GENDER DETERMINATION BASED ON BILATERAL SYMMETRY OF FINGERPRINT RIDGES

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ABSTRACT

Human Identification is crucial to forensic science and medicolegal investigations. Fingerprints are considered to be the most precise and reliable indicator for personal identification. The present study has been carried out on 100 subjects, 50 males and 50 females of different age groups in the range of 18 – 55 years from different districts of Kerala and Tamil Nadu. This study aims to determine gender based on the bilateral symmetry in fingerprint patterns. The research concludes very few ridges demonstrate similarity when bisected in halves. It is difficult to divide a pattern symmetrically because it has many ridge characteristics and significant differences are observed between two populations. The predominant fingerprint pattern was Ulnar loop followed by Whorl in both Kerala and Tamil Nadu. The least common patterns are Arch and Radial loops in both populations. It was observed that arch (3-5%), whorl (35-47%), and loop (50-65%) were present in both populations. According to the study fingerprints of females from Kerala have 31.96%, females from Tamil Nadu have 42%, males from Kerala have 39.96%, and males from Tamil Nadu have 36.2% symmetrical ridges and bilateral symmetry in the whorl and arch pattern. But in the loop, it is difficult to bisect.

Keywords: Fingerprint Pattern, Symmetrical ridges, and Ridge Count

INTRODUCTION

The word forensic comes from the Latin word 'forensis' meaning 'of or before the forum'. This is especially important in law enforcement where forensic investigation is done in relation to criminal or civil law.

Identification of gender plays an important role in Forensic and medico-legal investigations. **Human identification** means the individualizing of a person based on biological, visual, or morphological features. Anthropometry has been used for years to identify humans. Alphonse Bertillion created a system called anthropometry in which body components are measured to estimate a person's age, race, and stature. **Identification** can be divided into **Complete** and **Partial** identification. **Complete identification** is the exact fixation of personality and it is based on unique features like name, age, sex, address, etc. **In partial identification** certain facts are determined e.g.: race, and stature-like features. Race, sex, age, complexions, features of hair and eyes, fingerprint, footprint, lip prints, teeth marks, tattoo marks, scars, occupational marks, handwriting, clothes, gait pattern, DNA profile, or DNA fingerprints are some of the features for human identification. The most accurate and trustworthy evidence for determining a person's identity is their fingerprints.

A fingerprint is an impression left by the friction ridges of a human fingertip, able to be used for identifying individuals from the unique pattern and lines on the fingertip. The fingerprint is an oily impression of the contact ridges of the finger. These friction ridges are the raised portion of the epidermal part of the skin of a palmer surface. **Dermatoglyphics** is a systematic study that deals with the epidermal ridges and their configurations on specific body parts like fingers, palms, and soles. Unique finger impression is one of the most important biometric technologies and is truly outstanding, the least expensive, and genuine verification of recognizable proof. Apart from the flexion crease and secondary folds, dermatoglyphics is the scientific study of naturally existing epidermal ridges and their arrangements on the digits, palms, and soles. The raised portion of the upper layer of the fingertip skin is known as the ridges. Since the outermost layer of skin is called the epidermis, the finger ridges are also referred to as epidermal ridges. The depression between two ridges is called a valley or furrow. The ridges and valleys form a complex curved pattern on the fingertip. The pattern on each finger of a person is so unique that is not repeated on another

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finger of the same person or the fingers of any other person. This makes fingerprints the most unique identification method.

The use of Fingerprints for human identification:

i.   Fingerprint analysis helps to identify the unknown, deceased, and missing persons.

ii.   Criminals whose fingerprints are found at the crime scene and it helps to identify the culprits.

iii. Forgery-related cases, fingerprint helps with the investigation.

iv.   Fingerprint identification is to prevent either accidental or purposeful exchange of newborn infants in hospitals.

v.   Criminal cases like robbery, rape, and assault increase day by day, Fingerprint identification helps to investigate these kinds of cases.

Much research is conducted on the topic of gender determination from fingerprints. Vaishali et.al studied the topic of "Comparative study of bilateral symmetry in dermatoglyphic patterns with reference to Geographical parameters" and observed in their study that the ulnar loop is the predominant pattern followed by whorl and the majority of people exhibit 80% bilateral symmetry.

MATERIALS AND METHODOLOGY

The total 100 fingerprint samples were collected from both males and females belonging to different districts of Kerala and Tamil Nadu aged between 18 -55 years. Before taking their fingerprints on the recording slips, the subjects were briefed on the method and purpose of the study, and consent was taken from them. The fingerprint was recorded in a fingerprint slip. The preliminary information of the subject i.e., name, age, sex, and occupation were also documented at the top of the slip.

The pattern of fingerprints is identified from the collected prints. Arch, Loop, Whorl, and composite patterns were observed from the recorded prints. The ridge counts were calculated on the whorl and loop pattern. The symmetrical ridge count and white line count of each fingerprint were analyzed.

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RESULT AND OBSERVATION

After analyzing each fingerprint, the pattern and ridge count along with symmetrical ridges were found. When analyzed it was observed that males have more ridge count than females. For symmetrical ridges in the loop, it was found that there are no symmetrical ridges because of the presence of more minutiae characteristics, and in the whorl and arch pattern symmetrical ridges present significantly (Fig 1).
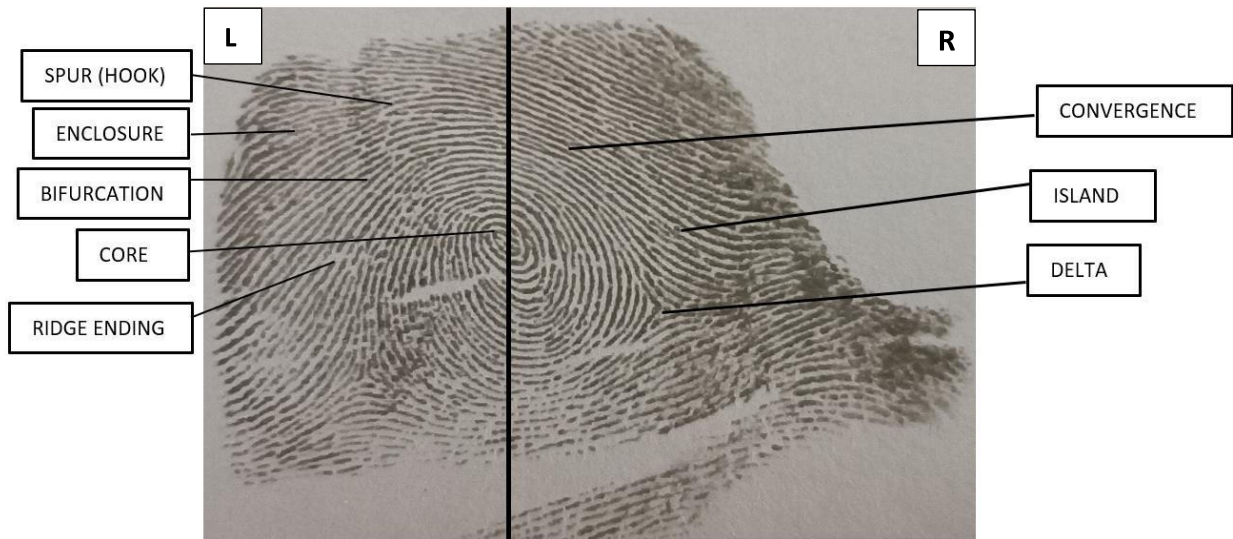

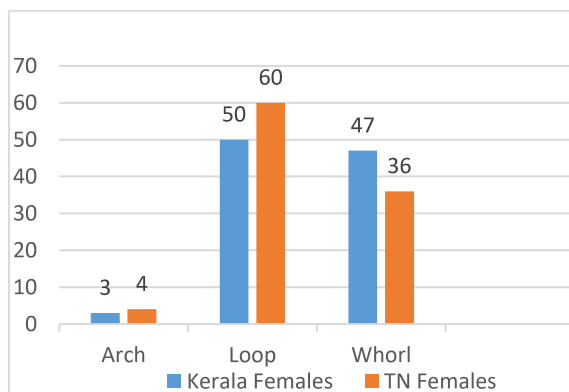Fig 1: A Whorl pattern depicting asymmetry of minutiae

Fig 2: Frequency of fingerprint pattern of Kerala and Tamil Males
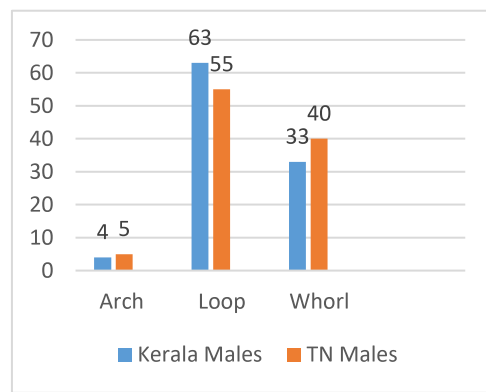

Fig 3: Frequency of fingerprint pattern of Kerala and Tamil Nadu female
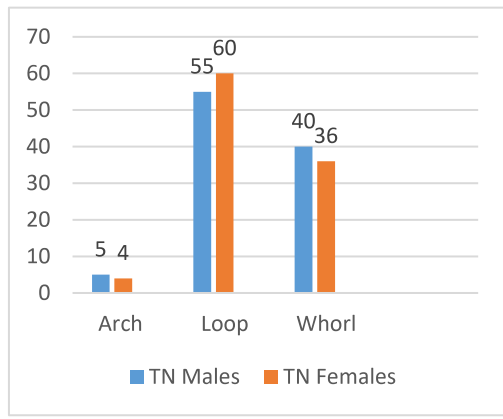
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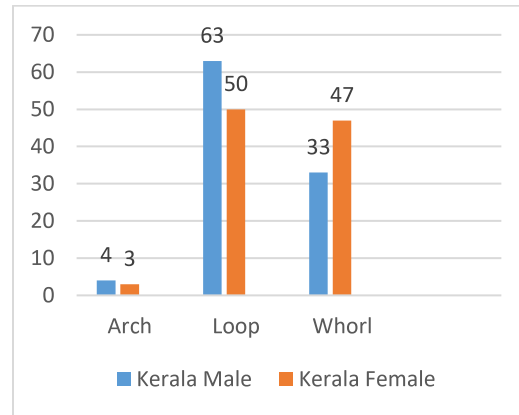Fig 4: Comparision of frequency of Pattern between and females

Fig 5: Comparision of frequency of Pattern between Kerala males and females
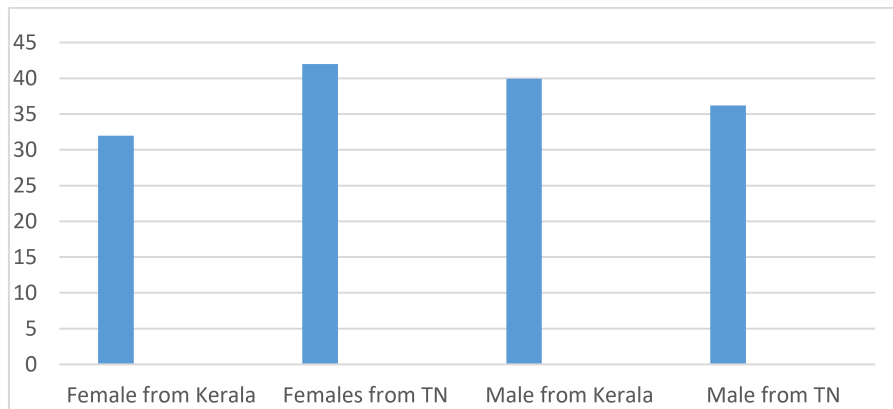

Fig 6: Frequency of Symmetrical Ridges of both Kerala and Tamil Nadu People

Gender determination based on symmetrical ridges from fingerprints depends on fingerprint patterns. When it is an arch pattern, the ridges start from one side and end on the opposite side, so in an arch pattern, more than 7 ridges are symmetrical. Similarly, when the whorl pattern is divided and analyzed bilaterally, many ridges come symmetrically (Fig 6). But the loop pattern starts from one end and ends on the same side, so the symmetrical ridges are less in the loop pattern.

DISCUSSION

Personal identification through Fingerprints has long been recognized and is regarded as the greatest contribution to law enforcement. The important characteristics of fingerprints like pattern,

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and ridge characteristics are unique in every individual. The invention of the individuality of fingerprints caused a gradual decrease in anthropometric methods of identification and led to the adoption of fingerprints for personal identification.

The most common fingerprint patterns were the Ulnar loop and Whorl and the least common patterns were arch and radial loops (Fig 2 and 3). When a fingerprint is bisected and observed for symmetrical ridges, the number of similar ridges is less due to the presence of ridge characteristics. When comparing fingerprint size with gender Male is wider than Females. And the comparison of ridge count Males have more ridge count than females and the symmetrical ridges are found depending on the pattern of the Fingerprint (Fig 4 and 5).

In the study Dr. Amit Patil et al Fingerprint Ridge Density is a tool for Gender Determination to distinguish the orientation of an individual in the characterized population utilizing unique mark edge thickness. The edge was not entirely settled by edge thickness and wrinkles present on the skin. Cummins and Ohler's work on edge thickness in fingerprint propose that male have less coarse finger edges than females with fewer edges in every space than females and subsequently have less edge thickness. This study exhibited that there is a massive distinction in the epidermal edge thickness between the two genders. A unique mark having >13 edges /25mm2 has a higher likelihood (p=0.99) of a unique mark of >14 edges /edges /25mm2 of being from a male beginning is extremely enormous. Females were found to have altogether higher edge thickness that males [p<0.001]. When comparing this study to the research of Maha A Hilal et al it showed that Edge differs as per age.

Eshak et.al.(2013) tracked that in boys the mean ridge count for the left hands was lesser than for the right hands. In females, the mean ridge count for the left hand was higher than the right hand.

In the present study it was observed that in the reach from 12-15 ridge count, the probability proportion for males was higher than for females. The inverse should have been visible just by changing the scope of the 16-21 ridge count. The probability proportion showed females predominant compared to males. This implies that a unique mark ridge count of $15/22mm^2$ or tonight it down would be best reasonable for male beginning and a unique mark edge count of more than $15/22mm^2$ is almost certain for female beginning. Additionally, Acree (1999) expressed that the inclination toward chances showed that finger impression edge thickness <13 edges/$22mm^2$ is probably going to be of male beginning. Similarly, fingerprints having edge count

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>14 ridges/22mm^2 are most likely to be of female origin. Vinod et.al.(2010) announced that critical distinctions in sexual orientation were tracked down in Chinese subjects. The finger ridge count of 12 ridges is bound to be of males and more than 13 ridges id bound to be of females. Likewise, a similar creator recorded that in Malaysian subjects, 11 ridges or less are probably going to be male, and in females over 13 edges were noticed. As opposed to the current review Khadri et. al. (2013) saw that the mean ridge thickness for females was lower than that for males (12 ridge density for females contrasted with 12.4 for males). The variations in the outcome could be because of the distinction in the counting strategy, the modest number of subjects under the study, or because of topographical variations.

Golembo – Smith et.al 2012 conducted research on bilateral differences in papillary patterns and the result is the sizes are different in patterns of Fingerprints and the fingertip pattern is asymmetric data. The ridges recording in two hands together showed the most dependable separation among males and females. Using each hand alone, the right hand was more precise than the left one. This study has proved that there is an increased ridge count in the female gender than in the male gender given less coarseness of ridges. The study of sex determination by ridge count is more specific and highly significant.

Comparatively, the result of this study's Fingerprint pattern also provides asymmetric data and difficult to determine the Gender of an individual.

CONCLUSION

In the present study, it is observed that the bilateral symmetry of Fingerprint analysis is difficult to determine the gender of an individual. There are more than 15 ridge characteristics present in a Fingerprint, due to the presence of minutiae difficult to bisect a fingerprint, and not easy to find symmetrical ridges. A Fingerprint of every individual has unique characteristics and it helps for personal identification. The most dominant pattern of fingerprints is the Ulnar loop followed by Whorl in both Kerala and Tamil Nadu Populations and the least common patterns are arch and radial loops. The ridge count can be used as a presumptive indicator of the gender of an unknown print left at a scene of crime and also as a method of identification.

The present study revealed that Females have a statistically significant ridge count than Males. Fingerprint evidence is without any doubt the most authentic and allowable evidence to date in a

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court of law. The fingerprint ridge counting and bisected symmetrical ridges might be useful for inferring the donor's sex from latent fingerprints of unknown origin.

The result of the study is significant as it can help the investigators. Unfortunately, this study failed to identify a significant association between Fingerprint patterns.

It was concluded that the differences in the Fingerprint ridge counting can be used as an important tool for the determination of gender. In this study, the result indicates that the symmetrical ridges of a Fingerprint cannot help to determine the individuality of a person but there are some differences in ridge counting of Males from females. Therefore, ridge counting can help determine the gender of an individual. Investigative authorities and Forensic experts use this tool for gender determination from a fingerprint left at a scene of the crime.

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