A Comparative Case Study of Fingerprint Patterns in Male Convicts of Sabarmati Jail (Ahmedabad) in Gujarati Population

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ABSTRACT

There are numerous applications of fingerprints for human identification as they are unique and extensively used tool for identification of criminals during forensic investigations, in both civil and criminal cases. More elaborate studies are required with reference to ethnic and geographical variations in Gujarat which could be useful in creating a biometric database of fingerprints in which criminal history of convicts could also be included which will go a long way in supporting the criminal justice system and law enforcement agencies. Therefore the study was conducted on the convicts of Sabarmati jail to assess the patterns frequency in the fingertips of the criminals and their comparison with reference to normal Gujarati population (control). The study revealed that the convicts (male) had greater frequency of patterns than control (males) but statistically there was no association between the control and convict related to patterns in the respective digits. As seen from the p-value of the tests, we conclude that H1 is accepted i.e. there is association between right and left hand fingerprint patterns in control males, convict males and their total also. Statistically it has also been found that there is no association between fingerprint patterns in both hands of convicts and control.

Keywords: Biometric, Convicts, Finger prints, Investigation

INTRODUCTION

Dermatoglyphics has been a very fascinating field of study for the anthropologist, medical professionals, geneticist, above all the criminalistics as they have been proved to be the most unique biometric for the identification of an individual. Though DNA fingerprint has been found to be same in monozygotic twins, the fingerprints have been found to be different in them. It is this uniqueness and infallibility property which is taken into consideration in forensic sciences to strengthen the criminal justice system and legal agencies. Since the years fingerprints have been used to solve several cases and were responsible for the punishment of the criminals. The most common pattern, a simple loop which comprises 60%-70% of all patterns is characterized by a single triradius. Whereas whoels have two triradii yielding two counts, while simple arches have no true triradii as can be seen in the fig no. 1, 2 and 3.

Fingerprints are still the most important unconquered tool for criminal identifications. The efficacies of procedure and cost effectiveness are the reasons which make the fingerprints still the most dependable tool for identification. The analysis of such fingerprints of various population groups may be useful for the prospects of the future.

The literature review indicates that hardly any study has been reported which could show if dactylographic was related to the criminal tendency
in the human beings. Therefore this study has been taken to find out the most common patterns prevailing in the convicts. Though it is not possible to directly ascertain that the individuals having any one of the patterns in more percentage would be having criminal tendency, but still there are chances and possibilities to have an idea that fingerprint patterns are one of the aspects which, cannot be ignored apart from biological, environmental, physical and mental conditions affecting an individual’s life to make him criminal. Moreover the database has been created to assess whether overall in the population the same number of loop, arch and wheel patterns are existing or not.

Therefore an attempt has been made to find out the frequency of percentage of populations having different patterns on fingertips.

Although significant advances have been made, many of them, in just last two decades are still on the tip of the iceberg. With the advent of newer, more powerful technologies, software, and computer algorithms, there are opportunities to explore our vast fingerprint databases. There is a dire need to assess and quantify the full extent of variation of friction ridge features, starting with perhaps the most basic (patterns and minutiae)—if one can truly call this “basic”—and then attempting to assess and quantify other features such as creases, scars, edge shapes, and so forth.

MATERIALS AND METHOD

In the present study, basically a qualitative work, in which subjects were chosen from different places depending on the age groups. Fingerprints of convicts to be studied were taken from Sabarmati Jail mainly undergoing life term imprisonment under section 302. The subjects were mainly males in the age group of 25 to 75 years. The control population was mainly Gujarati. The fingerprints of control population were basically taken from the old age asramas in Gandhinagar which comprised of 45 to 93 years and the younger groups 20 to 25 years from the students of M.Sc. Forensic Science, Institute of Forensic Science, Gujarat Forensic Science University, Gandhinagar.

The subjects have been explained the above procedure and the consent were obtained by them in the standard performa. Modified ink method was applied. The materials used were printer’s duplicating ink from Kores, cardboard roller, gauze pads and sheets of paper.

PROCEDURE

The hands of the individuals were washed thoroughly with the soap and water and wiped with dry cloth before taking prints to remove any amount of dirt present on the hand. A small quantity of ink was applied on the glass plate and was spread uniformly to prevent smudging of the ink. The fingerprint performa sheet was placed on the edge of the table and the right thumb of the right hand was rolled on the glass plate having ink and then was placed on the space allotted for right thumb on the fingerprint performa. Similarly all the ten fingers print were collected on the specified regions of the performa sheet by rolling method so that the entire print is covered for evaluation and analysis. The personal details of the convicts were also collected which included their name and address, gender, caste, history, etc. The ten digit fingerprints of the convicts were given in number and statistical analysis was done by using SPSS (Statistical Package for the Social Sciences) version 20.

RESULTS & DISCUSSION

The fingerprint patterns after comparison has shown that the loops were the most common patterns amongst convicts as well as controls but the frequency of percentage of loops (54.53%) was less in convicts when compared to that of controls (55.21%). Whorls were found to have higher frequency of percentage in convicts (41.15%) than controls (36.90%) followed by arch which was also higher in convicts (3.95%) than in controls (3.66%) as can be seen by table no. 6. This observation was similar to that of Nithin et al., who stated that the most frequent pattern was the unar loop in the total population. Gangadharu M.R., Rajasekara Reddy K reported in a study that the basic pattern type loops (57.11%) were common followed by whorls (27.89%) and arches (15.00%) in the general population with significant sex difference and insignificant bilateral difference. Purkait K observed in his comparative study, a tribal group of Midnapur district in West Bengal where Mundas exhibit higher frequency of whorl and loop patterns while loops are more frequent among Lodhas. These findings are almost in consistent with the present study findings loops followed by whorls. These findings are in agreement with the present study. Arabind Basu observed high frequency of loops, moderate whorls and low arches. The overall trends of frequencies of
the three patterns in males were observed to be similar in all the studies including the present one.

In the case of convicts it was found that the arch pattern was highest in both right and left index finger (5.82%), (12.79%) followed by middle finger of both right and left (4.65%) and (6.98%). Left ring had higher frequency of percentage (2.33%) when compared to RR (1.16%).

Whereas RL of convicts had higher percentage of arch (3.48%) when compared too little finger (1.16%). Left thumb did not show any pattern whereas right thumb had (1.16%) of arch. When the loop pattern was considered it was found that little finger (68.60%) in left hand had the highest percentage followed by middle finger (51.63%), Thumb (59.30%), Index finger (47.67%), Ring finger (45.02%). In comparison to left hand the right hand had the highest percentage frequency in middle finger (70.93%), followed by little finger (67.44%), then index finger (55.81%), followed by thumb and ring finger which showed drastic decrease in percentage (36.05%) and (34.88%). The percentage frequency of total loop pattern and arch pattern was highest in left hand than right hand of convicts whereas in the case of whorls the highest percentage of frequency was seen in right hand compared to left hand. In the case of left hand the whorls were found to have highest percentage of frequency in ring finger (54.65%) followed by thumb (40.70%) then index finger (39.53%) and middle and little finger had sharp reduction in frequency of percentage of whorls (31.36%) and (30.23%). Comparatively in the right hand ring finger had the highest frequency of percentage of whorls (63.95%) followed by thumb (62.79%) then index finger (38.37%), whereas there was tremendous decrease in percentage frequency of whorls in little and middle finger (29.06%) and (24.42%). It was also found that loop had highest frequency range in left hand than right hand and whorls was more in right hand compared to left hand. It is similar to study of Cummins in case of whorls and also conforms to the generalization of Cummins and Midlo where it is expected that whorl patterns and radial loops should occur more commonly on the right hand digits in both sexes as compared to the left hand digits.

In the left hand arch pattern had highest frequency of percentage in index finger (9.85%), followed by middle (4.22%). Arch pattern was showing highest frequency of percentage in both index and middle finger of left hand in convicts and left index and right middle of controls. Right thumb of convicts have shown arch pattern which was nil in controls. Loop and whorl patterns were having highest frequency in all fingers of the convicts compared to controls in the right and left hand. In the world population loops are supposed to occupy 60-65% which was comparatively less in convicts compared to controls. Arch pattern is supposed to be 5% but it was less in both convicts and controls. Whorl pattern should be around 30-35% which was found to be more in convicts whereas in controls was within the limit. The study revealed that the convicts (male) had greater frequency of patterns than control (males) but statistically there was no association between the control and convict related to patterns in the respective digits. Statistically it has also been found that there was no association between fingerprint patterns in both hands of convicts and control.

The study was also performed in both the hands to ascertain the bilateral symmetry. It was also observed that the highest percentage of symmetry in loop pattern was seen between LL of convicts and controls i.e. 59.15% followed by RL 47.88% then RM and LM showed (36.47%) and (45.96%) of symmetry. Least percentage of symmetry was seen between loop patterns of control and convict in RR (4.22%). Highest percentage of symmetry in whorl patterns was seen in RR (36.61%) and RT (33.80%) in of convicts and controls. 4% of symmetry of whorl patterns was seen in RM and LM of controls and convicts. In arch pattern symmetry was observed only in 1.40% of convict and control.

These disparities may be due to genetic as well as environmental factors and it has been reported that digital dermatoglyphic patterns are genetically determined and influenced by environmental, physical and topological factors. This study has provided the dermatoglyphic patterns of Gujarati population and convicts; it also shows that digital patterns are more specific in differentiating population groups. This data is just a part of database being created for Gujarati population but to state with confirmation whether the patterns are related to criminal activity a huge data has to be analyzed.

**CONCLUSION**

There was significant difference between the patterns on each finger/digit of right and left hand of convicts i.e. within the convicts the percentage of
frequency of patterns was more in one finger and less in the other and the same was true for the controls. As seen from the table No.3, P-value of the test is (P=0.000) we conclude that there is association between right and left hand finger tip patterns in control males, convict males and their total also.

Table No.1 Distribution of basic fingerprint patterns among the convicts (male) in both hands (N=86)

<table>
<thead>
<tr>
<th>Patterns on the fingertips</th>
<th>RH</th>
<th>RL</th>
<th>RM</th>
<th>RR</th>
<th>RT</th>
<th>LT</th>
<th>LL</th>
<th>LM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arches</td>
<td>11(11.6%)</td>
<td>4(4.6%)</td>
<td>7(7.9%)</td>
<td>1(1.1%)</td>
<td>3(3.4%)</td>
<td>0</td>
<td>5(5.7%)</td>
<td>7(8.1%)</td>
</tr>
<tr>
<td>Loop</td>
<td>31(36.3%)</td>
<td>35(40.4%)</td>
<td>61(70.8%)</td>
<td>23(26.4%)</td>
<td>24(27.7%)</td>
<td>11(12.7%)</td>
<td>5(5.7%)</td>
<td>25(29.3%)</td>
</tr>
<tr>
<td>Whorl</td>
<td>44(51.1%)</td>
<td>35(40.4%)</td>
<td>21(24.4%)</td>
<td>25(28.6%)</td>
<td>24(27.7%)</td>
<td>11(12.7%)</td>
<td>5(5.7%)</td>
<td>25(29.3%)</td>
</tr>
</tbody>
</table>

Table No.2 Distribution of basic fingerprint patterns among the control (male) in both hands (N=72)

<table>
<thead>
<tr>
<th>Patterns on the fingertips</th>
<th>RT</th>
<th>RI</th>
<th>RM</th>
<th>RR</th>
<th>RL</th>
<th>LT</th>
<th>LI</th>
<th>LM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arches</td>
<td>0</td>
<td>7(9.5%)</td>
<td>4(5.6%)</td>
<td>1(1.3%)</td>
<td>0</td>
<td>1(1.4%)</td>
<td>7(9.5%)</td>
<td>5(6.9%)</td>
</tr>
<tr>
<td>Loop</td>
<td>10(42.9%)</td>
<td>31(45.6%)</td>
<td>60(82.1%)</td>
<td>33(45.6%)</td>
<td>28(39.5%)</td>
<td>20(27.8%)</td>
<td>31(45.6%)</td>
<td>72(97.9%)</td>
</tr>
<tr>
<td>Whorl</td>
<td>10(50.0%)</td>
<td>31(45.6%)</td>
<td>57(69.4%)</td>
<td>45(62.5%)</td>
<td>22(30.6%)</td>
<td>30(40.3%)</td>
<td>16(22.2%)</td>
<td>72(97.9%)</td>
</tr>
</tbody>
</table>

Table No.3 P-Value for all: 0.00 at 0.01 level of significance

<table>
<thead>
<tr>
<th>Category</th>
<th>RH &amp; LT</th>
<th>RH &amp; LL</th>
<th>RM &amp; LM</th>
<th>RR &amp; LL</th>
<th>RL &amp; LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convict Male</td>
<td>22.047</td>
<td>55.544</td>
<td>65.545</td>
<td>70.545</td>
<td>59.545</td>
</tr>
<tr>
<td>Control Male</td>
<td>315.284</td>
<td>113.546</td>
<td>97.545</td>
<td>101.764</td>
<td>88.764</td>
</tr>
<tr>
<td>Convict &amp; Control Male</td>
<td>279.658</td>
<td>776.649</td>
<td>238.726</td>
<td>277.658</td>
<td>245.698</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Whereas when the complete right and left hand were taken into consideration the difference was not significant i.e. the patterns were in almost equal proportion in both convicts and controls as a $\chi^2 \text{cal} < \chi^2$ tab, can be seen by 'table No.5. The difference between the patterns in convicts and control for the same finger/digit has also not found to be significant statistically as can be seen in the table no.4. Overall the frequency of whori pattern was more in convicts but statistically it was not significant. Thus more study is required in this area to state that whori patterns are more in convicts.

Table No.4 (Degrees of freedom (DF) =3, at 0.01 level of significance)

<table>
<thead>
<tr>
<th>Category</th>
<th>RH</th>
<th>RL</th>
<th>RM</th>
<th>RR</th>
<th>RT</th>
<th>LT</th>
<th>LI</th>
<th>LM</th>
<th>RR &amp; LT</th>
<th>RR &amp; LL</th>
<th>RL &amp; LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convict Male</td>
<td>2.693</td>
<td>3.097</td>
<td>1.209</td>
<td>1.335</td>
<td>3.335</td>
<td>2.575</td>
<td>1.525</td>
<td>3.451</td>
<td>1.466</td>
<td>5.226</td>
<td></td>
</tr>
<tr>
<td>Control Male</td>
<td>2.693</td>
<td>3.097</td>
<td>1.209</td>
<td>1.335</td>
<td>3.335</td>
<td>2.575</td>
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<td>1.466</td>
<td>5.226</td>
<td></td>
</tr>
<tr>
<td>Convict &amp; Control Male</td>
<td>2.693</td>
<td>3.097</td>
<td>1.209</td>
<td>1.335</td>
<td>3.335</td>
<td>2.575</td>
<td>1.525</td>
<td>3.451</td>
<td>1.466</td>
<td>5.226</td>
<td></td>
</tr>
<tr>
<td>P-Value</td>
<td>0.485</td>
<td>0.228</td>
<td>0.894</td>
<td>0.827</td>
<td>0.304</td>
<td>0.596</td>
<td>0.757</td>
<td>0.289</td>
<td>0.335</td>
<td>3.132</td>
<td></td>
</tr>
</tbody>
</table>

Table No.5 (Degrees of freedom (DF) =3, at 0.05 level of significance)

<table>
<thead>
<tr>
<th>Category</th>
<th>RH &amp; LH (Observed)</th>
<th>RH &amp; LH (Calculated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convict Male</td>
<td>2.693</td>
<td>5.99</td>
</tr>
<tr>
<td>Control Male</td>
<td>2.693</td>
<td>5.99</td>
</tr>
<tr>
<td>Convict &amp; Control Male</td>
<td>2.693</td>
<td>5.99</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.485</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table No.6 Distributions of basic fingerprint patterns among the controls and convicts total

<table>
<thead>
<tr>
<th>Patterns on the fingertips</th>
<th>Convicts Male(N=86)</th>
<th>Controls Male(N=72)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH</td>
<td>14(5.26%)</td>
<td>20(4.66%)</td>
<td>34(3.95%)</td>
</tr>
<tr>
<td>LH</td>
<td>21(5.64%)</td>
<td>21(5.44%)</td>
<td>42(5.18%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>35(5.80%)</td>
<td>41(5.44%)</td>
<td>76(5.68%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table No.6 Distributions of basic fingerprint patterns among the controls and convicts total</th>
<th>Convicts Male(N=86)</th>
<th>Controls Male(N=72)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH (Arches)</td>
<td>14(5.26%)</td>
<td>21(5.64%)</td>
<td>35(5.80%)</td>
</tr>
<tr>
<td>LH (Loop)</td>
<td>21(5.64%)</td>
<td>21(5.44%)</td>
<td>42(5.18%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>35(5.80%)</td>
<td>42(5.18%)</td>
<td>77(5.58%)</td>
</tr>
</tbody>
</table>

Table No.6 Distributions of basic fingerprint patterns among the controls and convicts total

<table>
<thead>
<tr>
<th>Patterns on the fingertips</th>
<th>Convicts Male(N=86)</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>77(5.58%)</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENT

The authors are grateful to all the individuals for their co-operation in giving palm prints and Mr. Prasad for helping in statistical analysis.

Conflict of Interest: Authors have no conflict of interest

Source of Funding: Nil.

Ethical Clearance: Not applicable.

REFERENCES


A Descriptive Study to assess Variation in ATD, DAT and ADT Angles with Reference to Age and Gender in Palmprints of Gujarati Population

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ABSTRACT

In this study an attempt has been made to correlate the age and the angles of triradians along with the gender variation in angles. It was found that there was no significant difference between atd angles between male and female and there was significant difference between male and female in dat and add angles. On the other hand the correlation study of angle with age between male and female indicated strong positive correlation for angle adt, weak positive correlation for angle atd and strong negative correlation for dat angle. Thus neither age nor angle is the reason for increasing or decreasing the value of other as correlation does not mean causation.

Keywords: ATD, DAT and ADT Angle, Palm Prints, Biometrics, Investigation

INTRODUCTION

Dermatoglyphic patterns of the hand are unique to an individual in which atd angle is of paramount importance in forensic science and criminal investigation apart from medical field. This is true of all the skin-ridge patterns on the surface of the hand as a whole, and especially to the science of fingerprints as these patterns do not change. Among which palm prints study could have greater relevance in near future apart from fingerprints as it has got numerous applications in different areas of science apart from human identification and one characteristic among them is angle atd, dat and add. At the base of the palm, there are usually four triradii: a, b, c, and d (see Figure 1). An axial triradius (c) is usually located near the point where the palm is connected to the wrist. This angle is formed by lines drawn from the digital triradius (a) to the axial triradius (c) and from this triradius to the digital triradius (d). The more distal the position of c, the larger the atd angle. Sometimes accessory 'a' or 'd' triradii are present on the palm. Thus the atd angle is a dermatoglyphic trait formed by drawing lines between the triradii below the first and last digits and the most proximal triradius on the hypothenar region of the palm. This trait has been extensively used in dermatoglyphic studies with major applications in medical sciences.

Two percent of normal individuals have this triradius positioned near the center of the palm (termed 'c'). A triradius found halfway in between these two positions (c') is found on 21% of the normal population. Approximately 11% of the population will have some combination of more than one axial triradius. The atd angle averages 48° among normal individuals. People with Down syndrome have an atd angle averaging 81°. Elevated atd angles are also found on individuals with other forms of chromosomal abnormalities including trisomy 18, trisomy 13, Klinefelter Syndrome (XXY), and Turner Syndrome (XO).

The first important point to be considered is that atd angles change with age (the angle is larger in children than adults) and with sex (the angle is larger in men than in women; Cummins and Milden, 1961). If these two variables are not taken into consideration, biases may result if the age or sex-composition of the samples differs among studies.

In the present study dermatoglyphics of 136 normal Gujarati population of different age groups in the ranges of 22 to 93 were analyzed for axial triradius from prints of left and right palms of both males and females. This research was mainly focused on the correlation between three angles and age. Comparison
of the angles adt, dat and adt was also performed between male and female. Thus significant changes with the age group and gender were recorded with reference to all the three angles. There has been a tremendous study which has been done in the study of adt angle with respect to medical applications and genetic effects. But hardly there has been any study which has been done in Gujarati population nor there is any literature quoting the significance of other angles like dat or adt. The relativity between the age of the individual and the angle made by triradius has also not been recorded in the literature, though some studies have been done in different age groups and with respect to the gender. Therefore this study was performed whereby the changes in adt angle with the increase in age is observed and other angles are also studied which are further reported among Gujarati population. The comparison is also made between control male and female for correct assessment. Therefore it can be given that the adt angle is the most stable phenotype compared to some other palmar quantitative characters.

MATERIAL AND METHOD

The present study was performed in the vicinity of Institute of Forensic Science. The subjects were mainly the Gujarati population. The subjects were of different age groups varying from 22 to 90 years. Total 136 samples of Gujarati population in which male were 71 and females were 66 were included for the descriptive quantitative study. The fingerprints were basically taken from the old age ashrams in Gandhinagar which comprised of 30 to 93 years and the younger groups 20 to 25 were collected from the students of M.Sc. Forensic Science, Institute of Forensic Science, Gujarat Forensic Sciences University, Gandhinagar.

The subjects have been explained the procedure and the consent were taken by them in the performa letter. Simple ink method was applied for taking the palm prints. The materials used were printer’s duplicating ink from Korex, cardboard roller, glass plate, gauze pads and sheets of paper.

PROCEDURE

The hands of the individuals were washed thoroughly with the soap and water and were wiped with dry cloth before taking prints to remove if any dirt present. A small quantity of ink was applied uniformly over the glass plate. The palms of each individuals were placed on the ink on the plate and palm prints of both hands were taken on the plain paper. The palms were rolled on cardboard roller with paper, taking care that the cupped regions of the palm were printed properly.

The palm prints were further screened with the magnifying glass and then with the scale lines were drawn from triradii ‘a’ to ‘d’, ‘d’ to ‘t’ and ‘a’ to ‘t’ and the angles between them were measured with the aid of protractor. Parameter observed were three angles i.e. <adt, <dat and <adt. All the three angles were measured quantitatively in both right and left hand of males and female subjects for further comparison. Statistical test was performed with the software SPSS (Statistical Procedure for Social Sciences) version 20. T test and Correlation Coefficient of Variation were done to correlate the data at significant level of 0.05.

RESULTS AND DISCUSSION

Literature reports average angle of normal individual is in range 44.5°. Higher range of adt angle was reported in some cases of mental retardation. Any deviation from the stated value of angle would be strong indicative of certain anomaly in dermatoglyphics. The mean of adt, dat and adt angles among the Gujarati populations are given in table 1. Based on the statistical tests it was found that the mean values were higher in male series when total was considered whereas in males RH adt value was less compared to females and LH adt value was higher in males (RH=48.24; LH=53.52) than in female series (RH=48.78; LH=47.58). Bilateral and bisexual differences as evidenced by ‘t’ test in Gujarati population indicated that there was no significant difference in the value of adt (RH & LH) and total between male and female.

The result was proved to be on tract with the study of B. K. C. Reddy and K.S.N. Reddy, who have found that the mean values of ‘adt’ angle along with the statistical derivatives among the Sugalis were higher in male series than in female series and on left then on the right hand in both sexes of the Sugalis, bilateral and bisexual differences are not found to be significant as evidenced by ‘t’ test. Another study by E. Anibor et al study has shown that there was gender dimorphism which was observed in one of the study concerning the adt angle. The males had higher adt angles than the females (p < 0.05) which did not confirm to the findings of a previous study of the Jaws. In that study, females showed significantly greater adt angles than males (p < 0.05). This could be due to
differences in sample sizes of the two studies. Most of the previous investigators have not observed 'adl' and 'dat' angles. Whereas the present study we have done the comparison between all three angles. Therefore angle dat was (RH =60.86; LH=67.70) in males and (RH=65.14; LH=65.97) in females. There was large difference seen in this angle between male and female. Angle adl was found to be (RH=68.77; LH=70.11)) in males compared to (RH=64.14; LH=64.68) in females. It was noted that there was significant difference between angle dat (RH & LH), and angle adl (RH and LH) of males and females.

Though there has not been any study related to gender in all three angles the study by Osunwoke E.A., et al. was performed on adl and dat angles in both Krik and Ikwerre population, where they have found that there was no significant difference in the adl angles between the two ethnic groups. There was a significant difference (P<0.05) between the dat angles of both ethnic groups. However, in the dat angles, it was observed that there was a significant difference in both ethnic groups when compared statistically (P<0.05). Since dermatoglyphic variables have shown to have ethnic and racial variations (Harich et al, 2002; Kasuma et al 2002; Igbibibi and Mtsama, 2001; Oladipo and Akanigha, 2005) the difference in dat angles can be deduced to be as a result of variations in ethnicity. In another study related to adl and dat angle study it was found that the mean adl and dat angles of the two groups in both male and female were significantly different (P<0.05) on the left hand but not on the left hands of the subjects.

Correlation coefficient value of angle adl (RH & LH) in males is (0.592; 0.767) and females (0.802 and 0.731) is between 0.5 and 1 indicating strong positive correlation. Correlation coefficient value of angle adl (RH & LH) in males was (0.075 &0.076) and females (0.118 & 0.300) was between 0 & 0.5 indicating strong weak correlation i.e. the increase in value of one variable will increase the value of other and vice-versa. Whereas angle dat for males RH & LH (-0.774; -0.731) and females(-723 & -735) the value was between -0.5 & -1 indicating that there is strong negative correlation and increase in age might decrease the angle dat of other and vice-versa. i.e. higher values of age is associated with higher values of angles and lower values are associated with lower values, which indicates that as age(angle) is increasing the angle(age) is also increasing and vice-versa while decreasing. However here it should be noted that neither age nor angle is the reason for increasing or decreasing the value of other.

From the table no. 2 it can be found that among the male the angle adl was more in the age group of 20-30 but after that there was decrease and then consistent increase in the angle from the age 41-90 in the right hand. Whereas in the left hand there was no consistency and the angle kept on increasing and decreasing with the age. < dat in the right hand of male had shown highest angle in the age group of 20-30 later it decreased from the age group 41-50, then there was fluctuation in the angle with the age. In males < dat in the left hand was also highest in the age group 20-30 and lowest in the age group >90. In between age group the angle increased and decreased. < adl was found to decrease in male from the age group 41-90 in the right hand and left hand. Whereas < adl in right hand of age group 20-30 was less i.e. 59.86 when compared to left hand 58.67.

The adl angle in the age group 20-40 increased and then decreased. The same pattern was followed in the left hand. < dat in the right hand of female was highest in the age group 20-30 and then there was consistent increase in the angle with the age. Whereas in the left hand there was increase and decrease in the angle with the age and the highest angle was shown in the age group 20-30 and then in 51-60. < adl in female right hand had highest angle in the age group 41-50 then there was consistent decrease in the angle with the age. The same pattern was observed in the left hand also. But a sudden increase in the angle was noted in the age group >90. Whereas in male the angle adl increased consistently in right hand between 41-80 age group. Then there was sudden decrease in the angle adl in age group >90.

Thus as indicated earlier adl angle could be used as a dermatoglyphics marker for certain diseases and also for forensic and criminal investigation to indicate the tendency of criminality in individuals. This study is basically a non invasive study which could be useful for diagnostic & assessment tool for the mental retardation.

CONCLUSION

This analysis could be of immense importance to forensic scientists, anthropologists and clinicians in respect to genetics in the identification of the ethnicity of a particular individual and criminal investigation.
ACKNOWLEDGEMENT

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Conflict of Interest: Authors have no conflict of interest

Source of Funding: Nil.

Ethical Clearance: Not applicable.

Table No.1. Angle adt, dat and adt among males and females of Gujarati population

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>Control (N=70)</th>
<th>Male (N=60)</th>
<th>Female (N=60)</th>
<th>T Test</th>
</tr>
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<td></td>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Std. Error</td>
<td>Std. Dev</td>
</tr>
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<td>ADT_RH</td>
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<td>48.24</td>
<td>4.80</td>
<td>4.04</td>
</tr>
<tr>
<td>2.</td>
<td>ADT_LH</td>
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<td>53.57</td>
<td>7.049</td>
<td>59.397</td>
</tr>
<tr>
<td>3.</td>
<td>ADT.Total</td>
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<td>101.76</td>
<td>7.082</td>
<td>59.674</td>
</tr>
<tr>
<td>4.</td>
<td>DAT_RH</td>
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<td>60.86</td>
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<tr>
<td>5.</td>
<td>DAT_LH</td>
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<td>7.</td>
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Table No.2. Mean of angle adt, dat and adt in different age groups of males

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<tr>
<th>AGE</th>
<th>ADT_RH</th>
<th>ADT_LH</th>
<th>ADT_Total</th>
<th>DAT_RH</th>
<th>DAT_LH</th>
<th>DAT_Total</th>
<th>ADT_RH</th>
<th>ADT_LH</th>
<th>ADT_Total</th>
</tr>
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<tr>
<td>20-30</td>
<td>48.14</td>
<td>47.29</td>
<td>95.43</td>
<td>70.71</td>
<td>72.71</td>
<td>143.43</td>
<td>58.67</td>
<td>58.67</td>
<td>118.52</td>
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<tr>
<td>30-40</td>
<td>46.00</td>
<td>45.50</td>
<td>91.50</td>
<td>54.50</td>
<td>56.50</td>
<td>110.00</td>
<td>78.00</td>
<td>78.00</td>
<td>156.00</td>
</tr>
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<td>40-50</td>
<td>47.67</td>
<td>46.17</td>
<td>93.83</td>
<td>52.33</td>
<td>56.33</td>
<td>113.92</td>
<td>72.92</td>
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<td>47.20</td>
<td>95.60</td>
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</tr>
<tr>
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<td>95.17</td>
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<td>114.83</td>
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</tr>
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<td>95.00</td>
<td>58.00</td>
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Table No.3 Correlation Coefficient Values of Angles adt, dat and adt with reference to Age.

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<th>ADT_LH</th>
<th>ADT_Total</th>
<th>DAT_RH</th>
<th>DAT_LH</th>
<th>DAT_Total</th>
<th>ADT_RH</th>
<th>ADT_LH</th>
<th>ADT_Total</th>
</tr>
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<tr>
<td>20-30</td>
<td>49.27</td>
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<td>72.89</td>
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<td>57.65</td>
<td>114.76</td>
</tr>
<tr>
<td>30-40</td>
<td>42.00</td>
<td>45.50</td>
<td>92.10</td>
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<td>57.00</td>
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<td>151.80</td>
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<td>49.00</td>
<td>99.00</td>
<td>55.00</td>
<td>51.00</td>
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<td>75.00</td>
<td>152.00</td>
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<td>93.17</td>
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<td>63.00</td>
<td>119.00</td>
<td>72.00</td>
<td>70.90</td>
<td>142.90</td>
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<td>48.50</td>
<td>97.00</td>
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<td>99.09</td>
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<td>100.50</td>
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</table>

Table No.4. Mean of Angle adt, dat and adt in different age groups of Females

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male(Correlation)</th>
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<td>-0.74</td>
</tr>
<tr>
<td>DAT_LH</td>
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<td>0.00</td>
<td>-0.74</td>
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<tr>
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</tr>
<tr>
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<td>0.21</td>
</tr>
<tr>
<td>ADT.LH</td>
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</table>
REFERENCES


