Original Research Article

A cross - sectional study of palmar dermatoglyphic pattern in patients with type 2 diabetes mellitus at a hospital in South India

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ABSTRACT

Aim: To study dermatoglyphics of fingers and palms and to use it as a tool to screen the population for the pre-disposition to diabetes mellitus, for risk reduction and early therapy. Materials and methods - The study was conducted on 100 diabetic patients and 100 controls, age, sex matched. Quantitative parameters like finger ridge count, a-b ridge count, total finger ridge count, absolute finger ridge count, atd, adt and dat angles were studied. Qualitative parameters like finger ridge patterns were studied. Dankmeijer's, Furuhata's and Pattern intensity index were calculated.

Results: Difference of a-b ridge counts, Absolute Finger Ridge Counts and Total Finger Ridge Counts between cases and controls was statistically not significant. Adt angle was significantly more in cases in right hand as compared to controls. Tad angle was less in cases in right hand as compared to controls. Fingertip patterns in all digits combined and in both hands combined in cases and controls showed there was a statistically significant increase in the number of loops in controls as compared to cases. Dankmeijer's index was significantly more in male and female controls. Furuhata's index was significantly more in male and female cases. Pattern intensity index was significantly more in female cases and controls as compared to males.

Conclusion: Findings of the present study highlight on the possible dermatoglyphicmarkers. There were many supporting and contradictory findings to studies conducted by other researchers, hence there is lot of scope for further studies.

1. Introduction

'Dermatoglyphics', term was first coined by Cummins and Midlo from two greek words – (derma = skin, glyphe = carving).[1] Dermatoglyphics involves the study of epidermal ridges which are present on the surface of palms, fingers, soles and toes.[2] These epidermal ridges form individually characteristic well-defined patterns that have been found useful in the clinical diagnosis of hereditary diseases.[3]

The epidermal ridges remain unchanged throughout the life of an individual. Their Development is under genetic control, but influenced by environmental factors. Dermatoglyphics study is cost effective and requires no hospitalization. For these qualities they play a very crucial role in crime detection, personal identification, twin diagnosis, racial variation and in diagnosis of various diseases.

Diabetes mellitus is classified under non-communicable diseases. the prediction is th at, India will have the highest number of diabetic individuals globally by 2030. A n estimated 79.4 million by 2030., 75% of diabetic patients in India have first degree family history of diabetes. Type 2 diabetes mellitus has a strong hereditary background, hence variations in dermatoglyphics are seen in type 2 diabetes mellitus.[4]

The age of onset of type 2 diabetes mellitus is during the peak productive years of life of an individual and there is no definite tests available to predict who will develop

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the disease so that preventive measures can be taken.[5] A significant amount of the health budget allocated goes to treatment of non-communicable diseases like diabetes mellitus. So identification of individuals at risk and taking up of the preventive measures is highly economical.

2. Material and Methods

The present study was conducted in KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum on patients of type 2 diabetes mellitus attending Medicine Out Patient Department during the period during January to December 2012. It is a Cross sectional study.

The study was conducted on 100 patients with diabetes mellitus and 100 controls, age and sex matched. Patients aged between 40 to 70 years diagnosed with type 2 diabetes mellitus were included in the study. Patients with associated diseases like hypertension, heart disease, neurological disorders, psychiatric illness, tuberculosis, asthma, breast cancer and skin disorders were excluded from the study.

The patients were asked to wash their hands and dry them. The method adopted for palm printing was modified ink method by Purvis Smith (1969). Printers duplicating ink from Kores was used for taking prints. Cardboard roller, gauze pads and sheets of paper were also used. Fingertips were rolled manually to get full prints of ridges, then the palm was rolled on cardboard roller with pa per, taking care that all the regions of the palm were printed properly.

2.1. Method of counting

Loops, whorls, arches were studied (Figure 1). In a loop – A line was drawn from the core of loop to the triradius and counting of ridge
s crossing the line was done. The opening of the loop to the ulnar or radial side was noted as 'lu' and 'rl' respectively. In a whorl – 2 triradii are present in a whorl, hence counting was done by drawing 2 lines from core to the 2 triradii. In an arch – the triradius is a core, so the count will be zero. Angles – adt, dat, atd were measured using a protractor, a line was drawn from axial triradius 't' to the digital triradii 'a' and 'd' and all the 3 angles in the triangle were measured. a-b ridge count was counted by the number of ridges crossing the line drawn from 'a' to 'b' (Figure 2). Total finger ridge count (TFRC) w as calculated by adding the finger ridge counts taking the highest count of a whorl of all 10 fingers. Absolute finger ridge count (AFRC) w as calculated by adding the finger ridge counts of all 10 fingers taking both the counts of a whorl if present.

The quantitative parameters like finger ridge count, a-b ridge count, total finger ridge count, absolute finger ridge count and atd, adt and dat angles were studied, and qualitative parameters like finger ridge patterns and palmar flexion creases were studied.

Furuhata's Index, Dankmeijer's Index and Pattern intensity index were calculated for the fingertip patterns as follows:

Dankmeijer's Index

$$\left[\frac{\%\ of\ Arches}{\%\ of\ Whorls}\right] \times 100$$

Furuhata's Index

$$\left[\frac{\%\ of\ Whorls}{\%\ of\ Loops}\right] \times 100$$

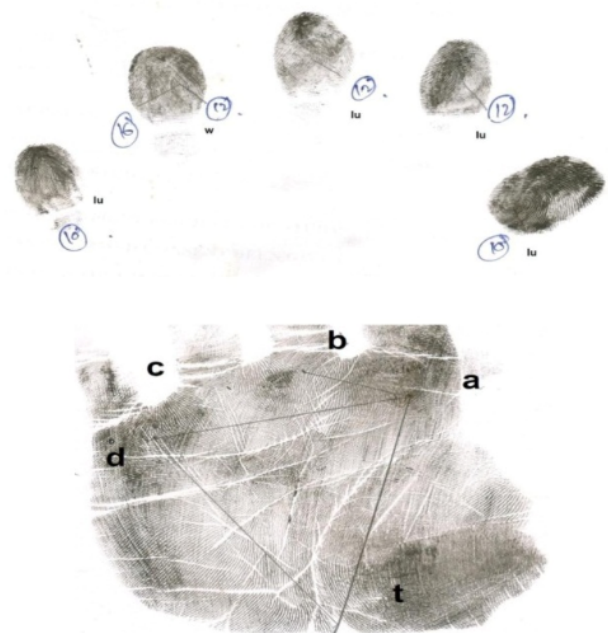3. Pattern intensity index –2 x (whorls + loops) ÷ n

Fig. 1: Method of ridge counting and measurement of angles

Fig. 2: Fingertip patterns

The arithmetic mean and standard deviation was calculated and the Student 't' test was applied for quantitative analysis. The Chi squared test was applied for qualitative analysis.

3. Results

Finger ridge counts in each digit with hands separate reveals that the difference between cases and controls was statistically not significant. Finger ridge counts in all digits with hands separate in cases had a mean of 66.47 in right hand with standard deviation of 29.23 and in the left hand the mean was 63.26 with standard deviation of 25.55. In controls the mean in right hand was 72.35 with standard deviation of 35.85 and in the left hand the mean was 68.14 with standard deviation of 29.75 (Table 1).

The mean of total finger ridge count in cases was 95.37 with standard deviation of 36.12 and in controls the mean was 105.18 with standard deviation of 41.09, the difference in total finger ridge count between cases and controls was statistically not significant, indicating decrease in total finger ridge counts in cases as compared to controls. The mean of absolute finger ridge count in cases was 129.65 with standard deviation of 56.65 and in controls the mean was 137.95 with standard deviation of 66.05. The difference was not statistically significant (Table 2).

The mean a-b ridge count in right hand of cases was 30.51 with standard deviation of 4.38 and in controls the mean was 31.56 with standard deviation of 3.83. In the left hand of cases the mean was 30.60 with standard deviation of 4.18 and in controls the mean was 31.64 with standard deviation of 3.54. The difference of a-b ridge count between cases and controls in both right and left hand was statistically not significant (Table 3).

The mean of adt angle of right hand of cases was 80.29^0 with standard deviation of 5.68^0, whereas in controls the mean was 77.59^0 with standard deviation of 4.87^0, the difference was statistically significant with p- value <0.001 indicating that adt angle was more in cases in right hand as compared to that in controls. The mean of adt angle of left hand of cases was 78.28^0 with standard deviation of 5.61^0, whereas in controls the mean was 77.96^0 with standard deviation of 5.00^0, the difference was statistically not significant. The mean of atd angle of right hand of cases was 41.80^0 with standard deviation of 5.80^0, whereas in controls the mean was 41.08^0 with standard deviation of 5.14^0, the difference was statistically not significant. The mean of atd angle of left hand of cases was 41.41^0 with standard deviation of 5.84^0, whereas in controls the mean was 41.37^0 with standard deviation of 6.01^0, the difference was statistically not significant. The mean of tad angle of right hand of cases was 59.24^0 with standard deviation of 5.84^0, whereas in controls the mean was 61.84^0 with standard deviation of 6.05^0, the difference was statistically significant. It indicated that tad angle was less in cases in right hand as compared to controls. The mean of tad angle of left hand of cases was 60.91^0 with standard deviation of 6.16^0, whereas in controls the mean was 61.48^0 with standard deviation of 5.92^0. The difference was statistically not significant (Table 4).

Fingertip patterns in all digits combined and in both hands combined in cases and controls showed that there was statistically significant increase in the number of loops in controls as compared to cases ($p - 0.025$), whereas the whorl and arch patterns did not show any statistically significant difference between cases and controls. Dankmeijer's index was significantly less in cases as compared to controls. Furuhatas index was significantly more in cases as compared to controls. Pattern intensity index was comparatively less in cases than in controls (Table 5).

Fingertip pattern in all digits combined and in both hands combined in both sexes in cases and controls showed a statistically significant decrease in the number of loops in the left hand of males in cases as compared to left hand of males in controls ($p - 0.029$). There was statistically significant increase in the number of whorls in the left hand of males in cases as compared to the left hand of males in controls ($p - 0.044$). There was statistically significant decrease in the number of loops in both hands combined of males in cases as compared to both hands combined of males in controls ($p - 0.010$). There was statistically significant increase in the number of whorls in both hands combined of males in cases as compared to both hands combined of males in controls ($p - 0.011$), whereas there was no statistically significant difference between hands and between cases and controls in females (Table 6).

In our study the Dankmeijer's index was significantly more in male and female controls as compared to cases. Furuhatas index was significantly more in male and female cases as compared to controls. Pattern intensity index was significantly more in female cases and controls as compared to males.

4. Discussion

Dermatoglyphics were used as proof of identity of individual persons as early as 300 B.C in China, as early as 702 A.D in Japan, and since 1902 in United States. Dr. Nehemiah Grew first described finger ridge impressions in the year 1684.[6] Professor Dr. Johannes E. Purkinje classified fingerprint patterns into 9 categories and gave each one of them a name, which were the precursor to the Henry 's classification system.[7] William Herschel, a British Commissioner to Indi, in 1858 was the first to experiment with fingerprints in India.[8]

Cummins and Midlowere were the first to coin the term 'Dermatoglyphics' (from two Greek words- derma = skin, glyphe = carving) in 1926.[1]

Bets L.V. et al, was among the first to study dermatoglyphic patterns among a group of Russian children with clinically diagnosed diabetes mellitus In 1994.[9]

Indian population studies have shown definite links between diabetes mellitus and dermatoglyphic patterns in hands.[10]

Table 1: Mean finger ridge counts of cases and controls in digits and hands separate

Finger Ridge Count	Cases MEAN+/-SD	Control MEAN+/-SD	P - Value	t
		Right Hand		
1st digit	13.58+/-7.38	15.24+/-9.96	0.182	1.338
2nd digit	13.74+/-9.16	13.72+/-10.56	0.989	0.014
3rd digit	11.03+/-8.02	12.85+/-9.09	0.135	1.500
4th digit	16.08+/-9.75	18.11+/-9.71	0.142	1.475
5th digit	12.04+/-8.13	12.43+/-8.28	0.737	0.336
Total	66.47+/-29.23	72.35+/-35.85	0.205	1.271
		Left Hand		
1st digit	12.56+/-6.67	15.21+/-9.42	0.023	2.294
2nd digit	12.60+/-9.77	11.85+/-10.19	0.596	0.531
3rd digit	12.22+/-8.30	13.97+/-8.60	0.145	1.436
4th digit	15.86+/-9.03	16.27+/-9.33	0.753	0.316
5th digit	10.02+/-6.96	10.84+/-7.36	0.419	0.809
Total	63.26+/-25.55	68.14+/-29.75	0.215	1.244

Table 2: Mean total finger ridge counts and absolute finger ridge count in cases and controls

Finger ridge count	Cases – MEAN+/-SD	Control – MEAN+/-SD	t	P Value
Total	95.37+/-36.12	105.18+/-41.09	1.393	0.074
Absolute	129.65+/-56.65	137.95+/-66.05	0.949	0.344

Table 3: Mean A-B – ridge count of right and left hands of cases and controls

AB – Ridge Count	Cases MEAN+/-SD	Control MEAN+/-SD	t	P Value
Right hand	30.51+/-4.38	31.56+/-3.83	1.803	0.073
Left hand	30.60+/-4.18	31.64+/-3.54	1.898	0.059

Table 4: Mean angles of palmar triradii in right and left hands in cases and controls

Angles	Cases MEAN+/-SD	Control MEAN+/-SD	t	P Value
		Right Hand		
ADT	80.29+/-5.68	77.59+/-4.87	3.608	0.001
ATD	41.80+/-5.80	41.08+/-5.14	0.928	0.354
TAD	59.24+/-5.84	61.84+/-6.05	3.281	0.001
		Left Hand		
ADT	78.28+/-5.61	77.96+/-5.00	0.426	0.671
ATD	41.41+/-5.84	41.37+/-6.01	0.047	0.962
TAD	60.91+/-6.16	61.48+/-5.92	0.666	0.506

Table 5: Fingertip pattern in all digits combined and in both hands combined in cases and controls

Digit	Type	Cases	Controls	P value
	Loop	247	270	0.146
Right hand	Whorl	170	149	0.154
	Arch	83	81	0.864
	Loop	263	290	0.086
Left hand	Whorl	148	129	0.179
	Arch	88	82	0.613
	Loop	510	560	0.025
Combined	Whorl	318	278	0.050
	Arch	171	163	0.632

Table 6: Fingertip pattern in all digits combined and in both hands combined in both sexes in cases and controls

Hand	Type	Cases		Controls		P Value	P Value
		Male	Female	Male	Female	Male	Female
	L	116	115	141	129	0.145	0.115
Right hand	W	92	78	81	68	0.115	0.417
	A	37	46	40	36	0.959	0.276
	L	115	138	151	139	0.029	0.298
Left hand	W	86	62	72	57	0.044	0.951
	A	39	51	39	37	0.673	0.205
	L	231	253	292	268	0.010	0.068
Combined	W	178	140	153	125	0.011	0.546
	A	76	97	79	73	0.794	0.095

Schaumann and Alter were the first to conclude that dermatoglyphic patterns develop in early fetal life and they are genetically determined, but environmental forces can modify and alter them.[11]

Finger ridge counts in all digits with hands separate in cases and controls was statistically not significant. This was in conformity to findings in other studies.

The difference in total finger ridge count between cases and controls was statistically not significant, indicating decrease in total finger ridge counts in cases as compared to controls. This was in contradiction to the findings of Ahuja and Chakarvarti et al (1981),[12] Iqbal et al (1978),[13] and Barta et al (1970),[14] where the mean total finger ridge count was higher in the diabetics than in the controls. The difference in the absolute finger ridge count between cases and controls was not statistically significant. These findings were not in accordance with those of Roopa. Ravindranath and I. M. Thomas (1995),[15] where the mean absolute finger ridge count was higher in the patients.

The difference of a-b ridge count between cases and controls in both right and left hand was statistically not significant. Similar findings were observed by Manoj Kumar et al in their study.[16] But this was in contrast with Ziegler et al (1993)[17] findings, which showed a significantly low a-b ridge count.

The difference between the mean adt angles of right and left hand between cases and controls was statistically not significant. Similar findings were observed by Manoj Kumar et al, in their study.[16] The difference between the meanatd angles of right and left hand between cases and controls was statistically not significant. Other studies done by Manoj Kumar et al,[16] Sant S.M. et al (1983)[18] and Rajnigandga V. et al (2006)[19] showed that atd angles of patients were significantly higher.

Our study indicated that tad angle was less in cases in right hand as compared to controls. whereas the left hand did not show any statistical difference. This was in contra diction to study done by Manoj Kumar et al,[16] Study done by Pramila et al[20] showed higher incidences of tad angles on right hand and left hand of both sexes. The statistically significant differences in adt and tad angles were not found in many other studies.

Fingertip patterns in all digits combined and in both hands combined in cases and controls showed that there was a statistically significant increase in the number of loops in controls as compared to cases, whereas the whorl and arch patterns did not show any statistically significant difference. In the study done by Pushpa et al[20] the percentage of arches was more in diabetic group than in the control group. Their study showed an increased frequency of arches in males and female diabetics. The difference observed in male group was statistically not significant. The difference was more marked in female diabetics, difference being more on the left hand. S. M. Sant et al[18] and Jullian Verbov[21] found an increased frequency of arches in female diabetic patients. Roopa Ravindranath and I. M. Thomas[15] found increased frequency of arches in males and female diabetics than controls while Sarthak Sengupta[22] found increased frequency of arches in male diabetics. Our findings do not correlate with findings of above workers.

In our study, there was statistically significant decrease in the number of loops in the left hand of males in cases. There was statistically significant increase in the number of whorls in the left hand of males in cases. There was statistically significant decrease in the number of loops in both hands combined of males in cases. There was statistically significant increase in the number of whorls in both hands combined of males in cases. In the study done by Pushpa et al[20] the frequency of ulnar loops was found to be more in diabetics than controls. Roopa Ravindranath and I. M. Thomas[15] found statistically significant increased frequency of ulnar loops in both sexes, more marked in left hand of diabetic females in contradiction to our study. S. M. Sant et al[18] observed that the frequency of ulnar loops and radial loops is decreased in both sexes.

Pushpa et al[20] found that the frequency of whorls was significantly reduced in diabetic group than control group. Jullian Verbov[21] found a decreased frequency of whorls in diabetic females. Roopa Ravindranath and I. M. Thomas[15] found decreased frequency of whorls in diabetic males and in left hands of diabetic females. Sarthak Sengupta[22] found increased frequency of whorls in male diabetics. S.M. Sant

et al[18] found an increased frequency of whorls in diabetic males and females. In our study whorls are significantly increased in diabetics than controls.

In our study the Dankmeijer's index was significantly more in male and female controls as compared to cases. Furuhatas index was significantly more in male and female cases as compared to controls. Pattern intensity index was significantly more in female cases and controls as compared to males. In the study done by Pushpa et al,[20] they showed that the Dankmeijer's index was highest in female diabetic group and Furuhata's index was highest in the male control group. Pattern intensity index was not studied by them.

Limitations of this study were that this study did not considered the other aspects of dermatoglyphics like thenar patterns, hypothenar patterns and digital asymmetry and more research is required on this with larger sample size.

5. Conclusion

Dermatoglyphics can serve as a screening and identification tool to select individuals from a larger population, and investigate them further to confirm or rule out diabetes mellitus. Findings of the present study highlight on the possible markers. There were many supporting findings and many contradictory findings to studies conducted by other researchers; hence there is lot of scope for further studies on a larger sample size and with other parameters.

6. Source of funding

7. Conflict of interest

None.

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