Heritability and correlation of lip print, palm print, fingerprint pattern and blood group in twin population

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Abstract

Background: Twins are similar in many ways owing to the genetical and environmental factors. However, still, there are certain things that are not similar among them, and this is the challenge for personal identification among the twins.

Objectives: Our present study aimed to know and assess the similarities and differences present between the monozygotic (identical) and dizygotic (fraternal) twins in relation to lip prints, palm prints, fingerprints and blood group and to evaluate their heritability among parents and their offspring.

Materials and Methods: The study group comprised 30 twins and their parents – 15 identical and 15 nonidentical twins. The age of twins ranged from 15 years to 40 years. Lip print, palm print, fingerprint and blood group were statistically analyzed.

Results: All the data were subjected to statistical analysis. The identical twins showed more percentage of similarities in comparison to the non identical twins. The inheritance pattern was significant for twins in case of their lip prints while palm prints and finger prints showed no such significance in inheritance pattern whereas there was significant association seen in case of blood groups of identical twins and their parents.

Conclusion: Lip prints, palm prints, fingerprints and blood groups are the important parameters in forensic science for individual identification. Many studies have been done till now in individual but very few studies done in twin population. To the best of knowledge, ours is the first study of its kind with multiple parameters and its heritability in twins. We have observed that heritability in twins with relation to lip print was statistically significant and all the parameters can be used independently to identify the twins.

Keywords: Blood group, fingerprint, hereditability, lip print, palm print, twins

INTRODUCTION

Forensic science implies to the areas of attempt that can be used in judicial cases which is accepted by the court and the general scientific community to separate truth from untruth.[1] Lip prints, fingerprint and palm prints

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are unique for an individual as they do not change during their lifetime. Lip prints deal with the study of lip lines and fissures present in the zone of transition of human lip (Cheiloscopy).[2-5] The science of dermatoglyphics involves study of palm print and fingerprint. Palm print is defined as prints on a palm which are mainly composed of palm lines and ridges. Principal lines are defined according to their position and thickness – heart line, head line and life line.[6,7] Fingerprint pattern is represented by the lines present on the fingertip which is basically divided into three types – arch, loop and whorl.[8]

Twins are classified as either dizygotic (fraternal) or monozygotic (MZ) (identical) twins. Twins are siblings carried together in the womb and born at the same time. Analysis of similarities and differences between twins can be used to answer questions about the role of genes and the environment play in the development of traits such as personality, intelligence and susceptibility to disease. The study of large number of twins allows researchers to draw conclusions about inheritance with significant degree of confidence. Twins are similar in many ways owing to the genetical and environmental factors. However, still, there are certain things that are not similar among them, and this is the scope for personal identification among the twins. On the contrary, if there are certain similarities among the twins, those can be used for solving medicolegal cases or identification problems in the absence of one of them, with the help of the other.[9]

Many studies have been reported for personal identification of a person in different population, but no study includes heritability and association of lip, palm and fingerprint in identical and nonidentical twin population, correlating with their blood groups.

### Aim and objectives
The aim of this study was as follows:
1. To evaluate the predominant pattern of lip, palm, fingerprint and blood group in twin population
2. To know and assess the similarities and differences present between the MZ (identical) and dizygotic (nonidentical) twins in relation to lip prints, palm prints and fingerprints
3. To evaluate the heritability of lip prints, palm prints and fingerprints among parents and their offspring (twins)
4. To evaluate the heritability and correlation of blood groups among parents and their twins.

MATERIALS AND METHODS

The study group comprised 30 twins and their parents – 15 identical and 15 fraternal twins each. The age of twins ranged from 15 years to 40 years. Those who were willing to participate in the study with no known history of allergy to any of the materials used for recording lip prints were selected. Participants who are suffering from trauma to lips, lip anomalies, pathologies and skin lesions, trauma to palms and physical abnormalities were excluded. The consent from all participants was obtained.

The participants (both twins and their parents) were asked to rinse the mouth with water and lips allowed to dry. Brown or dark red-colored lipstick was applied, and the participant was asked to spread it uniformly over the lips. Lip impression was made on a transparent self-adhesive tape by dabbing the glued portion of the tape first in the center and then toward the corner of the lips. Lip prints were traced in the normal rest position of the lips. The lip impression was immediately pasted on a white bond paper. The central one-third of each participant's lip print was analyzed with the help of magnifying glass. Lip print was also evaluated using digital photographs with smartphone. Y Tsuchihashi and T Suzuki's classification (1950) was used for lip print analysis. Materials used in this study were as follows: dark-colored lipstick, dark-colored lip liner, lipstick applicator brush, petroleum jelly, transparent cellophane tape, scissors, cotton wool, white-colored executive bond sheets, magnifying glass and disinfectant spray [Figure 1a and b].
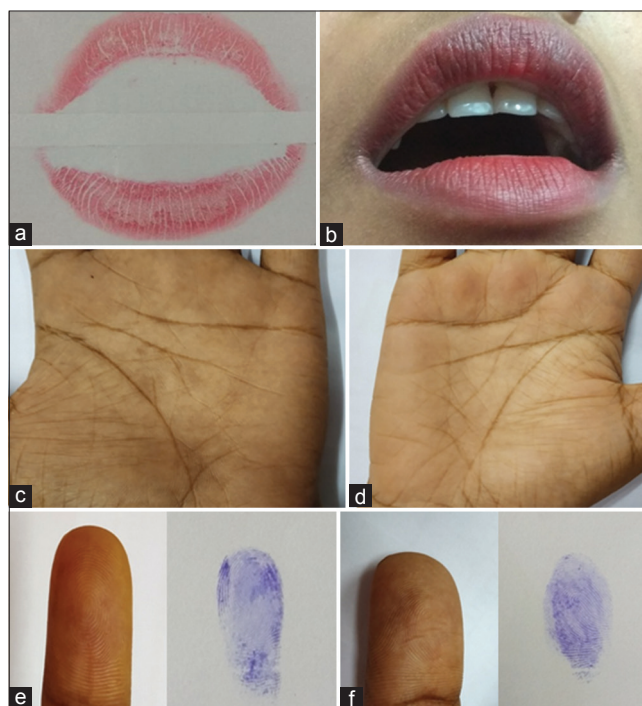
Figure 1: (a and b) Lip print with cellophane tape method and with digital camera method, respectively. (c and d) Various palm pattern using smartphone digital camera. (e and f) Various fingerprint using smartphone camera and ink print

Wu *et al.*'s classification was used for palm print analysis. Digital photograph of the right and left palms is shown in Figure 1c and d, all the five fingertips were taken with digital camera using smartphone and principal lines were analyzed [Figure 1e and f]. Blood groups were obtained and cross-checked with the medical reports. The blood group of participants was identified by placing a drop of blood on the slide and treated with anti-A, anti-B and then on anti-Rh sera. Positive agglutination of the blood on treating with anti-A is considered as blood Group A, and positive reaction with anti-B is considered as blood Group B; if no agglutination is produced, then the blood group is O, and if agglutination is seen with both antisera, then blood Group AB is considered. Similarly, positive agglutination reaction with Rh antigen is considered Rh$^+$ or otherwise Rh$^-$.

Data were compiled and analyzed by using the Statistical Package for the Social Sciences 20.0 statistical software. $P \leq 0.05$ was considered as statistically significant.

RESULTS

The most predominant lip pattern obtained in the present study was Type II [Graph 1]; Type I – complete vertical pattern (28%), Type II – branched groove (35%), Type III – intersected pattern (5%), Type IV – reticular pattern (32%) and Type V – other patterns (none). Category 5 was most predominant pattern of both left and right palms. Frequency pattern of the left palm was Category 4 – 37%, Category 5 – 66% and Category 6 – 14% [Graph 2]. The frequency pattern of the right palm was Category 4 – 34%, Category 5 – 51% and Category 6 – 16% [Graph 3]. Most predominant fingerprint pattern observed in the study population is that of loop. Most predominant blood group seen in the above study was that of O^{+ve}.

### Similarities observed in identical twins
The left palm shows 84%, right palm 80%, right thumb 78%, right index finger 66%, right middle finger 73%, right ring finger 66%, right little finger 86%, left thumb 93%, left index finger 66%, left middle finger 46%, left ring finger 53%, left little finger 53%, lips 93% and blood group 100% [Graph 4a and b].

### Similarity observed in nonidentical twins
The left palm shows 81%, right palm 78%, right thumb 73%, right index finger 73%, right middle finger 60%, right ring finger 73%, right little finger 73%, left thumb 66%, left index finger 53%, left middle finger 66%, left ring finger 66%, left little finger 60%, lips 93%, blood group 80% [Graph 5]. The similarities between the twins in various aspects were illustrated in Graphs 4 and 5a and b.
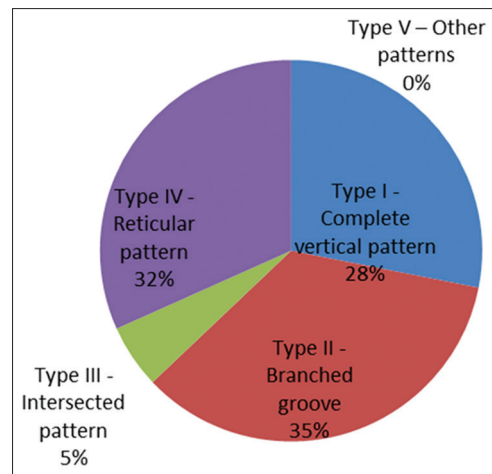
Graph 1: Presence of different types of lip pattern
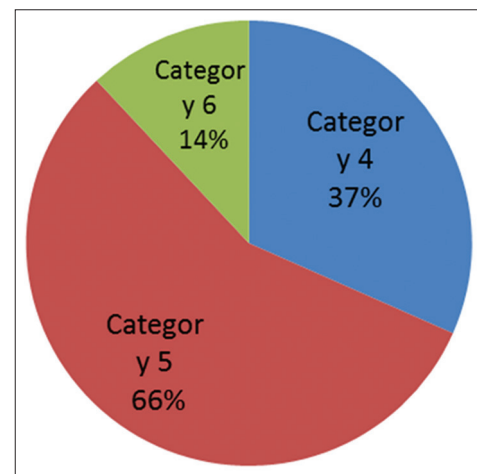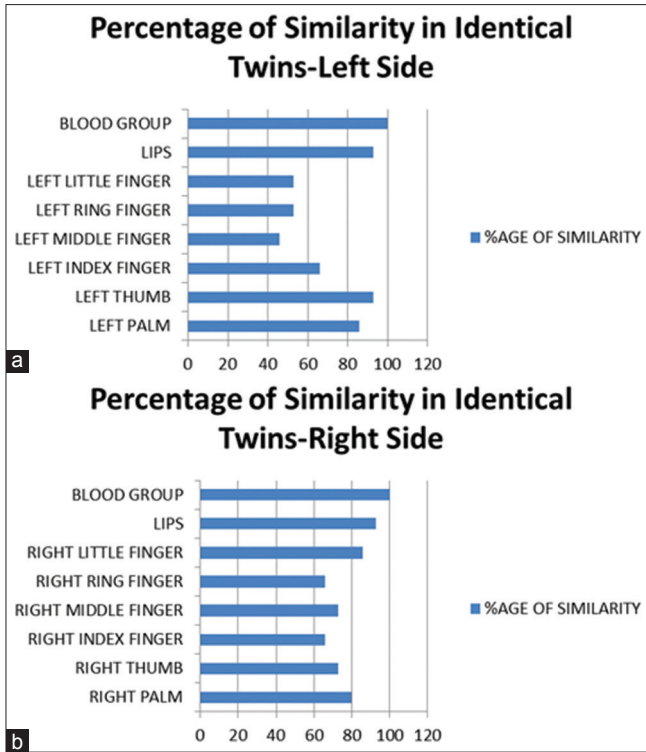

**Graph 2:** Presence of different types of the left palm pattern
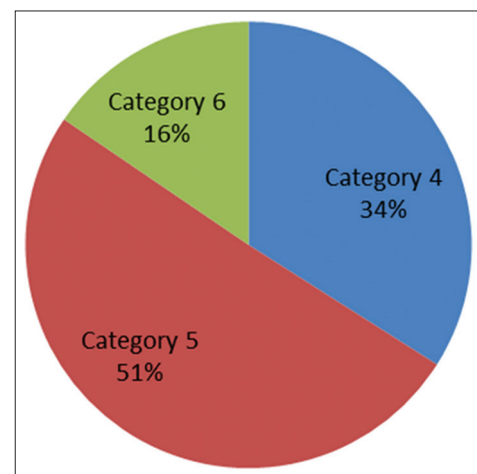
Graph 3: Presence of different types of the right palm pattern

Correlation of different parameters
1. There was a positive correlation between lip print pattern and parents of both identical and nonidentical twins, and it was found to be statistically significant, $P \leq 0.5$ [Table 1]

Graph 4: (a and b) Similarities observed in identical twins
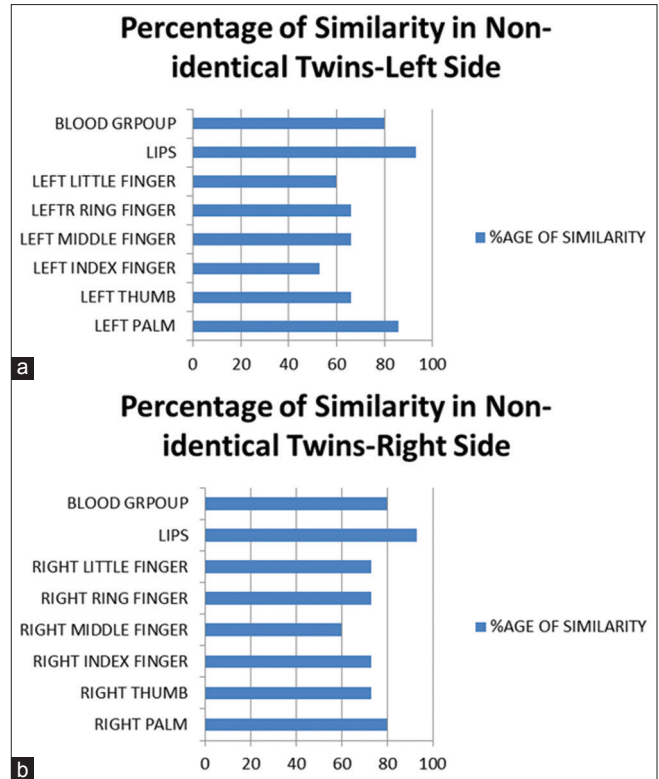
Graph 5: (a and b) Similarities observed in nonidentical twins

2. Association of palm print pattern of parents and twins showed positive correlation in case of both the left and right palms but was not statistically significant [Table 2]
3. There was a positive association between blood groups of parents and twins, but it was significant in case of identical twins [Table 3]
4. When the association of fingerprint pattern of twins was seen, mixed results were obtained. Some were negatively correlated, while some had positive correlation. However, none of them were statistically significant [Table 4].

DISCUSSION

Individual identification is a crucial task in forensic investigation. Although DNA comparison and fingerprint analyses are a common technique which are employed to ensure fast and secure identification, there are certain crime scenarios where other supplemental aids such as lip, palm and fingerprint become indispensable, since human identification involves combination of different procedures for individualizing a person or an object. The use of fingerprints and lip prints is of paramount importance, since doing a personal identification using other means such as DNA analysis is sophisticated and as they are not available in rural and developing countries.

Previously studies have been conducted to evaluate lip prints, fingerprints and blood groups separately in nontwin

Table 1: Association of lip print pattern of parents and identical and nonidentical twins

Variable	χ^2	P
All twins	4.66	0.04 (*P*<0.05)
Nonidentical twins	6.56	0.03 (*P*<0.05)
Identical twins	8.76	0.02 (*P*<0.05)

Table 2: Association of the left and right palm pattern among parents and twin

Variable	Palm print	χ^2	P
All twins	Left palm	7.78	0.254
	Right palm	6.72	0.342
Nonidentical twins	Left palm	9.24	0.312
	Right palm	8.32	0.210
Identical twins	Left palm	7.24	0.120
	Right palm	6.42	0.420

Table 3: Association of blood group between the parents and twins

Type of participants	χ^2	Significance (P)
Nonidentical twins and parents	3.96	0.111 (*P*>0.05)
Identical twins and parents	9.73	0.005 (*P*<0.05)

and twin population. To the best of our knowledge, in the past, none of the studies have been seen with multiple parameters and their inheritance from their parents in twin population.[2,9] Thus, our study aimed to evaluate multiple parameters in twins such as palm print, fingerprint, lip print and blood groups of twins and their inheritance pattern from the parents.

Lip prints and palm prints form a pattern that is unique for each individual. In 1950, two Japanese scientists, Y Tsuchihashi and T Suzuki, reported that the arrangement of furrows on the lip is unique and proposed a classification for the same, which is still in use.[10-12]

- Type I: Complete vertical (clear-cut grooves running vertically across the lip)
- Type I': Incomplete vertical (the grooves are straight but disappear halfway instead of covering the entire breadth of the lip)
- Type II: Branched groove (the grooves fork in their course)
- Type III: Intersected pattern (the grooves intersect)
- Type IV: Reticular pattern (the grooves are reticular)
- Type V: Other patterns (the grooves do not fall into any of the Type I to IV and cannot be differentiated morphologically) [Figure 2].

We have evaluated lip prints using magnifying glass and lipstick-cellophane tape method (conventional method). We have also evaluated lip print with digital camera photographs using smart-phone (digital method). As we identified the same lip print patterns with digital and conventional method, thus we suggest that in this digital era digital method is better as it save time and it's use easy to archived records for future studies and lot of
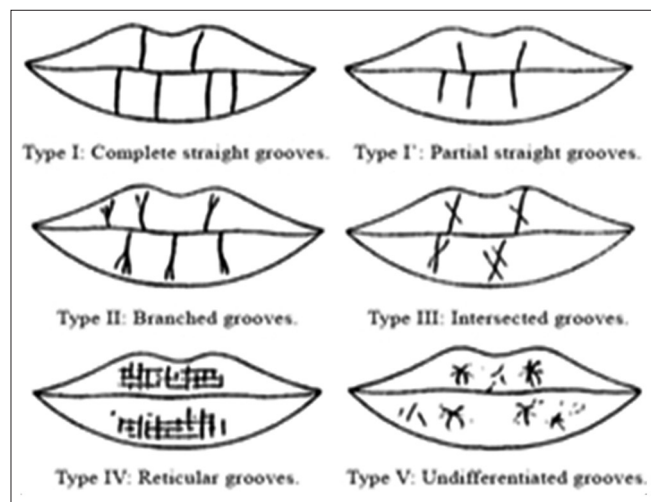

Figure 2: Tsuchihashi and Suzuki's categories of lip prints

convenience for patient as well as for investigator, whereas with conventional method patient feel inconvenience and sometime difficult to convince them to apply lipstick for printing. We found the most predominant pattern of Type II followed by Type IV in twin population. Regarding lip print, similarity observed in identical twins was 93%, and in nonidentical twins, it was 81%. We have also evaluated association of lip print pattern of parents with identical and nonidentical twins and found positive correlation between lip print pattern and parents of both identical and nonidentical twins, and it was found to be statistically significant [Table 1]. Thus, the inheritance pattern of the lips showed a significant value for the twins.

The study done by Verma *et al.*[13] confirmed the distinctiveness of cheiloscopy but in nontwin population. Thakur *et al.* suggested that resemblance of lip print patterns among MZ twins and dizygotic twins revealed that MZ twins resembled more with each other than dizygotic twins and also found a strong evidence of its inheritance.[14] Fernandes *et al.* also investigated that MZ twins presented a relevant percentage of cheiloscopic agreements and also suggested influence hereditary relationships on inherited cheiloscopic features.[15] Suzuki *et al.* and Hirth *et al.* also suggested in their study that twin families, mother/father and child combination proved a genetic basis of lip prints. This is concordance with our study. McDonell described two identical twins that seemed to be indistinguishable dentally, but lip print, handwriting and voice prints differed. Vahanwala and Pagare suggested that discrimination between a pair of identical twins can be made easy if lip prints assessed systematically and thoroughly. Hence, although the similarity percentage of identical twins is more than the nonidentical twins, still it is one of the important adjunct tools to solve forensic scenario.[16]

The palm print is one of the most reliable physiological characteristics that can be used to distinguish between individuals. Most palm prints show three principal lines: heart line, head line and life line. Regarding the number of their principal lines and the number of the intersections of these lines, palm prints can be classified into the following six categories, proposed by Wua *et al.*[2,6,7]

Table 4: Association of fingerprint pattern between the parents and the twins

	LT	LI	LM	LR	LL	RT	RI	RM	RR	RL
Association of fingerprint pattern between the parents and the identical twins										
χ^2	30	21	7	15	4	2	9	12	14	8
Significance (two-tailed) (*P*)	0.78	0.09	0.59	0.22	0.75	0.83	0.48	0.35	0.26	0.50
Association of fingerprint pattern between the parents and the nonidentical twins										
χ^2	3	18	5	2	11	5	6	13	15	4
Significance (two-tailed) (*P*)	0.77	0.15	0.68	0.86	0.38	0.67	0.64	0.28	0.24	0.75

LT: Left thumb, LI: Left index, LM: Left middle, LR: Left ring, LL: Left little, RT: Right thumb, RI: Right index, RM: Right middle, RR: Right ring, RL: Right little

- Category 1: Palmprints composed of no more than one principal line [Figure 3a]
- Category 2: Palmprints composed of two principal lines and no intersection [Figure 3b]
- Category 3: Palmprints composed of two principal lines and one intersection [Figure 3c]
- Category 4: Palmprints composed of three principal lines and no intersection [Figure 3d]
- Category 5: Palmprints composed of three principal lines and one intersection [Figure 3e]
- Category 6: Palmprints composed of three principal lines and more than one intersection [Figure 3f].

The most predominant pattern seen in our study was that of Type 5 followed by Type 4. Regarding similarity of
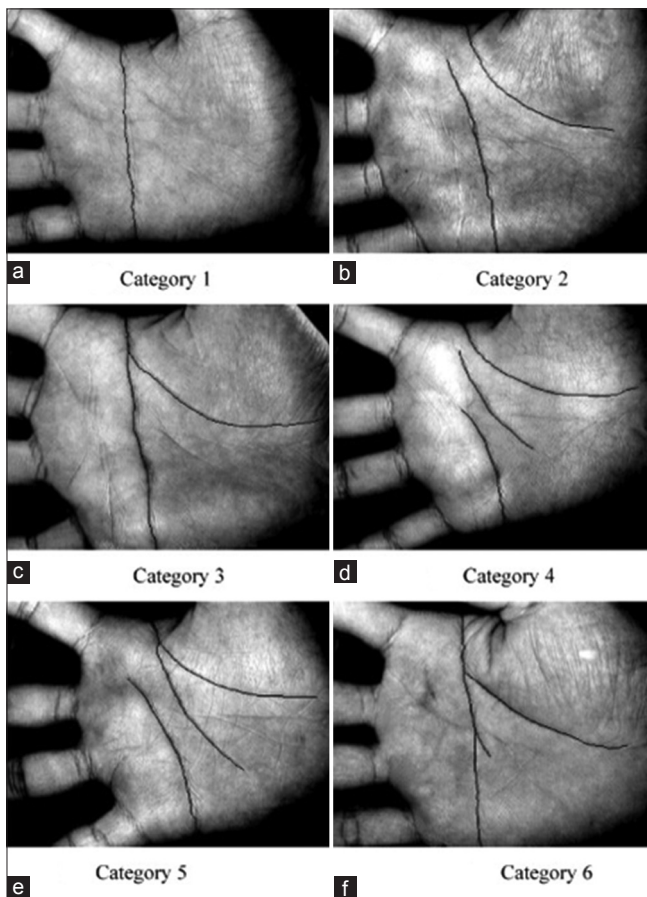

Figure 3: (a-f), Wua *et al*.'s categories of palm prints

palm print in identical twins, we found 84% similarities with left palm and 80% similarities in the right palm, and in nonidentical twins, we found 78% similarity with the right palm and 81% similarity with the right palm. We found association of palm print with their parents, but the inheritance pattern showed no such significance in case of palm prints of twins with their parents [Table 2]. Findings of Rekha *et al*.[2] in nontwin population of palm print are concordance with our study.

Fingerprints are divided into three groups, namely arches, loops and whorls [Figure 4]. Although numerous classifications have been subsequently offered, this simple classification is still recognized and used by majority of investigators today.[8] Jain *et al*. studied the similarity of identical twin fingerprints found that a state-of-the-art automatic fingerprint verification system can successfully distinguish identical twins though with a slightly lower accuracy than nontwins.[17] However, in a study done by Mishra *et al*. in 2013 on identical twin fingerprint similarity, it was seen that identical twins have 80%–95% dissimilarity in their thumbprints.[9] They evaluated only thumbprint in twin population, whereas we have evaluated all fingerprints in twins, and in our study, we found 78% right thumb similarity and 93% similarity with left thumb in identical twins. When the association of fingerprint pattern of twins was seen, mixed results were obtained. Some were negatively correlated, while some had positive correlation. However, none of them were statistically significant.

The similarity between twin prints is critical establish to the reliability of fingerprint identification. Liu and Srihari suggested that although the patterns of minutiae among twins are more similar, than in the general population, the similarity of fingerprints of twins is significantly different from that between genuine prints of the same finger. Twins fingerprints are discriminable with a 1.5%–1.7% higher equal error rate than nontwins.[18] Shrihari *et al*. suggested that there is more similarity between twin fingers than in the case of two arbitrary fingers, and there is no significant difference between the fingerprints of identical and fraternal twins, but twins can be successfully discriminated using fingerprints.[19]
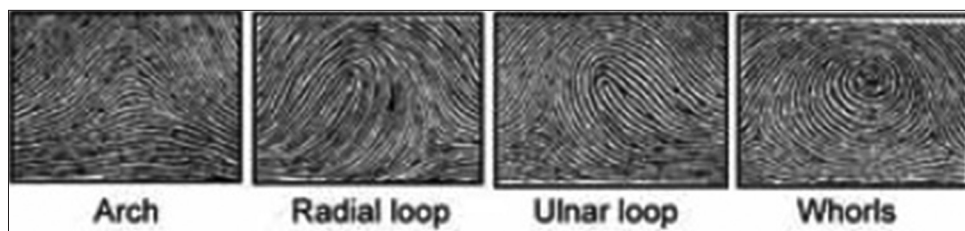

Figure 4: Types of fingerprints

Most predominant blood group observed in the study was that of O^{+ve}. It was seen that the identical twins have similar blood groups while the nonidentical twins could have different blood groups. This has been proved in many studies before too. However, DNA methylation has provided a suitable resource for MZ twin differentiation; however, studies addressing the forensic feasibility are lacking. The blood group is the biological record that remains unchanged throughout the lifetime of a person. Determining the blood group of a person from the samples obtained at the site of crime can aid in the forensic investigation. Vidaki A *et al*. did study regarding epigenetic discrimination of identical twins from blood under the forensic scenario and demonstrated the general feasibility of epigenetic twin differentiation in the forensic context and highlighted that some candidate markers identified in reference DNA were not shown informative in the trace DNA due to various, including technical, reasons. So the number of informative tDMSs (twin-differentially methylated sites) in the final trace DNA analysis is crucial. They suggested the need to address the optimal number of epigenetic markers required for reliable identification of MZ twin individuals including statistical considerations.[20] The study conducted by Eboh in 2016 showed that fingerprints, gender and blood groups can only be used independently to identify an individual and that there was no significant correlation between them.[21] We have also observed that there was no significant correlation between fingerprints or palm prints of twins with their parents, but the inheritance pattern of the lips showed a significant value for the twins.

CONCLUSION

It is known that individual parameters, i.e., lip print, fingerprint, palm print patterns and blood groups play an important role in forensic identification. We observed that these parameters cannot solely be used in twin's identification, but rather, they can be used to substantiate facts in crimes where there are utterly few evidence. The identical twins showed more percentage of similarities in comparison to the nonidentical twins. The inheritance pattern was significant for twins in case of their lip prints, while palm prints and fingerprints showed no such significance in inheritance pattern, whereas there was significant association seen in case of blood groups of identical twins and their parents. Nevertheless, further studies with larger sample size are needed in both identical and nonidentical twins, although it needs further genetic evaluation to locate the chromosome or gene responsible for inheritance.

Conflicts of interest
There are no conflicts of interest.

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