Research Article

IMPLEMENTATION OF INHERENT PALMAR PRINTS RIDGE DIMENSIONS FOR GENDER DETERMINATION TO FACILITATE FORENSIC INVESTIGATION

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A R T I C L E I N F O	A B S T R A C T
	In the legal justice system, fingerprints bear a pivotal connotation to support investigation whereas it's morphology, uniqueness, perpetuality and ubiquitous by nature. Such prints are recovered from the misdemeanour spectacle in various form which have been utilized in order to establish a link between the perpetrator and victim from earlier phase of scientific era. Several researchers and scientists carried out researches for establishment of identity, gender determination of accused from the ridges observed from spectacle. This study was attempted in same direction by implementing the Inherent Fingerprints and Palm prints ridge dimensions for Gender determination to facilitate Forensic Investigation. For which, 100 samples including male and females were subjected to provide the inherent palmar surface prints from the northern population of India. By an application of traditional intensification methods, prints were visualized for further analysis with the help of Stereo microscope and the micrometer to observe the ridges dimensions. The obtained resultant of palmar surfaces allows us to discriminate genders based on their dimensions. This study proclaims that any perpetrator along with their identical gender involved in any lawlessness can be apprehended based on the few ridges left over misdemeanour spectacle unknowingly.

INTRODUCTION

In forensic investigation, several evidences play pivotal expediency for identification of perpetrator/ accused. These evidences are recovered in numerous forms i.e. contaminated, blood gauze, skeleton remnants and inherent conditions. Among all the evidences, s few form of evidences i.e. voice of an individual, DNA profile and fingerprints are considered perpetual, exclusive and ubiquitous by nature[1]. Fingerprint is an exclusive ornament which is composed of the several number of ridges and furrows on the phalangeal, palmar and plantar surface of the individual[2]. These are considered as one of the dermatoglyphics traits which can be used for the identification of an individual. fingerprints are the prime issues which is significantly useful in the determination of individuality in forensic practice[3]. It has been proved that no two fingerprints share identical prints in every individual and even in the identical twin person[4].

Moreover, fingerprints are formed and made up of various features which helps in recognizing easily permitting to be classified and utilized it for the later references as a standard sample pertaining to the various concern crime cases[5]. Therefore, it has the possibility to not only identify the culprits but also the victims and unidentified corpses if the record database of the prints is available.

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The term dermatoglyphics was coined out by Harold Cummins in the year 1926 which refers the patterns of the ridges located on the palms, fingers, toes and soles of the feet[6]. The ridge formation is governed by multitude of genes and the embryo development stage during its first month of the development. Once the ridges are created, they do not change anymore throughout their lifetime provided they met with any injuries on the skin surfaces which alters the damaged region in the pattern temporarily only[7].

The main objective of this research study is to determine the age and gender variations in male and female from the variations in dimensions of inherent fingerprints. The patterns of the misdemeanour spectacle vary from each misdemeanour spectacle. The investigator and the forensic expert cannot expect to analyse each and every misdemeanour spectacle to solve the cases. Fingerprints is a very crucial and evidential value when it comes to the misdemeanour spectacle that may be in a distinct pattern. The main motive of these study is to bring a significance in the forensic field[8]. According to the objectives the fingerprint ridges and the palm print ridges dimensions have the variation with respect to the gender. For instance, there may be cases where the ridges may be partially found at the misdemeanour spectacle. So, in those cases we can refer to these studies and exclude most of the criteria's for the analysis and directly help to determine the gender[9].

Forensic aspects or the forensic identification's point of view, there can be a lot of significance towards this study since the misdemeanor spectacle patterns are different for each crime that has been committed by the culprit[10]. As inherent prints are highly possible to get adhered on the surface area of the misdemeanor spectacle, but the pattern of impression differs. Sometimes the investigator may come across to the latent prints found at the misdemeanor spectacle, and they are partially latent prints. Usually, the investigator or the exhibits collector cannot expect the full inherent prints after developing[11]. So, in those cases the dimensions of the ridges can be referred to base on this study and the criteria of discriminating and eliminating the characteristics can be done and undergo the individual characterization[12].

METHODOLOGY

The present study was carried out in Amity Institute of Forensic Sciences, Amity University, Noida, Uttar Pradesh, India. In this study, 100 samples including males and females were collected from the population of Northern part of India. All the samples were selected by adopting simple random sampling method from an age group of 12-65 years respectively and collected in May-June 2019.

MATERIAL AND METHOD

Before the sample collection, all subjects were informed about the objective of this study and their oral consent was appropriated. All the subjects were asked to clean their palmar surface by using hand Sanitizer (as per availability) or to wash their hands to control over the deposition process and instructed to dry by using any clean cloth. After this process, subjects were instructed to sit for 20-30 minutes at room temperature. Now, subjects were asked to implement their hands against the plain A4 size white paper sheer of 75 GSM. By confirming the deposition of inherited palmar prints on paper, all sheets were kept were preserved at room temperature (32^0C) for next 36 hours. The room temperature were note down to observe the effect of temperature over deposition of inherited prints and deposition of organic/inorganic materials i.e. amino acids, fatty acids, salts etc. For the intensification process of palm prints, all inherited samples were directed to easily available, inexpensive and traditional method -black powder. Since the inherent prints are subjected to distortion, smudged or affected due to the environmental and allied factors i.e. temperature, humidity, rainfall, etc. Hence, all intensified samples were preserved in white or brown paper envelope to avoid any contamination or distortion of samples[13].

Instrumentation requirement

As per the objective of this study, all the intensified prints were specified from several analyzed points of palmar surface. The dimensions of ridges were counted from 9 mm^2 area. For the preliminary omnipresence of ridges, hand lens with a capacity of 10 X magnification was used. In addition of it, the dimensions between the rides was analyzed and measured by using stereomicroscope and the micro-meter. Although the pattern at looked the anatomic features of the ridges also can be visualized using a stereomicroscope 10x magnification. The magnified palmar prints are given below in figure no. 1 (a) & 1 (b) below-
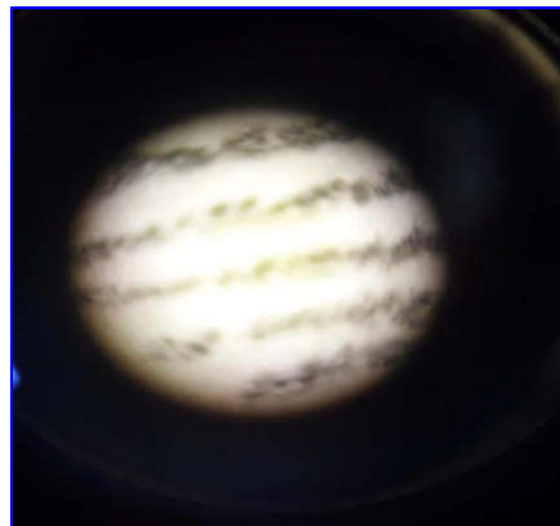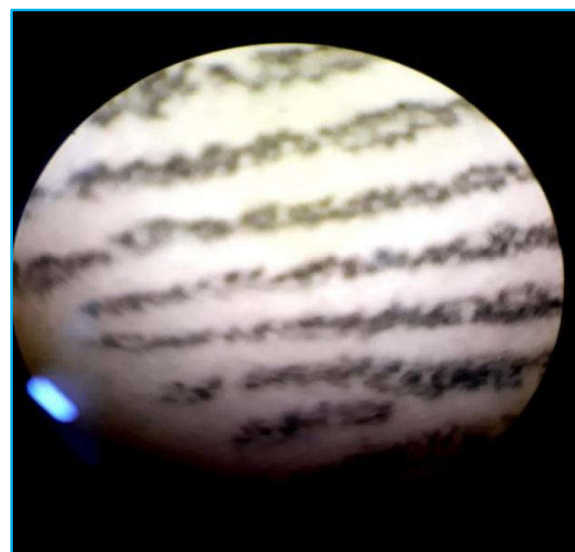

Figure 1 (a)

Figure 1 (b)

Fig 1 (a) & 1 (b) Ridges of the palm print observed under 10x magnification in stereomicroscope (a) male (b) female

Stereomicroscope of 500 X magnification provides the details of intensified ridges which also facilitate to identify and detect the tiny information of third level details (pores, shape and size). The micro-meter having the scales of 0-100 which the 100 parts of 1mm is utilized to determine the thickness value of the ridges

Statistical Analysis

The statistical T-test is also performed to test the differences or the variations between the males and females significantly.

$$\text{Test Statistic of Unpaired Samples} = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where

$$s^2 = \frac{\sum_{i=1}^{n_1}(x_i - \overline{x}_1)^2 + \sum_{j=1}^{n_2}(x_j - \overline{x}_2)^2}{n_1 + n_2 - 2}$$

The interpretation of the value is based on the t score which is the ratio between two ridge's difference of male and females. The variance is also utilized in the study and to determine the differences between the individuality a statistical correlation coefficient is used[14].

The correlation measures the degree to which two variables move in relation to each other. The collected data were analyzed using the formula of correlation coefficient as mentioned below:

Correlation Coefficient Formula

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

Where, n = no. of samples, x and y represents the subject (male & female)

The various statistical methods were used in this study such as standard deviation, variance, mean, T- test and the correlation coefficient.

RESULT AND DISCUSSION

The exploration of the inherent prints was performed under stereomicroscope at 10x magnification for visualization of ridges pores and dimensions. In the requirement of higher magnification, stereoscope with 500 X magnification can be utilized. This will enable us to identify and detect tiny pores and their relative positions, which are unique. The micrometer having the scales of 0-100 which the 100 parts of 1mm is utilized to determine the thickness value of the ridges in an area of 9 mm[2, 15].Several studies and researches have been conducted on the density of ridges between male and female but the dimension between the ridges of the fingerprint and the proximal region of the palm prints has to be determined yet. In this study, the ridge count was performed in distinct parts of palmar surface i.e.right thumb, right index, right middle, right ring and the right little prints ridges and the correlation with respect to the gender and the age were calculated. The possible outcome inference after the derivation among both of genders from various analysed points are given below in table no.1 below-

Table no.1 the obtained mean values of ridge from various analysed points of palmar surface of both genders.

Analysed point	Mean values of male subjects	Standard Deviation	Mean values of female subjects	Standard Deviation
Palm (Hypothenar)	5.08	1.2094	3.78	2.4014
Right Thumb	4.6	2.1665	3.82	2.7381
Right Index	4.88	1.8913	3.46	2.5810
Right Middle	5.1	2.1499	3.54	2.9569
Right Ring	4.36	2.2293	3.36	2.6784
Right little	4.54	2.1779	3.36	2.6077

As per discussion, the examination was performed in the right hand for both of genders of palmar surface. The analysed performance of subjects are given below in table no 2-

Table no. 2 Variance of the ridge count for male and female's palmar surface of the right hand.

Analysed point	variance values of male subjects	variance values of female subjects
Palm (Hypothenar)	1.4628	5.7669
Right Thumb	4.6938	7.497
Right Index	3.5771	6.6616
Right Middle	4.6224	8.7432
Right Ring	4.9697	7.1738
Right little	4.7432	6.8004

For determination of any correction between the ridge count between the male and female samples were analysed. The obtained values are given below in table no 3 below-

Table no.3 Correlation coefficient of the ridge count among the gender and specified age groups.

Variables	r value	Interpretation
P vs P	0.252	Weak positive correlation
RT VS RT	0.362	Weak positive correlation
RI VS RI	0.274	Weak positive correlation
RM VS RM	0.373	Weak positive correlation
RR VS RR	0.599	Partial positive correlation
RL VS RL	0.495	Weak positive correlation

The above table no. 3 represents the correlation of the ridge density or count between male and female. After the statistical observations of the correlation, it was found that 90% of the ridges between both of the genders are weak positive correlation and 10% of the ridges were partial positive correlation. It signifies that there is not strong correlation between the ridge count in a specific area from various parts of palmar surface doesn't differentiate among ridges.

Table no. 4 Ridge thickness (dimensions) mean from both male and female.

Male			Female		
PR1	PR2	PF	PR1	PR2	PF
127.80	122.43	115.85	142	137	87

PR1= Palmprint ridges1, PR2= Palmprint ridges2 and PF= Furrows between two palmprint ridge.

As per the observation of table no. 4, the dimensions between the right-hand palm print ridges od both of genders were measured from various points. As per the resultant of this study, either no correlation among both of genders, or it was weak and negative correlation among them. The obtained results are given below in table no 5 below-

Table no 5 Correlation coefficient of palmprint ridges dimensions between male and female.

Variables	r value	Interpretation
PR1 VS PR1	-0.238	Weak negative correlation
PR2 VS PR2	-0.156	Weak negative correlation
PF VS PF	0.038	Zero correlation

PR1= Palmprint ridges1, PR2= Palmprint ridges2 and PF= Furrows between two palmprint ridges

To verify the significance of this study, unpaired students t-test was performed at 95 % of confidence level. The obtained values of several selected points of palmar surface along with the dimensions between the ridges are given below in table no 6 below-

Table no. 6 T-test statistical difference test for ridge count and the palmprint ridges dimensions between male and female

| Ridge count (p value) Significant value= 0.05						Palm print thickness (p value) Significant value= 0.05		
Palm	RT	RI	RM	RR	RL	PR1	PR2	PF
0.001	0.117	0.003	0.002	0.045	0.014	0.10	0.08	1.59
High significant	low significant	High significant	high significant	low significant	High degree significant	moderate significant	Highly significant	low significant

The above table represents the T-test for the unpaired variance. A 9mm^2 area was drawn on a palm print and the fingerprint from RT to RL[16]. In order to measure the ridge count, the count was performed on the square box according to the method given by Acree and the counting of the ridges is done

diagonally from one corner to the other. The above value is the counting done under 9 mm square area which reflects the ridge density value. According to the above inference 20% of the ridge density together with palm prints and the fingerprints were highly significant i.e., P value is greater than 0.05 (p > 0.05). The ridges which shows highly significant values were Right-Thumb and Right Ring. The Right Little shows the partial significant value.
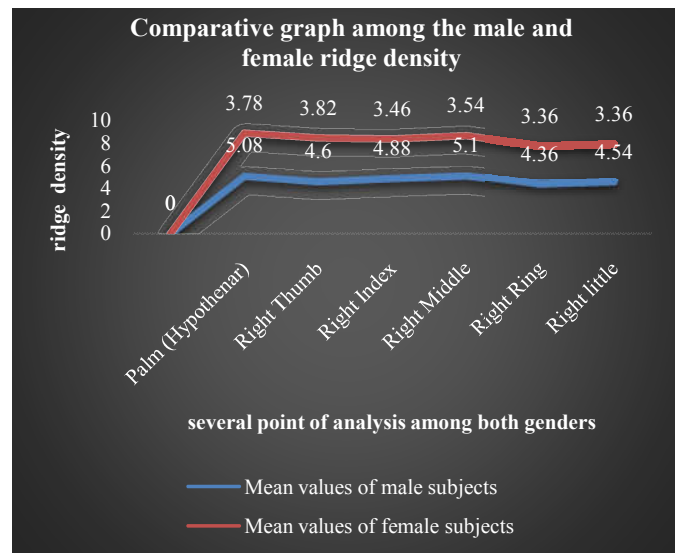
Graph no.1 Comparative graph among the male and females ridge density.

The values which shows low significant values were Palm, Right Index and Right Middle. The thickness or the dimension of the ridges representing the palm prints were Palm ridges1, Palm ridges2 and Palm Furrows. All the three have a highly significant value which means p > 0.05.
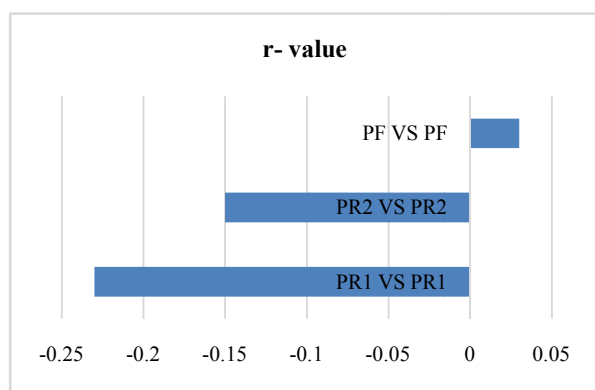
Graph 2 Bar graph representation of the correlation between male and female palm print ridges dimension.

CONCLUSION

As per the obtained results of this study, the variation of the ridges dimensions the palm ridges shows significantly higher than the ridges of the fingerprints. This shows that the palm print ridges dimensions varies from gender which means there is a great difference between male and female. The correlation between male and female ridge density shows that around 90% of the ridges will have weak positive correlation and around 10% of the ridges will have partial positive correlation. This depicts the number of the ridges will have insignificant differences between male and female but about 10% of the ridges will show a slight difference between them.

After an extensive study, it was found that female ridges tend to have higher than the male ridges. Even the sweat deposition on the epidermal ridges which means the sweat glands tends to excrete more on the female than male. It is observed that the sweat deposition is more in females as compared to the males because after the collection of the latent prints for the development after 36 hours, it was found that the female ridges tends to show more clarity than the females. So, the development of the female latent fingerprints was higher than the male individuals. After the observation of the ridges dimensions on the stereomicroscope it was found out that the female ridges have the higher dimensions but that cannot justify fully because it depends on the individual's profession, conditions and the activities and such information can help the investigating officer to apprehend the suspect.

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