Original Article

# Study of Different Patterns of Fingerprints Prevalent in Our Population

**1. Muhammad Saleem 2. Bashir Ahmad Siddiqui 3. Nighat Seema 4. Mushtaq Ahmad**

1. Asstt. Prof. of Forensic Medicine, PGMI, Lahore 2. Asstt. Prof. of Forensic Medicine, SMC, Sargodha
3. Asstt. Prof. of Forensic Medicine, AMC, Abbottabad. 4. Sr. Demonstrator of Forensic Medicine, PGMI, Lahore.

## ABSTRACT

**Objectives:** The objectives of the study is to observe and analyze different types of fingerprint patterns in our population and compare it with other studies conducted in Pakistan and abroad, their utility in Forensic investigations, diagnosis and prevention of diseases, criticism on their utility and its defense.

**Study Design:** Comparative study.

**Place and Duration of Study:** This study was conducted on the Medico-legal cases received in the casualty department of Lahore General Hospital, Lahore from January 2011 to June 2011.

**Materials and Methods:** 200 males and 200 females between the ages of 10 years to 65 years were included in the study for analyzing different type of fingerprint patterns. The fingerprints (impressions) were taken on the unglazed white paper by nail to nail rolled method of all fingers and thumbs of both hands with black ink. These cases were separated on the basis of four basic patterns of fingerprints, their subclasses in both sexes. The relevant data was collected on prescribed Performa and then the results were scrutinized and statistically analyzed.

**Results:** On analysis of data recorded, average percentage values of males and females, the loop type of the pattern was 54%, whorl 32%, arch 10.05% and composite 3.5% and the ulnar loop type of the pattern was 87.5% whereas radial loop type of the pattern was 12.5% in our population.

**Conclusion:** Fingerprints patterns (dermatoglyphics) are not only old standing helpful tool for identification of criminals during Forensic investigations, for the identifications of the persons in everyday business on civil side but also an emerging science to aid in the diagnosis and prevention of diseases. More elaborated studies should be conducted with reference to ethnic and geographical variations in Pakistan also. Biometric database housing fingerprints and criminal history of criminals must be developed to help out law enforcement agencies on the pattern of IAFIS.

**Key Words**: Finger prints, Population, Arch, Ulnar Loop, Whorl, Composite, Tented Arch, Radial Loop, Ridge ending, Bifurcation.

## INTRODUCTION

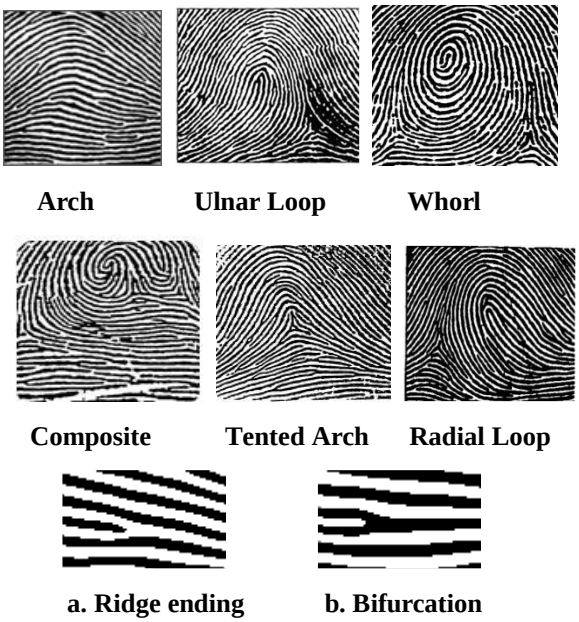
A fingerprint is formed from an impression left by the pattern of friction ridges on a human finger. A ridge is defined as single curved segment, and a valley is the region between two adjacent ridges[1].

Fingerprints have long been the main stay of Forensic identification even into the DNA age since fingerprints are unique to an individual even in uniovular twins. Ancient culture such as Babylonian and Chinese used them as signatures. In 1823, a Czechoslovakian physiologist J.E. Purkinje described the natural grooves on the human finger tips and gave first classification followed by Henry Fauld, Scottish physician who in 1885, then working in Japan recognized the importance of the skin ridges as an aid to identification. W.J.Herschel in 1958 began first known official use of fingerprints[2,3,4]. The Francis Galton produced proper scientific work and published his book on fingerprint subject in 1892. The fingerprints are so useful aid to the identification that they can be taken from the fresh dead bodies and also from the putrefied dead bodies even to the extent of removing peeled skin/degloved skin or finger-tips. Prints may often be obtained from desquamated skin or from underlying epidermis after shedding off the stratum corneum following prolonged submersion[3,5]. There are four basic patterns of fingerprints namely loop, arch, whorl and composite. However it is the ridge characteristics, type, number and relative position (major ridge path deviation) that make each fingerprint unique and these features collectively are called the "minutiae". For each instance of combined minutiae, maximum distance is used as a threshold to distinguish between the combined type and to distinct fundamental points[6]. There are three types of fingerprints found at the seen of crime, visible prints, plastic prints and latent prints.

The most popular ten-print classification systems include the Roscher system, the Juan Vucetich system, and the Henry Classification System. In the Henry system of classification, there are three basic fingerprint patterns: Loop, Whorl and Arch, which constitute 60–65%, 30–35% and 5% of all fingerprints respectively[7]. There are also more complex classification systems that break down patterns even further, into plain arches or tented arches, and into loops that may be radial or ulnar, depending on the side of the hand toward which the tail points.

The system used by most experts, although complex, is similar to the Henry System of Classification. Use of

ten digit system reduces the number of prints that the print in question needs to be compared with[8].




The fingerprint mark left at the scene of crime are developed by using different techniques including optical detection techniques like Luminescence using lasers, on many surfaces including metal like firearm. Diffused reflection technique is used on smooth shiny surfaces such as glass, plastic (e.g. credit cards) and polished metal .Chemical techniques like use of Ninhydrin for developing finger marks is applicable to the porous surfaces such as paper and cardboard. Aluminum powder which is mostly used to develop relatively fresh fingerprints in fingerprint powdering technique in latent fingerprints deposits, on smooth nonporous surfaces. Cyanoacrylate fuming technique is effective on most nonporous substrates such as glass and plastic and has become the most widely used process for the laboratory development of fingerprints on nonporous surfaces.

# MATERIALS AND METHODS

This study was conducted on the Medico-legal cases received in the casualty department of Lahore General Hospital Lahore during the period 01/01/2011 to 30/06/2011 (duration six months). 200 males and 200 females between the ages of 10 years to 65 years were included in the study for analyzing different type of fingerprint patterns. The fingerprints (impressions) were taken on the unglazed white paper by nail to nail rolled method of all fingers and thumbs of both hands with black ink. These cases were separated on the basis of four basic patterns of fingerprints, their subclasses in both sexes. The relevant data was collected on the prescribed Performa and then the results were scrutinized and statistically analyzed.

# RESULTS

On analysis of data of fingerprint patterns recorded, our study revealed the results as under:

In males loop type of pattern was found in 57%, whorl 29%, arch 12% and composite 2% only. Similarly in females loop type of pattern was found in 51%, whorls 35%, arch 09% and composite 05%. Loop type of pattern was found to be highest in percentage and arch type of pattern was lowest in percentage in both the males and females of our population. In average percentage values of males and females, the loop type of the pattern was 54%, whorl 32%, arch 10.05% and composite 3.5% only in our population.Table1.

In another study conducted in Pakistan loop type of pattern was seen in 57.2%, whorl 29.8%, arch 10.2% and composite 2.8% of our population and in a study conducted at Karluk village (Kodiak Island) loop type of pattern was seen in 52%, whorl 41.1% and arch 7% of the population of the Karluk (Europe) whereas in Henry`s classification loop type of the pattern was found in 60 to 65%, whorl 30 to 35% and arch 5% only. Table 2

**Table No.1: Distribution of different types of fingerprint patterns in Pakistani population**

| Type of the pattern | Male | % | Female | % | Male+ Female | Total % Male+ Female |
|---|---|---|---|---|---|---|
| Loops | 114 | 57% | 102 | 51% | 216 | 54% |
| Whorls | 58 | 29% | 70 | 35% | 128 | 32% |
| Arches | 24 | 12% | 18 | 09% | 42 | 10.5% |
| Composite | 04 | 2% | 10 | 05% | 14 | 3.5% |
| Total | 200 | 100% | 200 | 100% | 400 | 100% |

**Table No.2: Comparison of different studies about distribution of types of fingerprint patterns**

| Type of Pattern | Study at LGH (Our Study) | Another Study in Pakistan | Study at Karluk Village (Kodiak Island) | Henry Classification |
|---|---|---|---|---|
| Loops | 54% | 57.2% | 52% | 60-65% |
| Whorls | 32% | 29.8% | 41.1% | 30-35% |
| Arches | 10.5% | 10.2% | 7% | 5% |
| Composite | 3.5% | 2.8% | - | - |

Regarding the distribution of ulnar and radial loops in fingerprint patterns in our population, our study showed that the ulnar loop type of the pattern in males was 89% and in females 86% whereas radial loop type of the pattern in males was 11% and in females 14%. In average percentage values of males and females, the ulnar loop type of the pattern was 87.5% whereas radial loop type of the pattern was 12.5% in our population. It

is important and interesting to note that percentage of loop type of the pattern was highest in percentage in our study as well as other studies whereas percentage of arch type of pattern was found to be the lowest in our study and other studies also.

**Table 3: Distribution of ulnar and radial loops of fingerprint patterns in Pakistani population**

| Type of the pattern | Male | % | Female | % | Male+ Female | Total % Male+ Female |
|---|---|---|---|---|---|---|
| Ulnar Loops | 178 | 89% | 172 | 86% | 350 | 87.5% |
| Radial Loops | 22 | 11% | 28 | 14% | 50 | 12.5% |
| Total | 200 | 100% | 200 | 100 | 400 | 100% |

# DISCUSSION

It is important to study the distribution of different patterns of fingerprints in our normal population because fingerprints have been gold standard for personal identification within the forensic community for more than one hundred years. Science of fingerprints identification has evolved over time from early use of fingerprints to mark business transactions in ancient Babylonian to their use today as core technology in biometric security devices and as scientific evidence in courts of law throughout the world. Fingerprint identification is commonly employed in forensic science to support criminal investigations to identify the criminals from chance impression left at the scene of crime because when friction ridges come in to contact with rough surface taking a print material that is transferred on the friction ridges such as perspiration, oil, grease, ink or blood will be transferred to surface and thereby helping in identification of weapon used for homicide, suicide like firearm, prevention of impersonation and as an extra precaution in business transaction, legal documents and national identity cards issued by NADRA bearing fingerprint of thumb in addition to signature. Fingerprints have relationship with certain diseases thereby helping in their early diagnosis and treatment. Regarding relationship of fingerprints with different diseases, it was found in a local study that a pattern of 6 or more whorls was identified more frequently in women with breast cancer (48.7%) as compared in the control group (27.5%), ($P<0.05$). Conclusion was that digital dermatoglyphics play an important role in identifying women either with or at increased risk for breast cancer so that either risk reducing measures or earlier therapy may be instituted[9].

In another study conducted in U.S.A an increased frequency in number of arches on fingers-10.4%of all schizophrenic fingerprints verses4.9% of controls; an increased number of individuals with one or more arches among schizophrenics-32% against 18%among the controls: decreased frequency of radial loops on index finger among the schizophrenics was found. Numerous other differences of lesser frequency also noted[10].Similar study conducted in Thailand concluded that only male patient exhibited average scores for complex patterns (Whorls minus arches less than 2) which might be a biomarker for screening of schizophrenia in males[11].

Our study is consistent with another study conducted in Pakistan[12] with only negligible difference of percentage in all types of fingerprint patterns as mentioned in table-2 and also in coincidence with study conducted at Karluk village, Kodiak island (Europe) with only striking difference of whorl type of the pattern which was 41.1 percent as compared to our study where whorl type of pattern was found to be 32 percent[13]. Our study also matches with Henry classification with only minor difference of percentage in all type of the patterns mentioned in table-2. However these minor differences are not of such magnitude to be statistically significant which may be due to the ethnic, geographical and environmental conditions. The existence of ethnic variations have already been proved in a study conducted at Georgia state university USA in which it was found that the loop & arch type of the patterns dominated in blacks whereas loop and arch type of the pattern in Asian were minimum and those in white and Hispanic were in between[14]. It was also found in the study conducted in Maharashtra, India in which the results confirmed that dermal traits, in general, and palmer characters in particular, do help in understanding the biologic/ethnic affinities among different groups both at macro and micro levels and different types of traits are likely to be influenced by genetic/environmental factors giving rise to different clustering patterns[15]. Our study is also in agreement with another study conducted in India in which it was found that the most frequent fingerprint pattern was ulnar loop in total population as well as in sex wise distribution[16].

After the development of latent fingerprint patterns by different techniques on different types of surfaces, the comparative identification process, methodology or protocol known as "ACE-V" as adopted by Ashbaugh[17] in early 1990's and presented by Tuthill (1994), and more recently discussed during the Duabert hearing as state of art methodology for identification process adopted by Royal Canadian police. The ACE-V (analysis, comparison, evaluation and verification) is discussed as under:

**Analysis** consists of three levels that are level 1, level 2 and level 3.

**Comparison** basically is iterative comparison between the unknown mark and a known print, focusing on level 1, 2 and 3 features after their identification in the mark

and taking into account the tolerances dictated by the quality of mark.

**Verification** starts after the comparison between a mark and print, the examiner faces a set of observations from which an inference about the identity of source must be drawn. The ability to distinguish between distortion and dissimilarity is essential and relies mainly on examiner's experience.

**Evaluation** stage emphasizes the subjective nature of the fingerprint evaluation. The highly subjective recognition process exploits the extraordinary power of human eye-brain combination, and the ability of the examiner is crucial. There are various ways to achieve this, and each has been explored by the fingerprint profession e.g. initiatives under the SWGFAST (Scientific working group on friction ridge analysis, study and technology) group guidelines[18] and laid down standards in response to issuance of NAS report.

The acceptability of fingerprint evidence as being scientific in nature has been subject to a DAUBERT hearing in the U.S (U.S. v. Mitchell criminal case in eastern district of Pennsylvania) with 20 Daubert hearing in U.S with the outcome that fingerprint evidence passed the Daubert test and the judicial notice was given to the fact that fingerprints are permanent and unique. It was a strong defense against the criticism by Sandy L Zabell and others.

The utility of fingerprints in forensic investigation is advancing day by day. In 2008 British researchers developed methods of identifying users of marijuana, cocaine and methadone from their fingerprints residues of various chemicals and their metabolites present in the body[19].

Finger ridge skin present on the soles of feet and toes (planter surfaces) is also unique like ridge on fingerprints and palm, so when recovered from the crime scene, sole and toe impression can be used in same manner for identification. Footprint evidence has been admitted in courts in the United States since 1934[20].

AFIS (Automated fingerprint identification system) is biometric identification methodology that uses digital imaging technology to obtain, store and analyze fingerprint data which was originally used by the U.S Federal Bureau of Investigations and AFIS itself has been in use around in many countries of world. Now the FBI United States has developed more advanced system namely IAFIS (Integrated Automated fingerprint identification system) which was launched on July 28, 1999. It is the largest biometric data base in the world, housing fingerprints and criminal histories for more than 70 million subjects in the criminal master file, along with more than 31 million civil prints[21].

# CONCLUSION

Our study revealed that the prevalence of loop type of pattern was in highest percentage in Pakistani population (54%) and an arch type of pattern was found to be in lowest percentage (10.5%), as well as in other two studies conducted on dermatoglyphics in Pakistan and the other one abroad. Moreover ulnar loop type of pattern was prevalent in very high percentage amongst Pakistani population (87.5%) whereas radial loop type of pattern was found in lowest percentage (12.5%). Fingerprint patterns are not only old standing helpful tool for identification of criminals during forensic investigation but are also a developing aid in the diagnosis and prevention of different diseases. More elaborated studies should be conducted with reference to ethnic and geographical variations while using more sophisticated latest equipment as our study is third one in Pakistan, only two studies on the subject of dermatoglyphics have been conducted before in Pakistan. Biometric database housing fingerprints and criminal history of criminals should be developed in Pakistan to help out the local law enforcement agencies which can also exchange the prints electronically with international law enforcement agencies on the pattern of IAFIS.

# REFERENCES


1. Mahadik SR, Dixit MR. Identification of Fingerprints Class from Minutiae. International J Cryptol and Secur 2009;2(1):1-8.
2. Bell S. History of fingerprints. Encyclopedia of Forensic science. 1st ed. New Dehli (India): Publishers Viva Books Private Limited; 2005.p. 130-131.
3. Awan NR. Personal Identity. Principles and Practice of Forensic Medicine. 1st ed. Lahore (Pakistan): Publishers Sublime Arts; 2004.p.31-34.
4. Dikshit PC. Dactylography. Textbook of Forensic Medicine and Toxicology. 1st ed. 2007.p.80-86.
5. Knight B. Identification of living and dead Simpsons Forensic Medicine. 11th ed. New York (USA): Publishers Oxford University press Inc; 1997.p.32-37.
6. Champod C, Lennard C, Margot P, Stoilovic M. Statistical Data on Minutiae. Fingerprints and Other Ridge Skin Impressions. 1st ed. Florida (USA):Publishers CRC press LLC; 2004.p.211-16.
7. Henry, Edward R. "Classification and uses of fingerprints". London: George Rutledge & Sons Ltd;1900.
8. Conklin, Gardner B, Gardner R, Shortelle D. Encyclopedia of Forensic Science: a Compendium of Detective Fact and Fiction. Westport, Conn: Oryx, 2002. Print.
9. Abbasi S, Einollahi N, Dashti N, Vaez-Zadeh F. Study dermatoglyphics patterns of hands in women

with breast cancer. Pak J Med Sci 2006; 22(1): 18-22.
10. Stowens D, Sammon J W, Proctor A. Dermatoglyphics in female schizophrenia. J Psych Quart 2004;44(1):512-532.
11. Arunpongpaisal S, Nanakorn S, Mongcontha-worncha P, et al. Dermatoglyphics traits in Thai schizophrenia patients: a matching case-control study. J Med Assoc 2011; 94(3):386-94.
12. Bari AU, Naeem M, Rahman SB. Different Patterns of Dermatoglyphics in normal Pakistani population. Pak Armed Forces Med J 2004; 54(1): 67-70.
13. Meier RJ. Acrtic Anthropology 1996;3(2):206-210.
14. Swofford HJ. Fingerprint's patterns: A study on the finger and ethnicity prioritized order of occurrence. J Forensic Identification 2005;55(4):480-488.
15. Karmakar B. Distribution and population of total number of palmar triradii among 20 Dhangar castes of Maharashtra, India. Int J Anthropol 1990;5(3): 255-269.
16. Nithin MD, Manjunatha B, Shashidar C. Study of fingerprint classification and there gender distribution among south Indian population. J Forensic and legal Med 2009;16(8):460-463.
17. Ashbaugh DR. Ridgeology, J Forensic Identification 1991;41(1):16-64.
18. SWGFAST (Scientific working group on friction ridge analysis, study and technology) Report, September 2011.
19. Everts, Sarah. Fingerprints reveal drug use. J Chem and Engg News 2008;86(51):34.
20. People V. Les, 267 Michigan 648, 255 NW 407.
21. Federal Bureau of investigations report 2010, US department of justice.

**Address for Corresponding Author:**
Dr. Muhammad Saleem,
Assistant Professor,
Department of Forensic Medicine,
Post Graduate Medical Institute,
Lahore, Pakistan
Cell: 0300-9467512
Email: drsaleem44@yahoo.com