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A Dermatoglyphic Study in Cases of Polydactyly and Syndactyly

O.P. Jasuja, Gagan Deep Singh, Munish Kumar

Professor of Forensic Science, Punjabi University, Patiala- 147 002, India
Senior Research Fellow, Department of Forensic Science, Punjabi University, Patiala- 147 002, India
Department of Forensic Science, Punjabi University, Patiala- 147 002, India
Contact: the corresponding author O.P. Jasuja · opjasuja@gmail.com

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ABSTRACT

Purpose

Fingerprints of an individual are considered as mark of his/her identity. The identity of a person from fingerprints is based upon dermal ridges which have very large variations in the form of ridge characteristics. Though only few people have been reported for not having dermal ridges on their palmer and plantar surfaces, quite large number of population is reported with hand and foot deformities causing effect on dermal ridges also. Some of these deformities can be classified as syndactyly, polydactyly and polysyndactyly. In present work, cases of such deformities have been studied with respect to dermal ridges on distal phalanges of the fingers which are used for fingerprinting.

Method

Inked Fingerprints of affected fingers were obtained along with photographs of the hands with deformities. The pattern types, flow of ridges were recorded and relationship of these with deformity was attempted.

Results

Very interesting findings have been observed and have been reported in the paper, as commonness of ridge pattern or no pattern type of the ridges etc. It seems that there is a relationship between pattern type and type of deformity.

Conclusion

In spite of being brief study, it is hoped that it may lead to a study at larger scale to understand the dermal ridges configuration on hands with deformities. In the field of crime investigation when fingerprints having supernumerary finger are found at the crime scene, additional information about the culprit is available to draw the inferences.

Keywords: Forensic, Personal Identification, Dermal Ridges, Fingerprints, Hand Deformities, Polydactyly, Syndactyly, Polysyndactyly

Introduction

Palmer and plantar dermal ridge structure finds their high use in biological studies as well as in the field of forensic science. Generally known as dermatoglyphics, it is concerned with the study of ridged skin on the digits, palms, toes and soles of primates and other mammals.[1] Skin ridge formation starts as early as in third to fourth month of intrauterine life and ridge configurations, which are determined by various morphologic events, remain unchanged throughout the life.[2]

Any type of disturbed growth process affecting limbs in earliest stages of fetal life may result in abnormal development of dermatoglyphics also. One of the reasons may be attributed to the anomalies of underlying bone structure which may affect the number of fingers and toes, accompanied by changes in epidermal ridge patterns. This in turn is controlled by genetic factors (usually single gene mutation) which may produce specific limb malformations such as syndactyly, polydactyly, ectrodactyly and brachydactyly [3,4,5,6] as isolated features or in association with other abnormalities. Apart from the changes in epidermal patterns, single gene mutation may affect the normal development of single ridge, which may be completely abolished or their linear structure may fail to form at all.

The aim of the present study is to make use of the anomalies associated dermatoglyphic data for identification in forensic casework. As the frequency of such anomalies is very rare and fingerprints/ latent fingerprints of such an individual found at the crime scene may provide a unique feature leading to identification. Thus, dermatoglyphic patterns associated with congenital hand anomalies like polydactyly, syndactyly and polysyndactyly along with their frequency has been studied.

Material and Methods

The present study has been conducted on twenty eight subjects having polydactyly, syndactyly or polysyndactyly. The samples were collected from different villages and cities of Punjab, India. For the present study, rolled inked fingerprints of both hands were taken from the individuals. As it was difficult sometimes to obtain the rolled fingerprint due to anomaly, so to make it more convenient, the bond paper was cut into slips and pasted on a hard cardboard. The ink was applied

uniformly on the supernumerary and adjacent finger and the cardboard with bond paper was rolled on to the surface of supernumerary and adjacent finger.

Photography

Photography of the hand having anomaly was also done with digital camera (Canon IXUS 700) in normal and macro (close-up) mode.

Observations

Following questions were considered in the present study

1. What type of the distortion was present in the hand or fingers?

2. Which fingers were affected by distortion?

3. Whether ridges made patterns in various classes of distortions?

4. Whether affected fingers were having same patterns type or otherwise?

5. Whether ridge flows in affected fingers were continuous? If so, in what type of cases it was observed?

6. What is the frequency of each type of distortion and patterns type of supernumerary finger(s)?

Results

Polydactyly and syndactyly are common digital malformations which occur alone or in combination with other anomalies in a variety of syndromes. Dermatoglyphics of persons with these distortions were studied in the present work. Out of 28 subjects studied, frequency of incomplete radial polysyndactyly was 64.28% and radial polydactyly was 14.28% followed by complete complex radial polysyndactyly (10.71%) and ulnar polydactyly (10.71%).

Following types of polydactyly/syndactyly/polysyndactyly was observed during the present study.

1. Incomplete Radial Polysyndactyly

Incomplete radial polysyndactyly was most frequent type of anomaly observed in the present study. In this supernumerary finger and thumb were involved but not fully fused. This condition is known as incomplete radial polysyndactyly or preaxial polysyndactyly. It was observed in total of 18 subjects.

The extent of fusion was up to proximal phalanges only and distal phalanges were not involved. Dermal ridge surface was different for both fingers, therefore, the continuity of the ridges could not be observed at the distal phalangeal level. This particular feature is normally a characteristic of incomplete radial polysyndactyly.

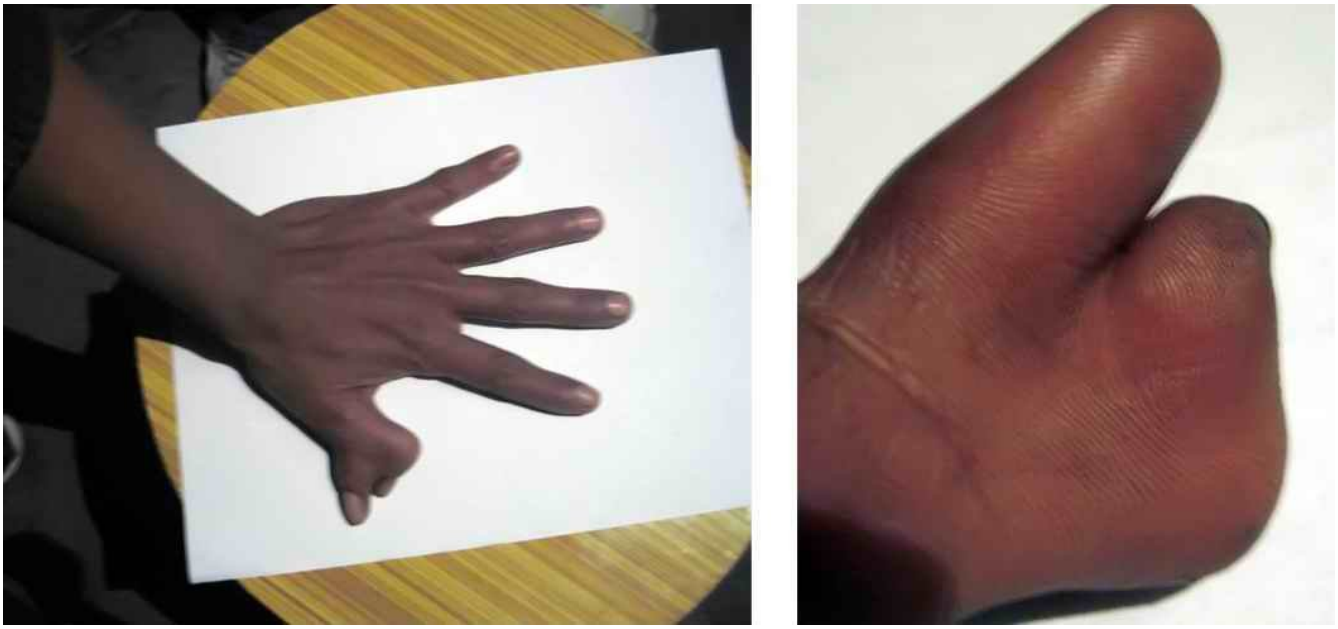


Figure 1. Incomplete Radial Polysyndactyly showing distortion and ridge pattern on supernumerary and main finger.

In three of the cases, it was interesting to note that due to this distortion, both the fingers were not having any pattern in ridges, thus, a continuous transverse ridge flow was seen (**Figure-1**). Also, in three other cases, ulnar loop was present on the main finger, while corresponding supernumerary finger showed patternless ridges. Another observation revealed that when on main finger a particular pattern is present (mostly ulnar loops were there), some ridge pattern can also be observed on the associated supernumerary finger. Although some specific relationship between patterns types of main finger and supernumerary finger could not be established and may be a matter of further research.

Table 1. showing details of ridge patterns on main fingers and associated supernumerary fingers in case of incomplete radial polysyndactyly

Subject No.	Patterns on main finger	Pattern on associated supernumerary finger
1.	Ulnar loop	Patternless ridges
2.	Ulnar loop	Patternless ridges
3.	Patternless ridges	Patternless ridges
4.	Ulnar loop	Patternless ridges
5.	Patternless ridges	Patternless ridges
6.	Patternless ridges	Patternless ridges
7.	Whorl	Loop
8.	Ulnar loop	Accidental
9.	Whorl	Radial loop
10.	Ulnar loop	Radial loop
11.	Whorl	Radial loop
12.	Whorl	Radial loop
13.	Ulnar loop	Central pocket loop
14.	Ulnar loop	Whorl
15.	Whorl	Radial loop
16	Ulnar	Radial loop
17.	Ulnar loop	Accidental
18.	Ulnar loop	Radial loop

From the table-1, it may be inferenced that in cases, where the main finger showed patternless ridges, same was present on associated supernumerary finger, invariably.

The patterns present on supernumerary and main finger are shown in Table-1.

2. Radial Polydactyly

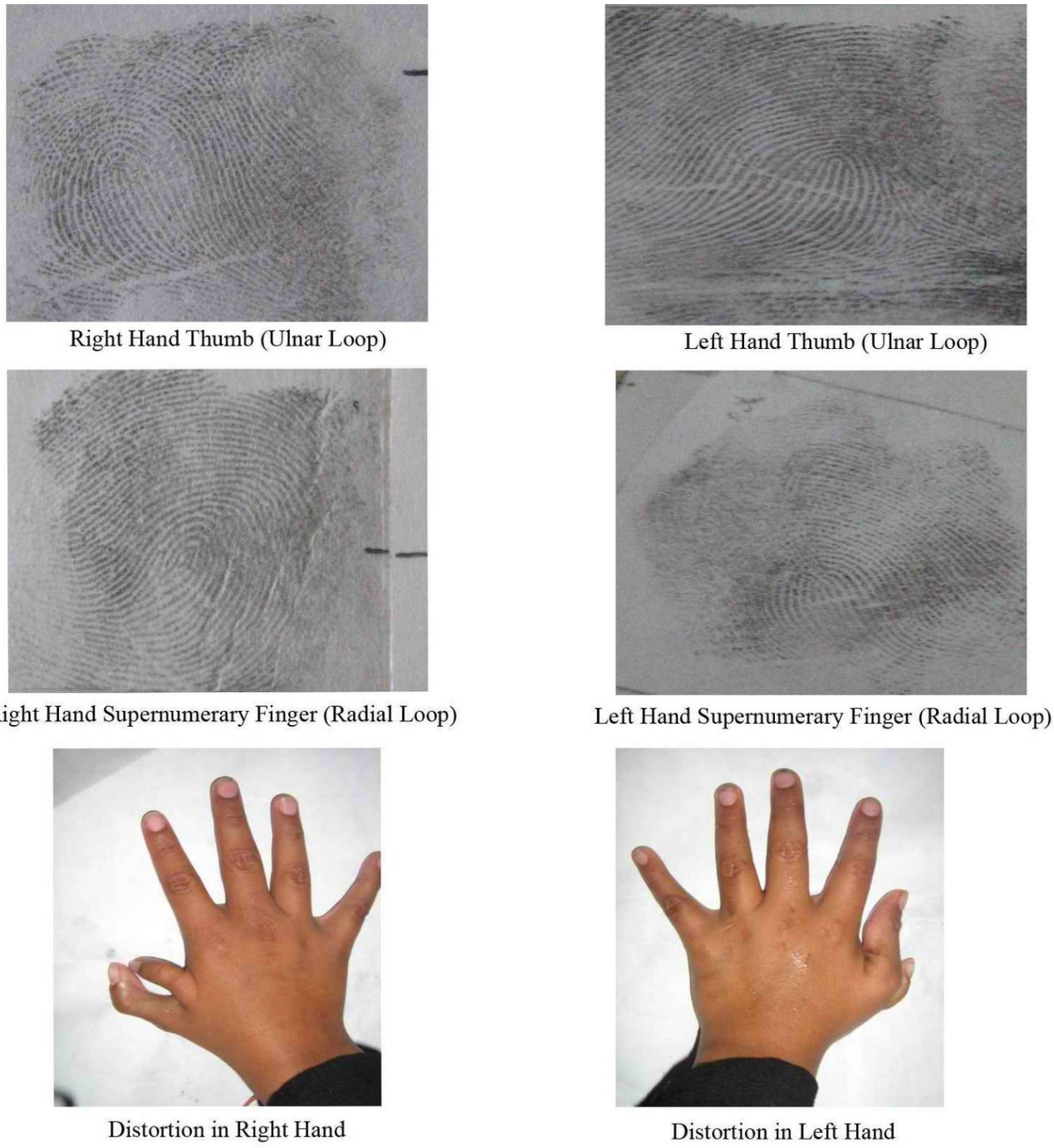


Figure 2. Radial Polydactyly showing distortion in both hands and inked fingerprints of supernumerary and main finger.

In this type of distortion, supernumerary finger or digit was present towards thumb side but was not fused with the thumb. This distortion may be present in either one or on both hands. In present study, four subjects were found to be having this type of distortion. Out of these four subjects, three subjects were having distortion on both the hands while in one of the subjects; distortion was present on only one hand. In all these cases as both the normal and supernumerary fingers were not joined together i.e. supernumerary fingers existed as independent structures, so there was no question of continuity of ridges.

Both the fingers were having well defined pattern types (Figure-2). As evident from the table-2, it can be seen that in case of loop, same type of pattern were present on both the fingers such that if one is ulnar loop the other has been found to be radial loop. Though it could not inferenced for all the cases as in one case (sub. no. 21), in one hand, main finger is having ulnar loop but the supernumerary finger had whorl pattern. A larger sample size study may lead to some definite relationship. The patterns present on supernumerary and main finger are shown in Table-2.

Table 2. showing details of ridge patterns on main fingers and associated supernumerary fingers in case of radial polydactyly

Subject no.	Patterns on main finger	Pattern on supernumerary finger
19.	Right Hand- Ulnar loop Left Hand- Ulnar loop	Right Hand- Radial loop Left Hand- Radial loop
20.	Central pocket loop	Arch
21.	Right Hand- Ulnar loop Left Hand- Lateral pocket loop	Right Hand- Whorl Left Hand -Whorl
22.	Right Hand- Tented arch Left Hand- Ulnar loop	Right Hand- Radial loop Left Hand -Radial loop

3. Complete complex radial polysyndactyly





Figure 3. Complete Complex Radial Polysyndactyly showing distortion in hands and ridge patters on fused fingers.

This type of distortion was found in three cases. It involved supernumerary finger and thumb. In these, complete fusion of bones took place but was restricted to basic phalanges. This condition is known as complete complex radial polysyndactyly. In case no.23, the subject had right handed radial polysyndactyly while in case number 24 and 25, left handed radial polysyndactyly was

noticed. In these three cases, dermal ridge surface was found to be in continuity for fused fingers but nails were different for fused fingers. The continuations of friction ridges were observed on these fused fingers. Friction ridges had either formed a common pattern on these fused fingers or there was no pattern at all but only flow of ridges was observed on both the fingers. Subject no. 23 was found to be having twin loop pattern common to the fused fingers while subject no. 25 was having whorl pattern. It was interesting to note that in subject number 25, along with whorl pattern, some ridges were flowing parallel to each other, which is generally not a characteristic of normal whorl pattern. Further simplification of flow of ridges was observed in subject no. 24, where no pattern was found but ridges were just flowing in continuity on both the fingers (Figure-3). The patterns present on supernumerary and main finger are shown in Table-3.

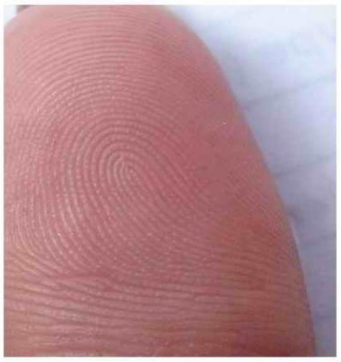
Table 3. showing details of ridge patterns on main fingers and associated supernumerary fingers in case of complete complex radial polysyndactyly

Subject no.	Pattern on main finger	Pattern on associated supernumerary finger
23.	Twin loop (Common pattern)	Twin loop (Common pattern)
24.	Patternless ridges	Patternless ridges
25.	Whorl and parallel ridges	Whorl and parallel ridges

4. Ulnar Polydactyly



Right Hand Little Finger (Ulnar Loop)



Left Hand Little Finger (Ulnar Loop)



RIght Hand Supernumerary Finger (Ulnar Loop)



Left Hand Supernumerary Finger (Ulnar Loop)



Distortion in Right Hand



Distortion in Left Hand

Figure 4. Ulnar Polydactyly showing distortion in both hands and ridge pattern on supernumerary and main fingers.

When an additional supernumerary finger is present towards little finger, such a condition is termed as ulnar polydactyly. In present study, this type of distortion was found in three subjects. The additional finger showed no fusion with little finger. Out of three cases, only one case was having distortion on both hands and in rest of the cases, distortion was there on either of the hands. Like radial polydactyly, in ulnar polydactyly also there was no fusion and dermal ridge surface were different, so again discontinuity of ridges observed (Figure-4). No direct relationship between pattern type on main finger and distorted finger could be found. Mostly ulnar loops were present on main and distorted finger. The patterns present on supernumerary and main finger are shown in Table-4.

Table 4. showing details of ridge patterns on main fingers and associated supernumerary fingers in case of complete complex radial polysyndactyly

Subject no.	Pattern on main finger	Pattern on supernumerary finger
26	Right Hand- Ulnar loop Left Hand- Ulnar loop	Right Hand- Ulnar loop Left Hand- Ulnar loop
27	Central pocket loop	Ulnar loop
28	Ulnar loop	Central pocket loop

What is already known on this topic

Fingerprints are considered as the most individualistic feature of the human body and are used in the crime scene investigations for personal identification. Presence of hand and foot deformities like polydactyly, syndactyly and polysyndactyly can significantly deviate the dermatoglyphic characteristics on the palmar and plantar surface. Due to the rare occurrence of these anomalies, discovery of associated ridge characteristics may lead to positive identifications.

What This study adds

Dermatoglyphic pattern studies have been done in case of palmar surface affected by the developmental anomalies. Pattern type and flow of ridges have been studied in individual prints and it has been tried to establish some relationship with a particular type of deformity. Frequency of different types of ridge patterns was found to be variable among different deformities.

Suggestions for further development

Although presence of dermatoglyphic distortions can significantly alter the normal dermal ridge patterns but it also provides enhanced chances of identification. In future, involvement of more number of subjects in the study can help in providing more accurate data which may serve to add more observations regarding dermatoglyphic trends in congenital deformities.

Discussion

In accordance with the observations during the study, there may be some relationship between radial and ulnar polydactyly as observed in present study. While radial polydactyly tends to be present mostly in both hands, ulnar polydactyly was found to be on either hand in majority of cases. Also, in all the cases involving syndactyly, no reductions in number of digits were observed while generally cases of complete syndactyly, involves reduction of digits, as observed by Loesch.[7]

The distribution of fingerprint pattern types on main fingers were found to be ulnar loop (54.83%), whorls (19.35%), patternless ridges (12.40%), central pocket loop (6.45 %) and twin loop, tented arch, lateral pocket loop (3.2%) while radial loop, plain arch and accidental were found to be absent. Regarding pattern types on supernumerary fingers, maximum percentage was found to be in case of radial loops (38.7%) followed by patternless ridges (22.58%), whorls (12.9%), ulnar loops (9.67%), accidentals and central pocket loop (6.45%) and plain arch, twin loop (3.2%) while tented arch and lateral pocket loop were absent in all the 28 individuals studied.

Preceding observation is not in complete agreement with Matton et. al.[8] who found a significant increase in frequency of complex fingerprint patterns in syndactyly I patients. Contrasting

observation may be due to the fact that in the present study none of the subjects is affected by pure syndactyly rather varied combinations of polydactyly and syndactyly. Nevertheless, frequency of patternless ridges on supernumerary fingers is relatively high. Also, Busret[9] described the dermatoglyphics patterns in syndactyly and reported that pattern was not present on fourth finger of both hands. The pattern analysis on the fingertips revealed large number of whorls (65.6%) ulnar loops (21.1%) Radial loops (7.8%).

Average population has the ulnar loop frequency of about 70 % and whorl frequency of about 25% which is in contrast to what was observed in case of probands (Table-5).

Table 5. showing comparisons of pattern frequency of the fingertips in case of main and corresponding supernumerary fingers in probands with the average population

S.No.	Category	Whorls	Ulnar loops	Radial loops
1.(a)	Probands (on supernumerary finger)	12.9%	9.67%	38.7%
1. (b)	Probands (on main fingers)	19.35%	54.83%	absent
2.	Average Population Cummins and Midlo(10)	25%	69.7%	5.7%

In cases of complete complex and incomplete radial polysyndactyly, frequency of patternless ridges was more. This pattern free condition is caused by the syndactyly.[9] As both cases involved a mixture of polydactyly and syndactyly, therefore, other ridge patterns were also observed in addition to patternless ridges.

Conclusions

Conclusions derived from the present study are as follows:

i. Maximum number of polydactyly or syndactyly cases were found to be on radial side.

ii. Dermatoglyphic distortions were present in supernumerary fingers.

iii. The patterns present on supernumerary finger were different from the patterns present on main finger.

iv. Continuity of friction ridges was present in three cases of complete complex radial polysyndactyly in which dermal ridge surface were common for fused fingers.

v. Parallel ridges without forming a pattern were present on both the fingers in three cases of incomplete polysyndactyly. Ridge flow of the ridges was found to be in continuation on the skin of both the fingers.

vi. Frequency of incomplete radial polysyndactyly distortion was found maximum out of all the distortions.

vii. The frequency of radial loop was maximum in case of supernumerary fingers and ulnar loop in case of main fingers.

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