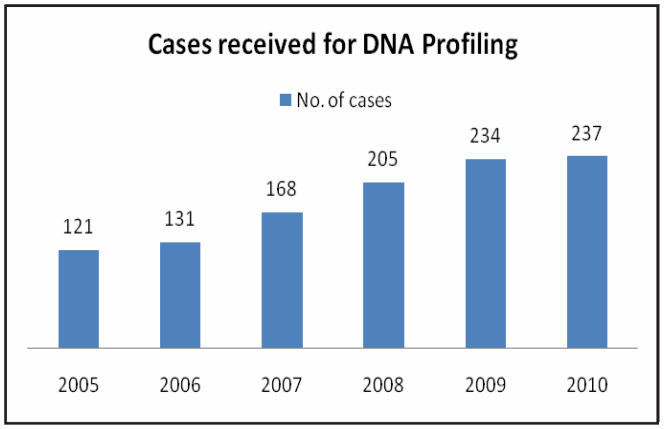

Figure 2: Cases received for DNA Profiling

Reliability of skull–photograph superimposition

Earlier, the reliability of skull-photograph superimpo-sition technique appears to have been over estimated. Researchers have always warned of mismatch and therefore this lack of reliability tends to dampen the confidence of the analysing expert. Gradually, additional parameters (facial features) were discovered to enhance the confidence of the analysing expert. A comparison of the results of skull-photograph superimposition technique and of DNA profiling technique for some cases is given in Table 3. It clearly shows the minimal percentage of controversy in identification between superimposition technique and DNA profiling technique.

'No Opinion' in SPS and DNA technique

Though the skull-face photograph superimposition does not give conclusive identity, it has solved identity problem in many vital cases. Table 4 and Table 5 (Figure 3) show the higher rate of 'No Opinion' in DNA profiles than in skull–photograph superimposition.

Reasons for 'No Opinion'

A study of case histories of 'No Opinion' cases in DNA Profiling shows that the following reasons could be attributed for its failure: high rate of decomposition, burning of the dead bodies at high temperature, bones buried in the soil for a longer period, and the preservation of the skull and bones in formalin and so on. The reasons for 'No Opinion' in SPS are attributed to the non-availability of original and clear photograph, hazy or distorted photograph not revealing the facial features and broken skull with missing facial skeleton and mandible[31].

Role of forensic anthropology in forensic sciences laboratories

The following cases demonstrate the significant role of SPS technique in personal identity when DNA profiles failed or delayed in aiding the investigation.

As corroborative evidence

Case 1

A skull without mandible along with a photograph of a

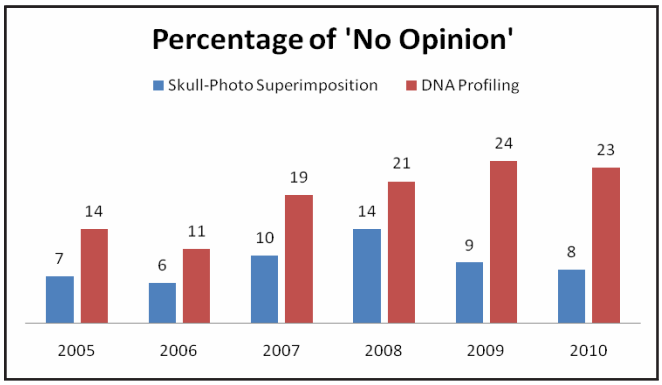

Figure 3: Comparison of Percentage in 'No Opinion' between SPS Technique and DNA Profiling

Table 3: Comparison of results between SPS Technique and DNA Profiling

Year	Total No. of cases received for skull-photo superimposition	Total No. of cases received for DNA profile	No. of cases referred to both techniques	Contradictory results between both techniques
2005	236	121	32	Nil
2006	179	131	45	Nil
2007	255	168	62	Nil
2008	227	205	72	1*
2009	237	234	90	1*
2010	265	237	110	1*
	1399	1096	382	3*

(*Positive Identity in superimposition technique, but exclusion in DNA technique)

Table 4: Percentage of 'No Opinion' in SPS Technique

Year	No. of cases received for skull -photograph superimposition	No. of cases rendered no opinion in identification	Percentage of 'No Opinion' cases
2005	236	16	7
2006	179	10	6
2007	255	25	10
2008	227	32	14
2009	237	22	9
2010	265	22	8

Table 5: Percentage of 'No Opinion' in DNA Profiling

Year	No. of cases received for DNA profiles	No. of cases rendered no opinion in identification	Percentage of 'No Opinion' cases
2005	121	17	14
2006	131	15	11
2007	168	32	19
2008	205	43	21
2009	234	55	24
2010	237	54	23

10-year-old girl was forwarded to the laboratory from one of the Indian states for personal identification using SPS technique. The murder was done due to personal enmity. The slightly decomposed dead body with certain belongings was identified by the parents. The case needed a corroborative evidence for identification purpose. Actually, the DNA profiling laboratory of their own state rendered 'no opinion' in identification due to the failure in amplification of extracted DNA from the bones of the dead body. Though the conclusive identity could not be achieved by SPS technique, a probable opinion was given to this case using Computer Aided Video Superimposition technique. The cranio-facial matching (skull-face comparison) of the features, especially the nasal ridge asymmetry and the asymmetry in the frontal bones (Figure 4a,b,c) during skull-face comparison increased the analyst's confidence. The SPS technique supported the investigation as corroborative evidence. This opinion helped in providing justice as well.

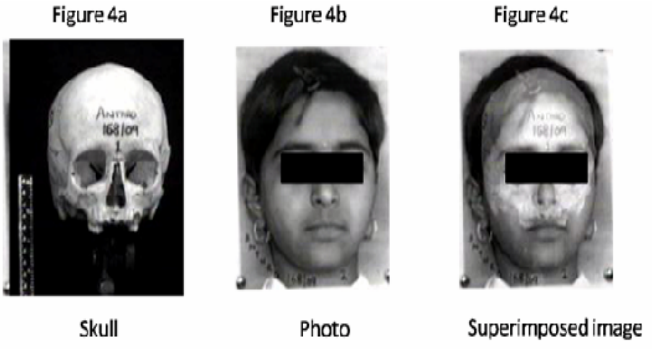

Figure 4a,b,c: Show how the skull matched with the photo during skull-photo superimposition

Case 2

An 8-year-old boy was kidnapped and murdered. The buried dead body was recovered inside a bush upon the confession by the accused. The parents of the deceased identified the dead body with the help of the clothing and also other belongings. A skull with mandible along with the photographs of the suspected deceased was forwarded to the laboratory for personal identification through DNA profiling as well as through SPS technique. The extracted DNA could not be amplified for the amelogenin that is, the sex locus and also for 15 STR loci using PCR amplified STR technique in DNA profiling unit. Though the anterior dental pattern revealing photographs were recovered, the dental pattern superimposition could not be carried out due to missing of anterior dentition in the skull. However, a positive identification was given through SPS along with cranio-facial matching (Figure 5a,b,c). The opinion from SPS was used as corroborative evidence in this case, while DNA profiling failed in personal identity.

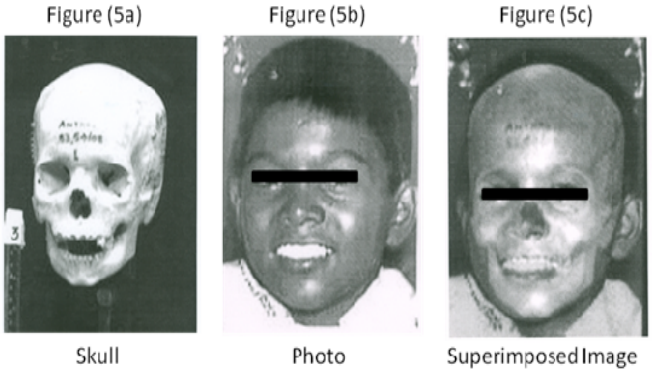

Figure 5a,b,c: Show how the skull matches with the photo during skull-photo superimposition.

Speedy delivery of reports

Case 1

This was a case of murder for gain. A decomposed dead body was found near a highway. The dead body was identified by her family members. This case was referred to both SPS and DNA profiling for personal identification. A positive identification was given through this procedure along with cranio-facial matching (Figure 6a,b,c) while the report from DNA profiling fixed the identity, but was

Figure 6:(a) The brow ridge eminences, the nasal ridge asymmetry and the occulusial asymmetry in the skull; (b) Manifestations of the above in the photograph of the deceased 6(b); (c) Matching of the skull during skull-photo superimposition

delayed. This speedy delivery of report through SPS unit helped the investigation.

Case 2

This was a case of murder due to a property dispute. The dead body was identified through the clothing, tattoo mark in the hand and other belongings such as cell phone and wrist watch. The forensic report on identity was required in this case. A report with positive identity using SPS with the conjoint application of cranio-facial morphanalysis (Figure 7a,b,c) was given within a week

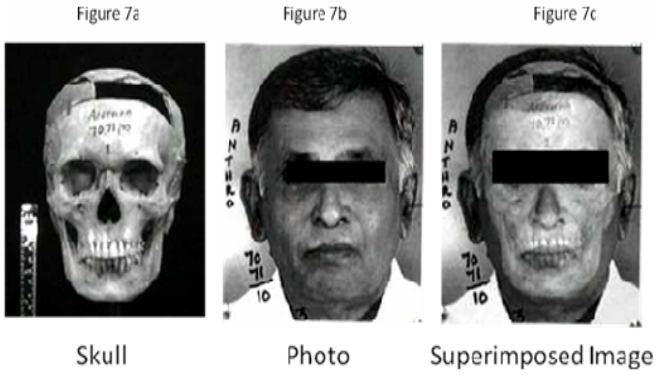

Figure 7:(a) The brow ridge asymmetry, the nasal ridge pattern and the conspicuous occulusial asymmetry in the skull; (b) Manifestations of the above in the photograph of the deceased; (c) Matching of the skull during skull-photo superimposition

while the report from DNA profile was received after a few months due to some technical problems.

Definite identity

Case 1

An unidentified burnt dead body was found inside a temple situated in rural Tamil Nadu. Femur bone of the dead body was taken during autopsy and was forwarded to the laboratory to get DNA profile which would be useful in future comparison. However, the DNA could not be extracted using PCR amplified STR technique. After a few months, the burnt and decomposed head of the above case was forwarded along with photographs of 16 different individuals for SPS. Among the 16 individuals, the police investigation suspected a person who had been missing for the past one month. This case eventually became very sensational as the missing person belonged to a political family. Fortunately, photographs revealing the dental pattern of the two suspected deceased among the 16 different individuals were received. Skull-face photograph superimposition was carried out for all the face photographs forwarded. A definite identity was tallied for one among the 16 individuals but not tallied with a missing person involved in the sensational case. This definite identity was given with the help of dental pattern superimposition along with SPS (Figure 8a,b,c,d). Furthermore, a molar tooth was taken from the skull and sent for DNA profiling. The DNA profile comparison was also done with the parents of one of the suspected deceased whose identity was fixed in superimposition technique. DNA profile also fixed the identity of the deceased person in this case. The work done in the superimposition unit was appreciated by the investigating agency as this technique solved a sensational case.

Case 2

A decomposed and broken skull found inside a forest was forwarded along with the photographs of a male individual for SPS. When this case was taken up for analysis, a peculiar pattern of dental arrangements were found in upper dentition. Broken pieces of skull were obtained after cleaning. A skull with mandible was obtained after the reconstitution of broken pieces of the skull. Dental pattern superimposition was carried out since the upper dental

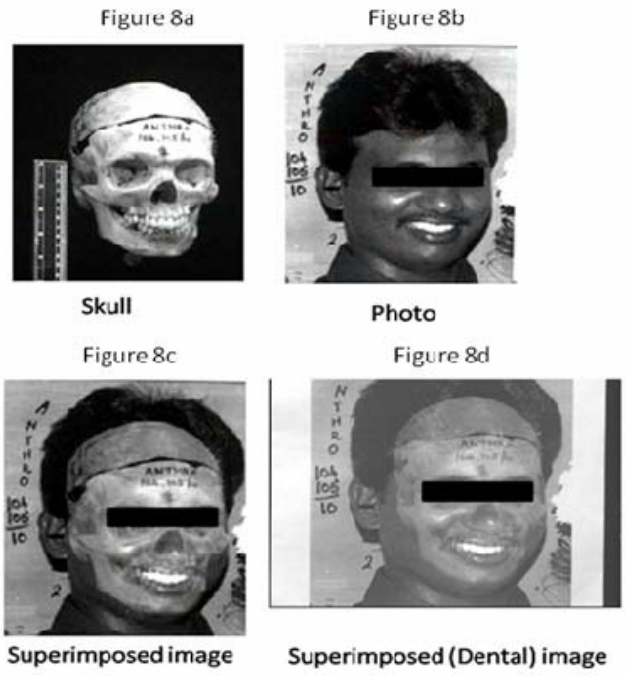

Figure 8:(a) The skull evidencing asymmetry in nasal ridge, nasal spine and dental pattern; (b) Manifestations of the above in the photograph of the deceased; (c) Matching of the skull during skull-photo superimposition; (d) Shows the matching during dental superimposition

arrangements of the face photograph (Figure 9a,b,c,d) had a striking resemblance to the skull, and definite identity was generated from superimposition technique. Simultaneously, the femur bone of the decomposed dead body was sent for identification through DNA profiling. However, the report of conclusive identity using dental superimposition was sent a few months before the DNA profile report for identity purpose.

Case 3

A partially burnt and skeletonized dead body was found in a mountain. Investigation suspected that the skeleton belonged to a famous priest living in that mountain who was missing since the last 15 days. The dead body was identified through partially burnt hair, sacred-beads (*rudraksha*) and shoulder bag with some other belongings of the priest. A skeletonised skull and the dental pattern revealing photograph of the priest were received for SPS. Examination of the dentition in the skull revealed an oblique

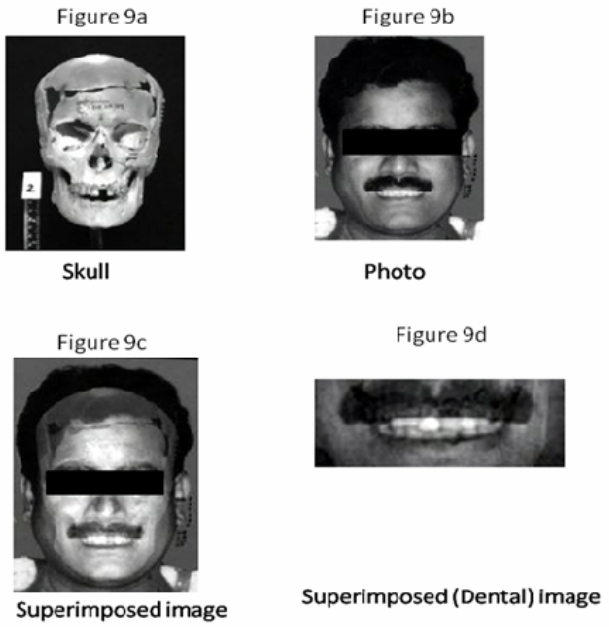

Figure 9:(a) The skull evidencing asymmetry in nasal ridge, nasal spine, the brow ridges, protruding mentum and dental pattern; (b) Manifestations of the above in the photograph of the deceased; (c) Matching of the skull during skull-photo superimposition; (d) Matching during dental superimposition

attrition in the left maxillary central incisor. While the skull was positioned in accordance with the posture of the face in the photograph revealing the teeth, the SPS (Figure 10a,b,c,d) revealed congruence between the dental outline and the oblique attrition seen in the incisal edge of the left upper central incisor of the skull demonstrated a striking match with the corresponding dental outline and attrition seen in the face photograph. Correlation based on dental morphology generated a 'definite identity' of the skull.

DISCUSSION

Skulls recovered from scenes of crime are excellent biological evidence for establishing personal identification. DNA profiling and SPS are the techniques used in forensic sciences for personal identification. DNA testing in a forensic setting was first performed in 1986. Presently, this technique is the 'primary identifier' as it gives conclusive identity. SPS is an accepted scientific method for individual identification of unidentified human skulls

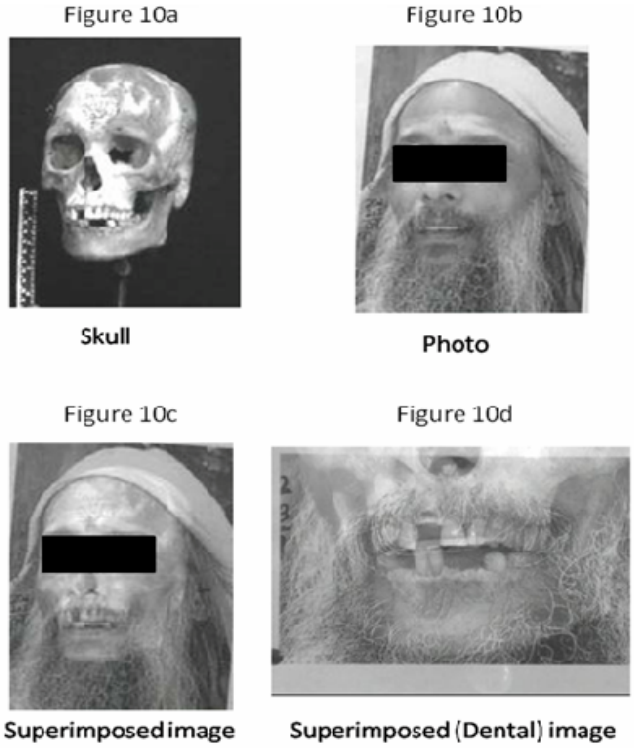

Figure 10:(a) The skull evidencing asymmetry in nasal ridge, nasal spine and dental pattern; (b) Manifestations of the above in the photograph of the deceased; (c) Matching of the skull during skull-photo superimposition; (d) Matching during dental superimposition

along with the conjoint applications of comparison of features of the face and corresponding bony traits of the skull. This technique was accepted in the courts of law from the year 1935 even before DNA profiling became popular. However, it gives only a possible identification due to the striking similarities in the facial features among siblings and close relatives[20, 22]. In the recent years, the court of law also expects 'definite identity' from the superimposition technique. The success rate of identification through SPS technique is higher than through DNA profiling technique. Under the above circumstances the role of 'SPS' in Forensic Science Laboratory must be established. The above study established that SPS helped investigation in the following ways.

1. Speedy investigation: the report can be obtained in a shorter time period.

2. It is used as an initial screening tool in some vital cases
3. It helps as corroborative evidence in all the cases where positive opinion is given.
4. It rendered definite identity in some vital cases.

However, the work of Austin-Smith and Maples[1] who verified superimposition using one skull with multiple photographs found a chance of about 10% wrong match between a skull and an unrelated photograph. They used only a 12-inch TV monitor and hence did not evaluate fitness in 'life size'. Furthermore, they did not apply anthropological measurements from the skull for bringing out the life size of the face photographs[21].There was only a minimal percentage of controversy in identification between DNA and superimposition technique. When the reliability of SPS was verified with the results of DNA profiling as it is the primary identifier, 378 out of 382 showed similar reports and only four cases out of 382 were contradictory in their result (excluded personal identity in DNA profiles were included in superimposition technique). The following points may/may not be attributed to the controversy raised in those cases.

The relatives (son/daughter) whose blood samples are produced for comparison were not born to the father.

The skull (for superimposition) and femur (for DNA profiling) from different dead bodies might have been sent for personal identification on an assumption that they belong to the same individual.

CONCLUSION

The role of SPS for personal identification in forensic laboratory is very important. It may be used as an initial screening tool[17]. Personal identity may be recognized within a short span of time. Its opinion should be used to supply corroborative evidence[24]. The use of ante-mortem radiograph in skull superimposition has been suggested to offer conclusive proof on personal identification[5, 8, 20, 22, 23, 26, 29, 37]. SPS technique is effective in situations where blood relatives of the suspected dead individuals cannot be located due to lack of tentative identity thereby hindering DNA based identification[21]. SPS is the only solution for personal identification when other identification techniques encounter certain practical problems relating to decomposition and the time involved. When the failure rate is more in primary identifiers, SPS is the only solution to solve a case and provide justice.

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