

Original Research Paper

Study of Fingerprint Patterns in South Indian Population

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Abstract

Study of finger prints as a method of identification is known as Dactylography or Dactyloscopy. Dactylography is a progressing science and new methods for the recording, lifting and developing of prints under different field conditions, including those from the decomposed body, are being introduced regularly. Identification using finger prints is absolute and infallible. Since the turn of the century, finger prints have been used as a very effective means of establishing identity of the individual. Study of finger prints as a method of identification is known as Dactylography. The present study was conducted on 100 males and 100 females of South Indian Population aged between 18 and 81 years. Rolled fingerprints were obtained using pre-inked strips, and their patterns were identified. Each type of fingerprint pattern and their subtypes were identified and analysed for gender differences.

Key Words: Dactylography, Fingerprint Pattern, Gender Difference, Identification

Introduction:

Study of finger prints as a method of identification is known as *Dactylography* or *Dactyloscopy* or *Dermatoglyphics* and at present, also as Henry-Galton system of Identification. [2] The word Dactylography is taken from two Greek words, *daktylos* meaning 'finger' and *graphein* meaning 'to write'. [3]

It is the study of the impressions of patterns formed by the papillary ridges on the bulbs of fingers and thumbs, when taken upon unglazed paper with the help of printer's ink. [1, 4, 5] Dactylography is a progressing science and new methods for the recording, lifting and developing of prints under different field conditions, including those from the decomposed body, are being introduced regularly. [5] As far back as seventeenth century AD, the finger print impressions in ink were used in Assyria and Far East as an evidence of good faith in the sealing of bonds or the issue of documents. [1]

Dr. Henry Faulds came to Darjeeling, Bengal in 1872 as a medical missionary and observed the use of Tip Sahi in lieu of signature and other official purposes. [1, 7]

He recognized the importance of finger prints, and published an article in *Nature* in 1880, [7, 8] but the first mentionable study on finger print was done by Sir Francis Galton, an English anthropologist in 1892.

Sir Edward Richard Henry, Inspector General of Police, Lower Bengal could develop and improve the applied aspect of Galton's observation, further by classifying the prints for practical application in the field of identification in the 1890's. [1, 7]

That system of finger print study is still in effect in most of the countries of the world, which is popularly known as *Henry-Galton system* or simply, Galton's system of identification. [2]

Characteristics of Fingerprints:

- They are present at birth, both on epidermis and dermis. [9] Finger prints appear for the first time from the 12th to 16th week of intrauterine life and their formation gets completed by 24th week of intrauterine life. [6, 10] The ridges appear on the fingers first, then on the palm or sole. [1]
- **Permanency or Persistency:** They remain constant for the whole life of the individual. [9] Herschel first demonstrated this, and his own impressions taken when aged 28 and again at 82 were unchanged except for the addition of coarse lines due to old age. [11]
- **Individuality or Variety:** They form patterns that are absolutely individualistic. No two hands are entirely alike, not even in identical twins. [1, 2, 4, 9, 13, 14]
- **Immutability:** Simple injuries, old age, diseases etc. will not change the formation

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of patterns and ridge characteristics, unless dermis is affected.

Finger prints are classified into four types:-

- 1) Loop
- 2) Whorl
- 3) Arch
- 4) Composite

Core or Inner terminus:

Core means the central part of the pattern, otherwise called the inner terminus. The type of core varies according to the pattern.

Fixing the Inner terminus: Inner terminus is a fixed point on the core. In the case of staple (innermost ridge in loop pattern which goes up and turns back in the same way) being the core, the point on its shoulder farthest from the delta, is the 'inner terminus'. When the core consists of uneven number of ridges, the top of the central one is the 'inner terminus'.

When the core consists of even number of ridges, the two central ridges are considered as joined at their summit by an imaginary neck, and the point farther from the delta on the shoulder is the 'inner terminus'. [16]

Delta or Outer terminus:

It may be formed either (1) by the bifurcation of a single ridge, or (2) by abrupt divergence of two ridges that hitherto had run side by side.

Fixing the delta: When the delta is formed by the bifurcation of a single ridge, the point of bifurcation is the 'outer terminus'. When there are several such bifurcations, the one nearest to the core is taken as the 'outer terminus'. When the delta is formed by the divergence of two ridges which run side by side, the first in front of the place where divergence begins, even it be a mere point, whether it is independent of, or sprung from the divergence ridges or not, is the 'outer terminus'. [16]

1. **Loop:** In loops, some of the ridges make backward turn, but without twist. There is one delta. There must be at least one ridge count between the inner and outer terminus. Loops can be :
 - **Ulnar loop:** the ridges about the core terminate in the direction of the ulna bone of the forearm. In other words, the ridges about the core slant towards the right in the case of right hand fingers, and towards left in the left hand fingers. (Fig. 1)
 - **Radial loop:** the ridges about the core terminate in the direction of radius bone of forearm. i.e., the ridges slant towards left in case of right hand fingers, and towards right in the left hand fingers. [10,16] (Fig. 2)

2. **Whorl:** In whorls, some of the ridges make a turn through at least one complete circuit. There are two deltas, one on the left and the other on the right. Whorls can be:
 - **Concentric / Circular** (Fig. 3)
 - **Spiral** (Fig. 6)
 - **Double core** (Fig. 4)
 - **Elliptical / almond shaped** (Fig. 5)
3. **Arch:** This pattern can be of two types:
 - **Plain Arch:** In this pattern, the ridges run from one side to the other making no backward turn. There is usually no delta. But when delta appears, no ridge must intervene between the inner terminus and outer terminus. (Fig. 7)
 - **Tented Arch:** In this pattern, the ridges near the middle may have an upward thrust, arranging themselves as it were on both sides of an axis towards which adjoining ridges converge. The ridges thus converging give to the pattern the appearance of a tent in outline, hence the name 'tented arch'. (Fig. 7)
4. **Composite or Compound:** A composite pattern means combination of two or more patterns, either of the same or different type, in one print. Types of composite pattern are:
 - **Central Pocket Loop:** this pattern can be described as an *incipient whorl*, because a few ridges about the core possess features of whorl type, and remaining ridges conform the loop type surrounding them as a pocket. There must not be more than four recurving ridges intervening between the core and the innermost delta. There must be two deltas. If an imaginary line is drawn between two delta points, it would not cut or touch a recurving ridge within the inner pattern area. (Fig. 8)
 - **Lateral Pocket Loop:** when the ridges constituting a loop bend sharply downwards on one side before recurving thereby forming an interspace or pocket on that side, ordinarily filled by the ridges of another loop. In lateral pocket loop, the ridges containing the point of core have their exit on the same side of delta. (Fig. 8)
 - **Twinned Loop:** It consists of two well defined loops one superincumbent on or surrounding the other. In this pattern, the ridges containing the point of core have their exit on different sides of the delta. (Fig. 9)
 - **Accidental:** It is comparatively uncommon type of pattern, being one of the more complicated combination of the same or

different patterns i.e. loop by loop, whorl resting on loop, loop resting on whorl, whorl resting on whorl, arch with pocket etc. It has two or more deltas. [16] (Fig. 9)

Materials and Methods:

Two hundred subjects (100 males and 100 females) brought for medico-legal autopsy at the Department of Forensic Medicine, State Medico-legal Institute, Medical College, Thiruvananthapuram, Kerala from May 2011 to April 2012 were selected for the study.

In this study we included fresh, identified dead bodies brought for autopsy of the persons above 18 years of age. We excluded the Subjects with any evidence of injury, scars or any alterations of fingertips and other than those from South India.

Materials Used: (1) Pre-inked strips, (2) Cadaver spoon, (3) Foldable magnifying lens, (4) Transparent film strip, (5) Pointer

Method: Hands were washed and dried to remove sweat, dirt and grease. The rolled impressions of each finger were obtained using pre-inked strip and cadaver spoon. Thus rolled finger prints were obtained. Similarly, prints of entire ten fingertips were prepared for each and every subject.

Results:

Rolled fingerprints of ten fingers of all the 200 subjects were collected. Hence a total of 2000 fingerprints were obtained, which were analysed and their patterns and subtypes were determined. Among the 2000 fingerprints obtained, 1142 were loops, 607 were whorls, 127 were composites and 124 were arches. (Table 1)

The distribution of different patterns of fingerprints was analysed separately for both males and females. (Table 2) Out of the 1142 loop patterns obtained in this study, 1089 were ulnar loops (95.36%) and 53 were radial loops (4.64%). Similar distribution was observed in both males and females. (Table 3)

Out of the 607 whorl patterns obtained in this study, 374 were spiral whorl (61.6%), 154 were circular whorl (25.4%), 48 were double core whorl (7.9%) and 31 were elliptical whorls (5.11%). In both males and females, same distribution pattern was observed. (Table 4)

In present study we observed that out of the 127 composite patterns, 64 were twinned loops (50.39%), 43 were lateral pocket loop (33.86%), 16 were accidental type (12.6%) and 4 were central pocket loop (3.15%).

Our study showed that in males, the most common type of composite pattern was twinned loop (63%), followed by lateral pocket

loop (27.4%) and accidental pattern (9.6%). Central pocket loop pattern was not observed in males. In females, the most common type was lateral pocket loop (42.6%), followed by twinned loop (33.3%), accidental pattern (16.7%) and central pocket loop (7.4%). (Table 5)

Of the 124 arch patterns obtained in the study, 118 were plain arch (95.16%) and 6 was tented arch (4.84 %). In both males and females, **plain arch** was the predominant type of arch pattern. (Table 6)

Overall frequency distribution of all subtypes of fingerprint patterns in either sex, was tabulated. (Table 7)

Discussion:

Aim of this study was to study various patterns of fingerprints and their distribution in the South Indian population. Most common pattern was **loop** and the least common was **arch** Prevalence of fingerprint patterns as given by other authors and that obtained in the present study were compared. (Table 8) When we compare the previous data with the present study, it is found that

- 1) Prevalence of loop pattern is between 60 and 70% according to other authors, whereas it is lesser in this study (57.1%).
- 2) Prevalence of whorls and arches corresponds to that quoted by other authors (6.2%).
- 3) Prevalence of composite pattern is quoted to be between 1 and 4% by other authors, but it is found to be higher in this study (6.4%).

On analyzing the distribution of fingerprint patterns in either sex, Loops were the predominant pattern in both genders, followed by whorls. In males, the third most common pattern was composite, followed by arch. While in females, it was arch followed by composite.

Hence we find that the distribution of fingerprint patterns in male subjects is similar to that observed in the general sample population, whereas the distribution in female subjects is similar to the general distribution pattern quoted by the previous authors. (Table 8)

Subtypes of each of the four fingerprint pattern were identified and their distribution is given below:

Loops: In both males and females, **Ulnar loop** is the commonest type and **Radial loop** is the least common.

Whorls: In both males and females, **Spiral whorl** is the predominant type and **Elliptical whorl** is the least common one.

Arches: In both males and females, **Plain arch** is the most common, **Tented arch** the least.

Composites: The most common type of composite pattern was **twinned loop** and the least common was **central pocket loop**. In males, **Twinned loop** is the commonest type; **Accidental pattern** is the least common type. In females, **Lateral pocket loop** the commonest, and **Central pocket loop** the least common.

On gender-wise analysis of all types of fingerprints together, In males, **Ulnar loop** is the commonest, whereas **composite loop** (subtype of composite) is the least common type.

In females, **Ulnar loop** is the commonest, whereas **tented arch** is the least common type of fingerprint pattern.

Conclusions:

In this study, distribution of types of fingerprints as well as their subtypes was made out. Loop pattern is the predominant type, and composites are the least common type.

Little data is available in the literature, regarding frequency distribution of subtypes of various fingerprint patterns. Ulnar loop is the commonest fingerprint pattern, in both males and females. Central pocket loop (subtype of composite) is the least common type in male, tented arch is the least common type in females.

No statistically significant gender-based differences could be established in the distribution of fingerprint patterns. This emphasizes the importance of fingerprints as an absolute and infallible tool for establishing identity.

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Table 1: Distribution of Different Patterns of Finger Prints

Pattern	Cases	%
Loop	1142	57.1
Whorl	607	30.35
Composite	127	6.35
Arch	124	6.2
Total	2000	100

Table 2: Fingerprint Patterns and Gender Distribution

Pattern	Males		Females	
	No.	%	No.	%
Loop	557	55.7	585	58.5
Whorl	318	31.8	289	28.9
Composite	73	7.3	54	5.4
Arch	52	5.2	72	7.2
Total	1000	100	1000	100

Table 3: Types of Loop Pattern

Type of loop	Males (%)	Females (%)	Total
Ulnar	532(95.5)	557(95.2)	1089
Radial	25(4.5)	28(4.8)	53
Total	557(100)	585(100)	1142

Table 4: Types of Whorl Pattern

Type of whorl	Males (%)	Females (%)	Total
Spiral	184(57.9)	190(65.7)	374
Circular	83(26.1)	71(24.6)	154
Double core	33(10.3)	15(5.2)	48
Elliptical	18(5.7)	13(4.5)	31
Total	318(100)	289(100)	607

Table 5: Types of Composite Pattern

Type of composite	Males (%)	Females (%)	Total
Twinned loop	46 (63)	18(33.3)	64
Lateral pocket loop	20(27.4)	23(42.6)	43
Accidental	7(9.6)	9(16.7)	16
Central pocket loop	0(0)	4(7.4)	4
Total	73(100)	54(100)	127

Table 6: Types of Arch Pattern

Type of Arch	Males (%)	Females (%)	Total
Plain	47(90.4)	71(98.6)	118
Tented	5(9.6)	1(1.4)	6
Total	52(100)	72(100)	124

Table 7: Frequency Distribution of Fingerprint Patterns

Subtype (Pattern)	Males	Females	Total
Ulnar (loop)	532	557	1089
Spiral (whorl)	184	190	374
Circular (whorl)	83	71	154
Plain (arch)	47	71	118
Twinned loop (composite)	46	18	64
Radial (loop)	25	28	53
Double core (whorl)	33	15	48
Lateral pocket loop (composite)	20	23	43
Elliptical (whorl)	18	13	31
Accidental (composite)	7	9	16
Tented (arch)	5	1	6
Central pocket loop (composite)	0	4	4
Total	1000	1000	2000

Table 8: Comparison of Prevalence of Fingerprint Patterns

Fingerprint Pattern	Prevalence given by previous authors (%)	Prevalence in the present study (%)
Loops	60 [4] 65 [2,5,12] 65 to 67 [7] 60 to 70 [6,10]	57.1
Whorls	25 [2,5,7,12] 25 to 35 [10] 30 to 35 [6]	30.4
Arches	5 [4] 6 to 7 [7,10] 7 [2,5,12] 5 to 10 [6]	6.2
Composites	1 to 2 [6,10] 2 to 3 [2,5,12] 3 to 4 [7]	6.4

Fig 1: Ulnar loop-Right and Left Hand

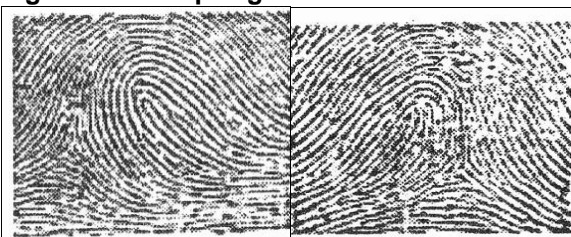


Fig 2: Radial loop-Right and Left Hand

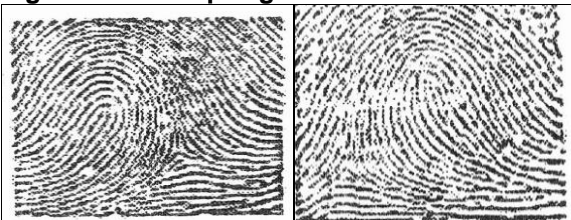


Fig 3: Single Cored Whorl



Fig 4: Double Cored Whorl



Fig 5: Elliptical Whorl

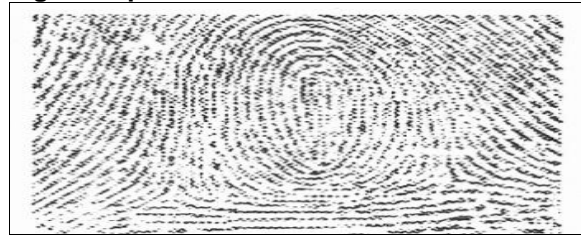


Fig 6: Spiral Whorl



Fig. 7: Plain and Tented Arch



Fig. 8: Central and Lateral Pocket Loop



Fig. 9: Twinned and Accidental Loop

