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Monozygotic and Dizygotic Twins Differences in Fingerprint Patterns of Swat District

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Abstract

Background: The identification of individual is important for both legal and humanitarian reasons. It is of great importance because every individual exists as an entity in a society and is dealt with as such by the legal system. The most commonly used method for identification is fingerprinting which relies on the uniqueness of ridges present on thumbs and fingers. These are unique in arrangements and remain constant throughout an individual's life. Fingerprints of no two individuals are same even if they are twins. The power of discrimination of the basis of fingerprinting is about one in 64 billion. The study was designed to carry out analysis of fingerprints from mono and dizygotic twins and to differentiate them on the basis of fingerprinting.

Methods: This was a prospective cross-sectional study carried out among 30 pairs of twins including 17 pair of monozygotic twins and 13 pair of dizygotic twins. After taking an informed expressed consent, the participants were asked to press their individual fingers on the stamp pad. They were asked to then put and roll the stamped finger onto an A4 size paper on which blocks for each finger were already made. Both left and right hands were fingerprinted and with the help of magnifying glass, different types were identified including Arches, Composite type, Loops and Whorls. SPSS software was used for data analysis.

Results**:** There was 7.6% of Arch type, 6.1% of tented arches, 1.5% of plain arches, 62.32% of loops, 6.66% of double loop, and 3.83% of central pocket loop, 44.83% of ulnar loop, 7% of radial loop, 0.83% of accidental loop, 29.93% of whorls, 9% of plain whorl and 20.1% of central the pocket whorl.

Conclusion: When the left and right thumbs are compared with each other using eight (8) points, there are matches on the first six (6) points, matching percentage for each of these pairs of fingers is 75%. But when the both fingers were rotated on 180° and compared, the matching percentage was 87.5%. These 8 points fingerprinting can be used to distinguish twins.

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Introduction

The identification of individual is important for both legal and humanitarian reasons. It is of great importance because every individual exists as an entity in a society and is dealt with as such by the legal system. These identifications are of use in civil or criminal cases such as Identification of offenders or interchange of newborn babies in hospital. There are many ways of identifying individuals. Some of them are not reliable and should be trusted such as handwriting, habits, gait and speech but there are methods which are certain and convincing. Fingerprints are one of the best ways of identifying an individual and it is the preferred way of individual ID within the scientific public for over a hundred years.

There are two types of twins: fraternal and identical. Fraternal twins can be easily identified as they differ in genetic composition, DNA sequence as well as face structure. However, identical twins have the exact same DNA sequence as well as face structure because they are produced from the same egg [1]. Nevertheless, these twins can be identified using thumbprints. A thumbprint image includes bifurcation points, ridges, left loop, right loop, arc and end points which are crucial in identifying twins [2,3]. Population genetic diversity as well as random process of editing during the development of embryo are responsible for the different characteristics of individuals [4,5].

Exactly matched DNA sequence is either present in identical twins or clones. Therefore, it is necessary to use biometric identification techniques which rely on an assessment of diversity in the traits due to random process affecting human development. Such an assessment strategy would necessarily rely on biometric samples from individuals who are similar in their genetic constitution. Fingerprint is the pattern of ridges on the tip of our fingers. It is one of the most established biometric technologies and is routinely presented in courts of law all over the world as a legitimate evidence. These ridges are fully formed at about 7 months of fetus development and these configurations normally do not change throughout the life unless fingers are bruised, cut or other accidental damage occurs on the finger tips.

Fingerprints are routinely used by forensic science labs and identification units for criminal investigations. Lately, due to the availability of inexpensive but accurate solid-state scanners, there is an increase number of routine identification scenarios e.g. logging in to electronic devices, attendance and welfare fund disbursement, where fingerprint identification is employed [6,7]. An important consideration is how heredity affect the ridges pattern? It has been shown in previous studies that identical twins significantly share fingerprint class as well as ridge count, ridge width, ridge separation, and ridge depth. Studies have found the maximum differences in fingerprint patterns between individuals from different races. In the same race, different persons who are unrelated shows little similarity while offspring share similarity with their parents. There is more similarity in fingerprint patterns of siblings while identical twins have been observed to have the maximum similarity [6]. Fingerprints are represented as a set of points, where each point corresponds to a minutia in the fingerprint. Different factors like location, type and direction of the ridge characterize each minutia. When using algorithms for fingerprinting, it works by first locating fingerprint ridges followed by extracting the minutiae as singular points on the thinned ridge map. Practically, automatic systems find it difficult to accurately locate these ridges on a fingerprint image. Quality of fingerprint image plays an important role in the performance of the ridge location algorithm, due to a number of factors such as aberrant formations of epidermal ridges in fingerprints and postnatal marks [8,9].

In Pakistan, fingerprints are used routinely in almost every walk of life, from banks to educational institutes to revenue department. However, scientific analysis of these fingerprints for identification is relatively new in Pakistan. It was started during the last decade or so when different provincial and federal governments started to establish forensic science laboratories for forensic case work including fingerprint identification [10].

Methods

This was a prospective cross-sectional study carried out among 30 pairs of twins including 17 pair of monozygotic twins and 13 pair of dizygotic twins. aged ranging from 5 to 29. Individuals with injuries or other abnormalities affecting their fingerprint patterns were excluded. After approval of the Institutional Ethical Committee, informed oral and written consent was obtained from the participants or their parents/guardians before taking fingerprints. The participants were asked to wash and dry their hands before starting the procedure. The participants were asked to press their individual fingers on the stamp pad. They were asked to then put and roll the stamped finger onto an A4 size paper on which blocks for each finger were already made. Other related information was also obtained on the fingerprint page like gender and age. Efforts were made to avoid smudges of prints. Both left and right hands were fingerprinted and with the help of magnifying glass, different types were identified including Arches, Composite type, Loops and Whorls. The participants were made cautious not to double roll the fingers to prevent smudging of the print. The data were analyzed using IBM SPSS Statistics v 21 (IBM Inc. USA) employing descriptive statistics and comparison of means.

Results

A total number of 720 fingerprints were used in this survey. Fingerprints were collected from 36 pairs of twins in which 20 were of monozygotic twins and 16 were of dizygotic twins. But of these 720 fingerprints, 6 pairs or 120 prints were distorted which were excluded and not used for comparison and the remaining 600 fingerprints were used. These included 17 fingerprints pairs of monozygotic and 13 pairs of dizygotic twins. The process was done manually in the laboratory instead of using any database or software.

Figure 1: Different types of fingerprints: (A) whorl type of fingerprint (B, C) loop type of fingerprint (D) arch type of fingerprint.

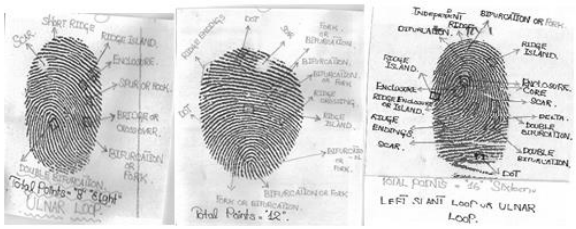

Figure 2: Using 8, 12 and 16 points for fingerprint analysis.

Figure 3: Thumb prints of non-identical twins.

Figure 4: Fingerprints of non-identical twin. (A1, A2, A3 and A4): left hand starting from little to index. (B1, B2, B3 and B4): right hand fingers starting from index to little finger.

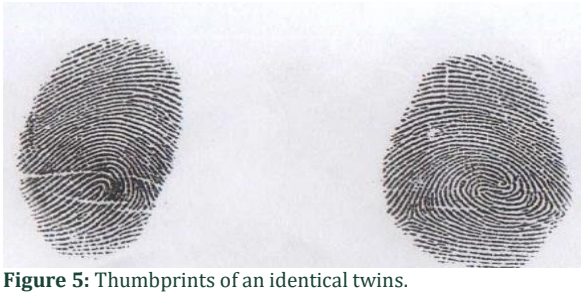

Figure 5: Thumbprints of an identical twins.

Figure 6: Fingerprints of identical twins. (A1, A2, A3 and A4): left hand starting from little to index. (B1, B2, B3 and B4): right hand fingers starting from index to little finger.

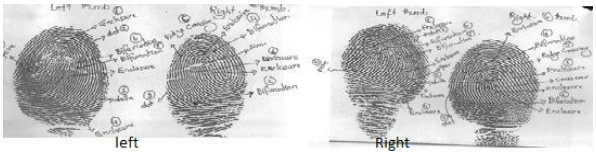

Figure 7: Comparison of prints from both left and right thumbs.

Each with eight (8) points. In both cases there are matching on the first six (6) points out of the total eight (8) points while the rest of the two (2) points remained unmatched. The matching percentage for each of these pairs of fingers is 75% whereas, that of the mismatched is 25%.

Figure 8: The above figure shows the rotation of the two fingers i.e. left middle and right middle finger.

The left middle finger is rotated on 180°.These fingers were then compared with a total of 8 points and the matched percentage was 87.5%, while the mismatched percentage was 13.5%.

Our results showed that the types of the fingerprints identified include Arch: 7.6% (plain 1.5%, tented 6.1%), Whorl: 29.93% (plain 9%, central pocket 20.1%, accidental 0.83%) and Loop: 62.32% (radial 7%, ulnar 0.83%, double 6.66%, central 3.83%).

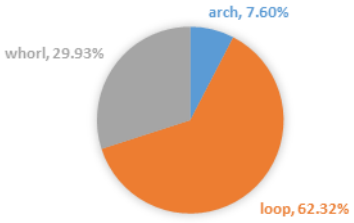

Figure 9: Overall percentage of the finger print types.

As in the row of Sig (2-tailed) the values are greater than 0.05 except of the right and left ring finger of dizygotic, monozygotic twins and right little finger of both twins was statistically significant. The significance of using Levene's Test is that it verifies the assumption of when samples have equal variances.

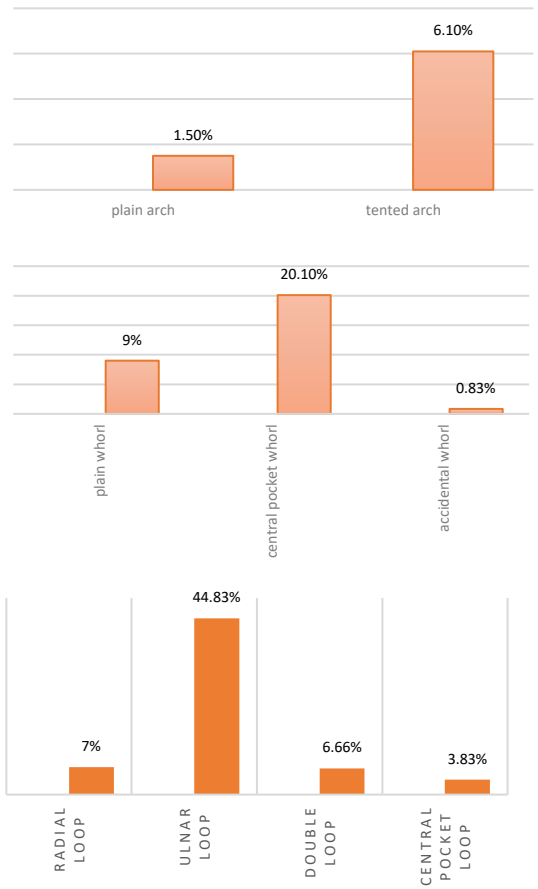

Figure 10: Distribution of arch, whorl and loop fingerprint patterns in the study twins.

Fingers	Twin Types	Pairs	Mean	Standard Deviation	Significant 2-tailed	95% CI	
						Lower	Upper
Right thumb	Monozygotic	17	0.0645	0.14971	0.385	0.06805	0.17094
Right thumb	Dizygotic	13	0.5938	0.17125	0.396	0.07145	0.17435
Left thumb	Monozygotic	17	0.7253	0.19831	0.151	0.64361	0.2695
Left thumb	Dizygotic	13	0.6123	0.21913	0.158	0.07751	0.2727
Right index	Monozygotic	17	0.5924	0.20092	0.258	0.06660	0.2369
Right index	Dizygotic	13	0.5069	0.20056	0.259	0.06658	0.23744
Left index	Monozygotic	17	0.5859	0.13802	0.614	0.08951	0.14897
Left index	Dizygotic	13	0.5562	0.18122	0.627	0.09558	0.15504
Right middle	Monozygotic	17	0.5124	0.15209	0.644	0.06906	0.10921
Right middle	Dizygotic	13	0.5446	0.22615	0.662	0.07277	0.11955
Left middle	Monozygotic	17	0.5641	0.14757	0.253	0.05709	0.20840
Left middle	Dizygotic	13	0.4885	0.20772	0.277	0.06550	0.21681
Right ring	Monozygotic	17	0.5265	0.17934	0.037	0.00857	0.26130
Right ring	Dizygotic	13	0.3915	0.15010	0.033	0.01155	0.25832
Left ring	Monozygotic	17	0.5788	0.17592	0.049	0.00048	0.23871
Left ring	Dizygotic	13	0.4592	0.12984	0.041	0.00522	0.23396
Right little	Monozygotic	17	0.5265	0.17934	0.037	0.00857	0.26130
Right little	Dizygotic	13	0.3915	0.15010	0.033	0.01155	0.25832
Left little	Monozygotic	17	0.5718	0.1885	0.204	0.05447	0.24415
Left little	Dizygotic	13	0.4769	0.2095	0.212	0.05766	0.24734

Table 1: Distribution of fingerprint patterns in ten fingers of right and left hands.

Discussion

In our survey, we have investigated that can identical twins be differentiated based on the fingerprints and how much similarities and difference having monozygotic and dizygotic twins.

Total fingers used in the study were 600 and out of these plain arch fingers are 9, 37 are tented arch fingers, 54 are plain whorl fingers, 121 fingers are central pocket whorls, 5 are accidental whorls fingers, radial loop fingers are 42, ulnar loops fingers are 269, double loop fingers are 40 and central pocket loops are 23 fingers. The result showed that dizygotic twins though having the same phenotype or having genetic similarities, but their fingerprints are different from each other in a wide range. But besides this, the results showed that identical twins or monozygotic twins as having the same DNA, their fingerprints also show much of the similarities, but that is also not the exact same, they also have differences in their fingerprints up to some extent. This proves that the identical twins have relatively similar fingerprints as compare to dizygotic twins. Additionally, the results also proved that the arch type fingers are more abundant in monozygotic twins as compared to the dizygotic twins.

The results showed that the identical twins can be recognized or distinguished by their fingerprints. Our study shows that loop is dominant in our study which is similar to other studies which were conducted by different people at different times. Earlier studies conducted by Igbigbi and Msamati on indigenous black Zimbabweans, found that ulnar loops were the most prevalent digital pattern type in most sexes, followed by whorls in males and arches in females [11]. One more study by Gangadhar and Reddy on 360 unrelated Adi Karnataka population of Mysore city of Karnataka State showed that the frequency of loop patterns (57.11%) was common followed by whorls (27.89%) and arches (15.00%) [12]. A comparative study conducted by Purkait, on the frequency of fingerprint patterns and variation in the 10 digit classification on males of Mundas and Lodhas tribals from Midnapur district in West Bengal stated that Mundas exhibit higher incidence of whorl and loop patterns whereas loops are more frequent among Lodhas [13]. Another study was done on the types of the fingerprint in which it was resulted that the most commonly found types of the fingerprint in both males and females was loop, followed by arch and whorls. And the accidental type was last observed [14]. Our study shows differences with their study that is arch types of fingerprints are mostly found in the monozygotic twins. A study was made on the discrimination of the fingerprints of twins in 2008 which shows a great similarity with our studies that is the fingerprints of twins are more similar to each other as compare to the other individuals. They found that there are 30% of right loops, 27% of left loops, 19% of whorls, 13% of arch, 7% of twin loop and 5% of tented arches [15]. Our study included the fingerprints of non-twins, in order to check out the similarities and differences. We first compared our fingerprints one by one and side by side and then pointed out the similarities, that were not enough so. Then we used our fingerprints to rotate one of the print and then compared both the prints with the fingerprint of the same person. This

rotation showed a little more similarity in both the fingerprints as compare to the normal and non-rotated fingerprints. After this, fingerprints of twins were examined. The results showed that the twins have almost same type of fingerprints as compare to the non-twins.

A study conducted by Gungadin suggest that in male, mean ridge count of 13 is more frequent, whereas 14 ridges are likely to be of females [16]. Another study by Nayak *et al*. reported significant gender differences are present in the Chinese subjects with finger ridge count of 12 ridges more likely to be of males and more than 13 ridges are more likely to be of female origin [17]. Whereas in Malaysian male 11 or less ridges were commonly observed and 13 ridges were observed in female [17]. Jantz noticed that the Parsis of Indian males showed significant higher average correlations than females in fingerprint ridge count [18]. One more study suggested that in Spanish Caucasian male the ridge density <16 and in females it comes ≥17 ridges/25 mm^2, respectively [19].

The results concluded that the fingerprints of identical twins are more similar to each other as that of the non-identical twins, when two fingers both the left and right thumbs were compared each with eight (8) points. In both cases there are matching on the first six (6) points out of the total eight (8) points while the rest of the two (2) points remained unmatched. The matching percentage for each of these pairs of fingers is 75% whereas, that of the mismatched is 25%. But when both fingers rotated on 180°, and then compared with a total of 8 points and the matched percentage was 87.5%, while the mismatched percentage was 13.5. However, these 8 points were found enough for differentiation of identical and non-identical twins.

It is further recommended that a large population study will be needed, including some basic database and software for identifying fingerprint of two single monozygotic and dizygotic twins instead of group comparison.

Authors' Contribution

Adil Shah and Romana Bibi collected the samples and performed the experimental work. Murad Ali Rahat and Muhammad Haris analyzed the data. Fazal Akbar, Muzafar Shah and Akhtar Rasool helped in writing the manuscript and reviewing of the data. Muhammad Israr was PI of the study.

Competing Interest

The authors declare that they have no competing interests.

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