

ORIGINAL ARTICLE

Fingerprint-Based Prediction of Gender: An Important tool in Criminal Investigation

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Abstract:

Fingerprinting is considered as the most reliable evidence of identification. The aim of this study is to determine fingerprint patterns and predict gender from them. This will serve as an important aid in forensic identification at the site of crime. This is a prospective study conducted on 298 medical students of Career Institute of Medical Sciences and Hospital, Lucknow. Fingerprints of all participating individuals were obtained in a predesigned proforma on an unglazed white bond paper and were analyzed for their relationship with gender. The most common fingerprint pattern was loops (39.6%), followed by whorls (33.7%), arches (25.2%) and composite (1.5%). Separately, in males, the most common fingerprints pattern was loops (39.6%), followed by whorls (37.4%), arches (22%) and composite (1%), but in females, though loops (39.7%) were the commonest fingerprint pattern, arches (31.2%) were more predominant than whorls (26.9%) followed by composite (2.2%). Incidences of individual fingerprint patterns were varied in different sexes. Frequency of loops, arches, and composite was found to be higher in females and whorls were higher in males. Males show predominance of loops, whorls and arches in left middle finger (6.9%), right ring finger (6.5%) and right thumb (4%) respectively. And composite was present in equal numbers in left thumb, left middle, and left little fingers (0.2% each). In females, maximum number of loops, whorls, arches and composite was found in left little finger (6.4%), right ring finger (5%), right little finger (5.2%) and right thumb (0.5%) respectively.

Keywords: Fingerprint; Gender prediction; Identification.

Introduction:

Identification is an important part of criminal investigation, and includes identification of perpetrators in addition to identification of the victims. Dactylography (i.e. fingerprinting) is considered as the most important technique employed in the field of forensic science for the purpose of personal identification. Reason is that fingerprints (FPs) are never the same in two individuals even in identical twins. Hence, they are key evidence for crime scene investigators. Fingerprints are the contact impressions of the patterns formed by raised papillary or epidermal ridges of the skin of fingers. Epidermal ridges are formed during foetal period and do not change their course of alignment throughout the life of individual until destroyed by mutilation. Fingerprint is an individual characteristic. There is one chance in 64 billions of two persons having identical FPs.¹

However, fingerprints are ubiquitous due to the use of hands to do all types of work. Fingerprints may be found on a variety of items, including window glasses, utensils, door handles, knives, car steering, guns, sticks and even human skin itself. Unidentified fingerprints obtained from a crime scene can be used to identify a suspect and quickly solve a case. Biometric information, such as gender predicted using fingerprints, can also be effectively used to narrow down a list of suspects; such information is particularly

useful when combined with other investigative information.

The aim of this study was to determine fingerprint patterns and predict gender from them. This will serve as an important aid in forensic identification at the site of crime.

Material and methods:

The present study "Fingerprint-Based Prediction of Gender: An Important Tool In Criminal Investigation" is a prospective study conducted on 298 medical students of Career Institute of Medical Sciences and Hospital (CIMSH), Lucknow, Uttar Pradesh for a period of 6 months. Individuals from both genders and all age groups were included in the study. A predesigned proforma was used to collect the fingerprints. Ethical clearance for the present study was obtained from the institutional ethical committee, CIMSH, Lucknow. Persons having healthy hands were included in this study. Individuals with any congenital or acquired deformity or scars on fingers, suffering from any chronic skin disease, having worn fingerprints or extra or bandaged fingers were excluded.

Informed consents were obtained from the subjects before taking the samples. Each individual was asked to wash his/her hands thoroughly with soap and water to remove dirt and oil and dry them using tissue-paper. Individuals were then asked to press their fingertips on the ink pad of CAMLIN Company and roll it laterally on the ink slab and then placed on an unglazed white bond paper with one lateral edge and roll over in opposite direction. Bond papers were divided into 10 columns for each finger of the right and left hands. Fingerprints were taken into respective columns on the bond paper. Care was taken to avoid sliding of fingers to prevent smudging of the print. The primary

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fingerprint patterns were observed with the help of a magnifying lens and were identified as four patterns: loops, whorls, arches and composite. Confidentiality of the subjects was maintained. The fingerprint patterns in both hands of individuals and their relationship with gender was analyzed.

Observations and results:

We studied fingerprints of 298 students, out of which, 192 (64.5%) were males and 106 (35.5%) were females, with male to female ratio of 1.8:1. The most common fingerprint pattern among both males and females was loops (39.6%), followed by whorls (33.7%), arches (25.2%) and composite (1.5%) (Table 1).

It is observed that, in males (n=192), the most common fingerprint pattern was loops (39.6%), followed by whorls (37.4%), arches (22%) and composite (1%). Whereas, in females (n=106), commonest fingerprint pattern was loops (39.7%) followed by arches (31.2%), whorls (26.9%), and composite (2.2%). It is evident that the loops remain the most common and composite remains least common fingerprint pattern in both males and females, but the whorls are more common than arches in males and less common in females (Table 1).

Frequency of loops was found to be marginally higher in females

Table 1. Gender-wise distribution of fingerprint patterns.

Gender	Fingerprint patterns			
	Loop n (%)	Whorl n (%)	Arch n (%)	Composite n (%)
Male	760 (39.6%)	718 (37.4%)	422 (22%)	20 (1%)
Female	420 (39.7%)	285 (26.9%)	331 (31.2%)	24 (2.2%)
Total	1180 (39.6%)	1003 (33.7%)	753 (25.2%)	44 (1.5%)

Table 2: Fingerprint patterns in individual fingers of males.

Finger type	Fingerprint patterns			
	Loop n (%)	Whorl n (%)	Arch n (%)	Composite n (%)
Right Thumb	62 (3.2%)	56 (3.0%)	74 (4.0%)	1 (0.05%)
Right Index	30 (1.6%)	118 (6.1%)	44 (2.3%)	0 (0.0%)
Right Middle	44 (2.2%)	100 (5.2%)	48 (2.5%)	1 (0.05%)
Right Ring	22 (1.1%)	126 (6.5%)	44 (2.3%)	1 (0.05%)
Right Little	74 (3.9%)	92 (4.8%)	22 (1.1%)	3 (0.1%)
Left Thumb	106 (5.6%)	18 (1.0%)	64 (3.3%)	4 (0.2%)
Left Index	102 (5.3%)	60 (3.1%)	30 (1.6%)	0 (0.0%)
Left Middle	132 (6.9%)	30 (1.6%)	26 (1.3%)	4 (0.2%)
Left Ring	88 (4.6%)	74 (3.9%)	26 (1.3%)	2 (0.1%)
Left Little	100 (5.2%)	44 (2.2%)	44 (2.3%)	4 (0.2%)
Total	760 (39.6%)	718 (37.4%)	422 (22%)	20 (1.0%)

Table 3. Fingerprint patterns in individual fingers of females.

Finger type	Fingerprint patterns			
	Loop n (%)	Whorl n (%)	Arch n (%)	Composite n (%)
Right Thumb	41 (3.9%)	24 (2.2%)	33 (3.1%)	5 (0.5%)
Right Index	30 (2.9%)	30 (2.9%)	41 (3.9%)	2 (0.2%)
Right Middle	51 (4.9%)	16 (1.5%)	35 (3.3%)	4 (0.4%)
Right Ring	20 (1.9%)	53 (5.0%)	29 (2.8%)	2 (0.2%)
Right Little	34 (3.2%)	16 (1.5%)	56 (5.2%)	1 (0.1%)
Left Thumb	56 (5.2%)	16 (1.5%)	31 (3.0%)	4 (0.4%)
Left Index	38 (3.5%)	37 (3.4%)	30 (2.9%)	1 (0.1%)
Left Middle	49 (4.7%)	29 (2.8%)	28 (2.6%)	0 (0.0%)
Left Ring	33 (3.1%)	52 (5.0%)	22 (2.0%)	1 (0.1%)
Left Little	68 (6.4%)	12 (1.1%)	26 (2.4%)	2 (0.2%)
Total	420 (39.7%)	285 (26.9%)	331 (31.2%)	24 (2.2%)

(39.7%) as compared to males (39.6%). Whorls were found to be higher in males (37.4%) as compared to females (26.9%). Arches were more common in females (31.2%) as compared to males (22%). And composite pattern of fingerprint was more common in females (2.2%) than in males (1%). This suggests that loops, arches and composite were found in higher frequency in Females and whorls were found more frequently in males (Table 1).

In males, loop was found to be the commonest pattern in left middle finger (6.9%). Whorl was more common in right ring finger (6.5%). Arch was more common in right thumb (4%). And composite was predominant in left thumb, left middle, and left Little fingers (0.2% each) (Table 2).

In females, maximum number of loops was found in left little finger (6.4%). Maximum numbers of whorls were seen in right ring finger (5%). Arches were found maximum in right little finger (5.2%). And composite was the commonest pattern in right thumb (0.5%) (Table 3).

Discussion:

In our study, loops (39.6%) were found to be the commonest fingerprint pattern among both males and females, followed by whorls (33.7%), arches (25.2%) and composite (1.5%). Similar pattern was found in the studies conducted by Bharadwaja et al.² (loops 51.87%, whorls 35.83% and arches 12.30%), Umraniya et al.³ (loops 51.54%, whorls 35.79% and arches 12.67%), Gangadhar et al.⁴ (loops 57.11%, whorls 27.89% and arches 15.00%), Bhavana D et al.⁵ (loops 58.9%, whorls 29.6% and arches 11.5%), Deepa Deopa et al.⁶ (loops 58.29%, whorls 37%, and arches 4.71%), and Prateek Rastogi et al.⁷ (loops 60.95%, whorls 32.55%, arches 6.5%).

It is observed that, in males and females separately, there were some differences in the predominance of fingerprint patterns. In males, the most common fingerprints pattern was loops (39.6%), followed by whorls (37.4%), arches (22%) and composite (1%). In females, though loops (39.7%) were the commonest fingerprint pattern, arches (31.2%) were more predominant than whorls (26.9%) followed by composite (2.2%).

Incidences of individual fingerprint patterns were varied in different sexes. Frequency of loops was found to be marginally higher in females (39.7%) as compared to males (39.6%). Whorls were found to be higher in males (37.4%) as compared to females (26.9%). Arches were found to be more in females (31.2%) as compared to males (22%). And composite pattern of fingerprint was more common in females (2.2%) than in males (1%). This suggests that frequency of loops, arches and composite were higher in females, whereas, whorls were more frequent in males. Similar pattern was seen in a study conducted by Bhavana D et al.⁵ in which the frequency of loops was found to be higher in females (620, 52.63%) and whorls were found to be higher in males (338, 57.09%). Arches were found more in females (119, 51.73%) compared to males (111, 48.26%). In another study conducted by Prateek Rastogi et al.,⁷ frequency of loops was found to be higher in females (52.42%) than in males (47.58%) whereas whorls were more frequent in males (55.78%) as compared to females (44.22%). Arches were more common in females (55.38%) than in males (44.61%). So, the similar pattern

found in various studies at different geographical locations suggests that there is an association between the fingerprint pattern and gender and thus prediction of gender of a person is possible based on his fingerprint pattern.

In our study, males show predominance of loops, whorls and arches in left middle finger (6.9%), right ring finger (6.5%) and right thumb (4%) respectively. Composite was present in equal numbers in left thumb, left middle, and left little fingers (0.2% each). In females, maximum number of loops, whorls, arches and composite was found in left little finger (6.4%), right ring finger (5%), right little finger (5.2%) and right thumb (0.5%) respectively. In a study conducted by Gopinath M et al.,⁸ in both males and females, most loops were seen in left little finger (177), maximum whorls were seen in right ring (94), arches were seen maximum in left index (23) and composite was seen maximum in right thumb. In another study conducted by Sagun S et al.,⁹ in males, percentage of loops was maximum in left little finger (81%). Percentage of whorls was maximum in right ring finger (66%) and arches in left index finger (18%). Whereas in females, percentage of loops was maximum in right little finger (88%). Whorls were found in equal numbers in right thumb, right ring and left ring finger (46% in each). Arches were maximum in left index finger (15%). In another study conducted by Amit A et al.,¹⁰ it was observed that the majority of loops were present in middle and little finger of both males and females. Kanchan et al.¹¹ found in their study that arches were more in index finger of both male and females. Despite some similarities in the results of our study and the observations of other authors, we could not find any fixed pattern of predominance of fingerprint patterns in individual finger. More studies are required to be conducted to make the prediction for gender possible from the predominance of fingerprint patterns in individual finger.

Conclusion:

Fingerprints are the key evidence for crime scene investigators. Fingerprints obtained from crime scene play a key role in positive identification of the individuals. However, positive identification of fingerprint requires matching of the fingerprints obtained from the crime scene, with a known database or with the fingerprint of a suspect. But, in cases when suspects are many, prediction of the sex from fingerprint pattern can effectively help to narrow down the list of suspects. This can be of great help to law enforcement agencies involved in medico-legal processes, crime scene investigations and identification of victims of mass-disaster especially involving mutilated and fragmented remains.

With the result of our study, we could conclude that there is an association between the fingerprint pattern and gender and thus prediction of gender of a person is possible based on his fingerprint pattern. But we could not find any fixed pattern of predominance of each fingerprint pattern in individual fingers. And therefore further research on predominance of each fingerprint pattern in individual finger is required to make the prediction of gender possible from the predominance of fingerprint patterns in individual fingers. Based on these findings, we recommend combination of fingerprint with other

identification data for the determination of sex.

Ethical clearance: Ethical Clearance was obtained from Institutional Ethics Committee, Career Institute of Medical Sciences and Hospital (CIMSH), Lucknow prior to the study. Confidentiality was maintained.

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Conflict of interest: The Authors declare that there is no conflict of interest.

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