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Original Article

Anatomy Section

Dermatoglyphics: A Diagnostic Tool to Predict Diabetes

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ABSTRACT

Introduction: The study of the epidermal ridges on the volar aspect of the hands and feet which form a variety of pattern configurations is called "DERMATOGLYPHICS". All configurations are laid down permanently from the 3rd month of the intra-uterine life and they remain unchanged throughout the life. A positive association of the dermatoglyphic features with different diseases like diabetes, mongolism, schizophrenia and leprosy have been well documented in recent years.

Methods: In the present study, 50 diabetic cases and 50 controls were selected from the SMS Hospital, Jaipur, India for the establishment of the correlation between the two groups by checking for the presence and absence of any dermatoglyphic pattern. Hand prints were taken by Indian ink methods and examined for Total Finger Ridge Count (TFRC), Absolute Finger Ridge Count (AFRC), (a-b) ridge count , distal and lateral deviation (quantitative parameter) and digital and palmer pattern frequency, lateral deviation, angles and the C- line pattern frequency (qualitative parameter).

Aim: The aim of the present was to evaluate the dermatoglyphic features and the specific variations which were to be used as diagnostic tools for an economic and early detection of diabetes.

Results and Conclusion: The TFRC, AFRC, and the (a-b) ridge count were higher in all the patients but they were statistically insignificant. The 'atd' angles in the hands of both sides in the patients were increased in all the groups, except in males (left side), but they differed significantly on the right side (overall, p<.01) and on the left side (female, p<.001). The 'tad' and the 'tda' angles on both sides of the hands in all the groups were lower in the patients except in males (left 'tda'), but they differed only significantly in the females (left 'tad' p<.01, right 'tda' p<.001) and in the overall groups (right 'tda' p<.01)

The whorl, loop and arch digital frequencies in females and in the overall groups (except loop) were increased insignificantly (p<.05). The vestige and the spiral whorl pattern were restricted to the thenar and the hypothenar areas of the male patients respectively as compared to the controls.

Except an increase in the radial variety and the absence of the proximal variety, other C-line patterns were decreased in diabetics than in the controls. The results of the present research work indicate that dermatoglyphic abnormalities may be used as a diagnostic tool for predicting the possibility of the development of diabetes at a later date.

Key Words: Dermatoglyphics, Palmer ridges, Flexion creases, Diabetes, Finger Prints

INTRODUCTION

The formation of dermal ridges takes place in the foetus during the third month of the intra-uterine life as a result of the physical and the topological growth forces [1]. The dermal ridges and the configuration which is once formed are not affected by age, development and environmental changes in the post-natal life and so , it has the potential to predict various genetic and acquired disorders with a genetic influence [2,3]. The classification of dermatoglyphics has been done as below:

(1) Digital Pattern of the ridges (Digital Dermatoglyphics).
(2) Palmer Pattern of the ridges (Palmer Dermatoglyphics).

(1) Digital Pattern of the ridges (Digital Dermatoglyphics): The epidermal ridges form a definite local design on the terminal segments of the digits and on the inconsistent sites on the palm. Galton (1895) [4] classified them as arches, loops, whorls and composite.

ARCH: In the arches , the ridges enter from one side and flow to the other side, making the background turn to form simple and tented arches. These arches have a zero ridge count.

WHORL: The whorl is the most complex type of pattern which is continuously circumscribed by the type lines. These type lines are an extension from the two triradii. The area which is enclosed by these type lines is called the pattern area. The subtypes of whorls are simple whorl (simple whorl and symmetrical whorl), double loop whorl, central pocket loop whorl and accidental whorl.

Loop: A loop includes a triradius, at least one recurving ridge and a ridge count of at least one across a recurving ridge. If any one of these features is lacking, the pattern is classified as a tented arch and not a loop. The ridges of a loop enter from one side, recurve and exit on the same side of the finger. When the ridges leave from the ulnar side, they are known as an ulnar loop and when they leave from the radial side, a radial loop is formed. A loop possesses only one triradius.

Composite: In the composite type, there is a combination of the arch, loop and whorls which are found in the same print and are classified as the central pocket loop, the lateral pocket loop, the twinned loop and the accidental loop.

(2) Palmer Pattern of the ridges (Palmer Dermatoglyphics): The palmer area is divided into various zones with in which a pattern may or may not be present. It includes:

RIDGES AND PATTERN: It includes four interdigital areas (11, I2, I3 and I4 from the radial to the ulnar side), the axial triradius

(t, t', t" according to the position of the triradius), the hypothenar eminence and the thenar eminence.

FLEXION CREASES: Dermatoglyphic studies have few advantages like ready accessibility, their ages and environmental stability [3]. There was scarcity of dermatoglyphic data on the prevalence of diabetes in a population of western India (Rajasthan).This created an interest in attempting the present study. Our aim was to evaluate the dermatoglyphic features in diabetes and to note the specific variation in the cases of diabetes mellitus for an early detection of the disease.

MATERIALS AND METHODS

This study was conducted on 50 cases and they were compared with 50 controls. Age and sex criteria were excluded. The confirmation of diabetes mellitus was based on the history of the subjects, their clinical examinations and their blood glucose levels.

Three methods were used for taking prints:-

(1) Inkless methods (Walker 1957) [5]
(2) The Holister system for young and new born infants.
(3) The Indian ink method (Cumins and Midlow, 1961) [2].

Inkless methods (Walker 1957) [5] :

Macarthur and ford (1937) [6] described a procedure for making prints in the latent form from face cream which was spread on a kymograph paper. The latter was fixed in shellac after developing an impression with lamp black fine powder. This saved the subject from the inconvenience of the staining or the discolouration of the hands.

The X-Ray (Roentgen's method) has scored its useful value over other unsuccessful techniques for finger printing in the advanced states of decomposed bodies. They used the X-Ray record for the indirect correlation of the position of the triradii and the hand skeleton by fastening lead pallets with adhesives at the point of the triradii.

Castellanos (1939) mentioned Beclare's procedure which consisted of smearing the skin with lanolin and bismuth carbonate and taking shadow graphs by the usual X-Ray method.

The above three methods are not applicable easily because of the non availability of the appliances which are required for taking the prints.

The Holister system for young and new born infants: In infants, prints have been developed on photographic paper from a moistened blotter, which was pressed against the fingers and passed through a developing mixture which was prepared from a stock solution which consisted of sodium sulphide, NaoH, starch and distilled water). This was made permanent by fixation in hypo solution.

The Indian Ink method (Cumins and Midlow , 1961): The Indian ink method (Cumins and Midlow, 1961) [2] was used for taking impressions with camel duplicating ink.

The materials which were used were: A double plain paper (8.5"×11"), a glass plate (8.5"×11"), a round bottle(10"×4"), a roller for spreading the ink, a table, a scale, a pointed H.B Pencil, a mercury lamp, a biological pointer, a protractor, soap and ether for washing hands and a good quality magnifying lens.

The hands were washed with soap and water and the humidity was cleaned off with ether. A small daub of camel duplicating ink was squeezed out on an inking slab of the roller onto a thin film for the direct inking of the fingers. The palm was carefully and uniformly smeared with the inked roller to cover the whole area of the palm which had to be printed for the examination. The paper was set over the round bottle and the moderately open fingers and the palm were successively rolled by applying some pressure on them for permitting the bottle and the paper to move forward [Table/Fig-6]. The rolled finger prints were taken by the rotation of fingers, both in the inking and the printing to obtain a complete impression of the finger tips. This method enables to record the complete imprints of the palm, including the palmer surface of all the five digits in one attempt. These prints were studied with the help of a magnifying lens for observation under different heads. The family history was not mentioned, as only the documented cases of diabetes were selected for the present research work.

OBESERVATIONS AND RESULTS

The observations were recorded to get the quantitative and qualitative dermatoglyphic features from the hand prints of 50 diabetics (25 males and 25 females) and 50 controls (42 males and 8 females).

The TFRC of the patients was 44% (range 150-200) and it was 42% (range 100-150) for the controls. Their mean values were 140.04 and 137.88 respectively, which did not differ significantly. A sex wise comparative difference was also not significant [Table/Fig-1].

The AFRC of the diabetics was 42% (range -100-200) and it was 44% (range- 200-300) for the controls. The differences in their mean values (202.76 for the diabetics and 199.24 for the controls) as well as their sex wise comparison were statistically insignificant [Table/Fig-6].

The mean values of the right side and the left side (a-b) ridge count of the patients and the controls, as well as their sex wise comparison showed an insignificant difference [Table/Fig-2].

The highest pattern of distribution of the whorl, loop and arch were present in the 4th, 5th and 2nd fingers respectively, whereas they were present in the 4th, 5th and 3rd fingers in the controls respectively. The whorl spiral (D-41% , C-52%) and the whorl symmetrical (D-41% ,C- 57%) were found to be highest in the 4th finger, but a double loop whorl was seen in the 1st finger (D-23%, C- 16%). The loop ulnar was the highest in the 5th finger (D-80%, C-76%), but the loop radial was highest in the 2nd finger (D-8%, C-7%). These differences between the two groups were statistically insignificant.

In diabetic males, the whorl, loop and arch frequency were 47.2%, 48% and 5.2% in comparison to the controls in which they were 37.6%, 57.7% and 4.35% respectively. These differences were significant ($p<.05$) but these were insignificant when the fingers were compared individually [Table/Fig-5] and [Table/Fig-9].

In the palm, the patterns which were seen were the loop vestige, whorl, double loop and the spiral whorl. The vestige pattern (2%) was seen in the thenar areas of the diabetics only. The double loop pattern was seen in the I4' area in the both groups (D-8%, C-2%) . The loop patterns were mostly distributed in the I3 area of the diabetics (53%) and in the I4 area of the controls (50%). The difference between the palmer patterns of both the groups was statistically insignificant [Table/Fig-3] and [Table/Figure-8].

A C-line pattern was observed for the absent, proximal, ulnar and the radial varieties. The proximal C-line pattern was absent in the diabetics, but it was present in the controls only (10%) on the left

	TFRC				AFRC			
	Male		Female		Male		Female	
	Diabetic	Control	Diabetic	Control	Diabetic	Control	Diabetic	Control
Mean (±)	143.72	135.69	136.36	149.37	212.76	195.12	192.76	220.87
SD	± 39.51	± 39.51	± 31.66	± 12.17	± 77.30	± 80.69	± 73.76	± 41.49
P-Value	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05
Significance	NS	NS	NS	NS	NS	NS	NS	NS

[Table/Fig-1]: P-Value of Significance of Trfc and Afrc
NS = Not Significant.

	Rt. (a-b) ridge count				Lt. (a-b) ridge count			
	Male		Female		Male		Female	
	Diabetic	Control	Diabetic	Control	Diabetic	Control	Diabetic	Control
Mean (±)	± 39.6	± 39.86	± 38.00	± 35.87	± 39.68	± 39.09	± 38.4	± 36.37
SD	4.5	5.88	5.92	4.81	3.39	5.44	4.69	4.63
P-Value	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05
Significance	NS	NS	NS	NS	NS	NS	NS	NS

[**Table/Fig-2]:** P-Value of Significance of Right and Left (A-B) Ridge Count
NS = Not Significant

Pattern Frequency			
Area	**Type**	**Right**	**Left**
Thenar/I_1	Diabetic	7	8
	Control	8	11
	Significance X^2=0.074	df=1	P>0.05 NS
I_2	Diabetic	3	3
	Control	5	4
	Significance X^2=0.045	df=1	P>0.05 NS
I_3	Diabetic	32	24
	Control	31	11
	Significance X^2=2.904	df=1	P>0.05 NS
I_4	Diabetic	21	25
	Control	25	29
	Significance X^2=0.004	df=1	P>0.05 NS
Hypothenar	Diabetic	17	14
	Control	12	14
	Significance X^2=0.428	df=1	P>0.05 NS

[Table/Fig-3]: P-Value Significance Of Palmer
NS = Not Significant
I_1 = I Palmer area
I_2 = II Palmer area
I_3 = III Palmer area

side. An absent C-line pattern was seen on the left side (12%) in the diabetics [Table/Fig-10], while it was present on both sides in the controls (right – 6% , left – 14%). The radial inclination pattern was found to be more in the diabetics than in the controls, but the findings were found to be reversed for the ulnar inclination.

The right 'atd' angle mean values of the patients (43.66) and the controls (40.00) differed significantly (p<.01). On doing a sex wise comparison in females, the left 'atd' angle's mean values were found to be between D-44.52 and C-36.87 they showed a significant difference (p<.001). Only the left 'tad' angle in females among the diabetics and controls on doing a sex wise comparison showed a significant difference (p<.01). The maximum right side 'tad' angle distribution in the diabetics fell in the range of 60*-69* (46%) as compared to that in the controls [50*-59* (46%)].

This was reversed on the left side. On comparison of the 'tda' angle, both the groups showed a significant difference (p<.01) on the right side only. Its maximum distribution range on the right side was 70*–79* (48%) in diabetics as compared to 80*- 89*(66%) in the controls, but this fell in the same range on the left side i.e.80*–89* [Table/Fig-4] and [Table/Fig-7].

DISCUSSION

Dermatoglyphics is a Greek word which is derived from 'derma', meaning skin and 'glyphae', meaning carving (Cumins and Midlow, 1926). Dermatoglyphics is one field which gets affected by genetic changes, as seen in Down's syndrome, Schizophrenia, Huntington's chorea and syndactyly. Diabetes is a hereditary disease with a multifactorial type of inheritance. Hence, the heredity of the dermatoglyphic features conforms to the polygenic system with an additive effect for its prediction, whether a person is prone or not.

In the present study, the mean TFRC was higher in the diabetics than in the controls. This was consistent with the findings of Ahuja and Chakarvarti et al (1981) [7], Iqbal et al (1978) [8] , and Barta et al (1970) [9].

The mean AFRC was higher in the patients (overall and males), but it was less in the female patients. These findings were in accordance with those of Ravindranath and Thomas et al (1995) [10].

In diabetics, the (a-b) ridge count rise was not significant. This was in contrast with Ziegler et al's (1993) [11] findings, which showed a significantly low (a-b) ridge count (p<.001).

The rise of the whorls and arches with a decrease in the number of loops was not significant on the fingers of diabetics. These findings were consistent with the results of Sant S.M et al (1983) [12] and Vera M et al (1995) [13], which showed a significant rise of the whorls and arches with a decrease in the number of loops in the patients.

The palmer pattern frequency of both the groups was statistically insignificant, which was consistent with the findings of Sant S.M et al (1983) [12], Verbov (1973) [14] and Eswariah and Bali et al (1977) [15].

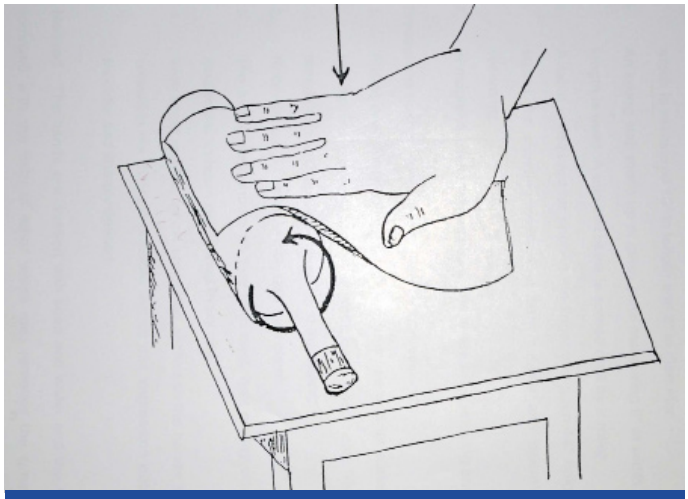
The present study showed a decrease in the frequency of the patterns in the I4 area of male diabetics, which was consistent with

Angles		Mean ± SD				P-Value		Significance	
		Diabetic		Control					
		Rt	Lt	Rt	Lt	Rt. Hand	Lt. Hand	Rt. Hand	Lt. Hand
'atd'	Male	42.12 ± 7.56	39.92 ± 3.68	39.17 ± 6.49	40.93 ± 8.44	> 0.05	> 0.05	NS	NS
	Female	45.2 ± 7.75	44.52 ± 8.61	44.37 ± 4.21	36.87 ± 3.55	> 0.05	< 0.001	NS	Sig.
	Total	43.66 ± 7.81	42.22 ± 7.01	40.00 ± 6.40	40.28 ± 8.00	< 0.01	> 0.05	Sig.	NS
'tad'	Male	58.32 ± 5.74	47.48 ± 4.97	59.97 ± 6.20	56.78 ± 7.05	> 0.05	> 0.05	NS	NS
	Female	56.76 ± 7.28	53.66 ± 7.41	56.87 ± 7.90	60.25 ± 4.57	> 0.05	< 0.01	NS	Sig.
	Total	57.54 ± 6.60	55.54 ± 6.60	58.64 ± 6.54	57.34 ± 6.84	> 0.05	> 0.05	NS	NS
'tda'	Male	79.56 ± 5.50	82.52 ± 5.04	81.86 ± 6.21	82.28 ± 4.37	> 0.05	> 0.05	NS	NS
	Female	78.04 ± 4.43	81.88 ± 4.67	83.75 ± 5.54	82.87 ± 2.85	< 0.001	> 0.05	HS	NS
	Total	78.8 ± 5.05	82.2 ± 4.87	82.16 ± 6.15	82.38 ± 4.17	< 0.01	> 0.05	Sig.	NS

[Table/Fig-4]: P-Value Significance of Angles
Rt Hand = Right Hand; Lt Hand = Left Hand; NS = Not Significant; HS = Highly Significant; Sig. = Significant.

Digits	Type	Whorl	Loop	Arch	Whorl	Loop	Arch	Whorl	Loop	Arch
I	Diabetic	54	39	7	27	21	2	27	18	5
	Control	47	48	5	11	5	-	36	43	5
	Significance	χ^2=1.749	df=2	P>0.05 NS	χ^2=0.777	df=1	P>0.05 NS	χ^2=3.104	df=2	P>0.05 NS
II	Diabetic	47	48	5	24	23	3	28	25	2
	Control	41	53	6	6	10	-	36	43	6
	Significance	χ^2=0.747	df=2	P>0.05 NS	χ^2=0.881	df=1	P>0.05 NS	χ^2=0.592	df=2	P>0.05 NS
III	Diabetic	31	60	9	12	32	6	19	28	3
	Control	25	70	5	7	9	-	18	61	5
	Significance	χ^2=2.555	df=2	P>0.05 NS	χ^2=1.459	df=1	P>0.05 NS	χ^2=4.429	df=2	P>0.05 NS
IV	Diabetic	60	39	1	22	28	-	38	11	1
	Control	61	38	1	11	5	-	50	33	1
	Significance	χ^2=0.021	df=2	P>0.05 NS	χ^2=2.970	df=1	P>0.05 NS	χ^2=4.284	df=2	P>0.05 NS
V	Diabetic	17	81	2	6	43	-	11	38	2
	Control	20	77	3	2	14	-	18	63	3
	Significance	χ^2=0.544	df=2	P>0.05 NS	χ^2=0.027	df=1	P>0.05 NS	χ^2=0.012	df=2	P>0.05 NS
Total	Diabetic	209	267	24	91	147	11	118	120	13
	Control	194	286	20	37	43	-	158	243	20
	Significance	χ^2=1.575	df=2	P>0.05 NS	χ^2=3.458	df=1	P>0.05 NS	χ^2=6.358	df=2	P>0.05 Sig

[Table/Fig-5]: P-Value Significance of Digital Pattern Frequency of Finger Tip Pattern Distribution
NS = Not Significant; Sig = Significant



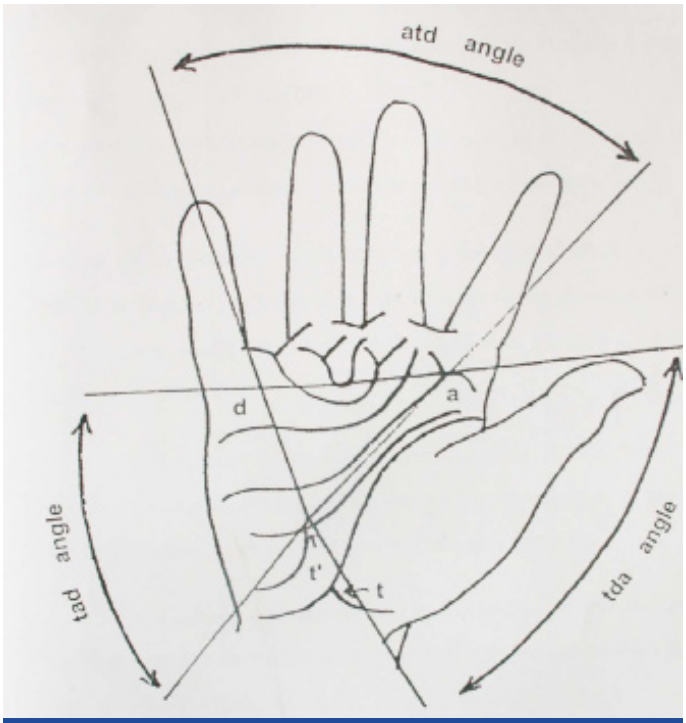
[Table/Fig-6]: Showing the technique used in taking a print

the observations of Eswariah and Bali et al (1977) [15] and Zeigler et al (1993) [11].

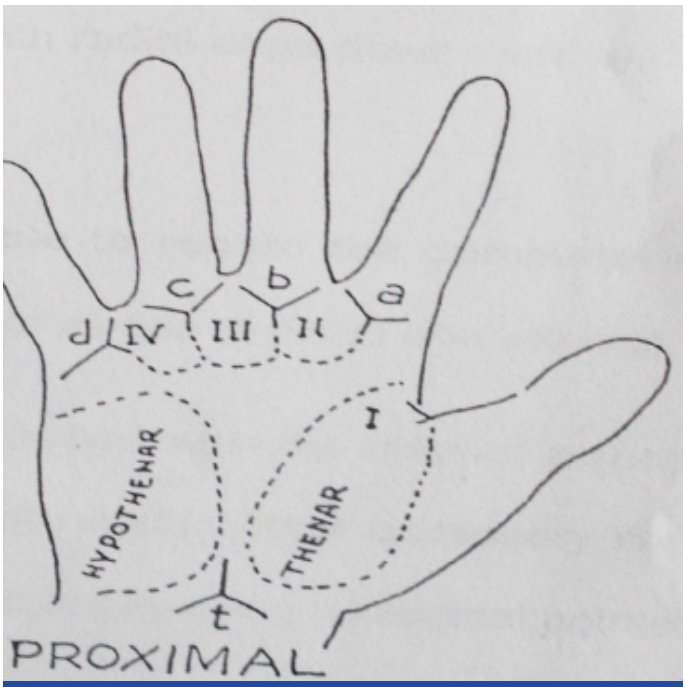
The C-line pattern was observed for the proximal, absent, ulnar and the radial categories. All these three varieties except the radial one, was decreased in the patients, which showed a similarity with the findings of Platilova H et al (1996) [16]. The proximal variety was absent on both the sides in the diabetics, whereas in the controls, it was present only on the left side. This was in conformity with the observations of Sant S.M et al (1983) [12] for the female patients only.

On both side and sex wise 'atd' angles of patients were higher in the present study, which was consistent with the finding of the increase of the summed 'atd' angle which was observed by .Sant S.M et al (1983) [12] , Platilova H et al (1996) [16] and Rajnigandga V et al (2006) [17] .The maximum right side 'tad' angle distribution in diabetics fell in the range of 60*–69* (46%) as compared to that in the controls [50*-59* (46%)], but it was reversed on the left side. Only the left 'tad' angle in the diabetic females differed significantly (p>.01) from that in the normal females.

On the right side, the 'tda' angle among the compared groups, showed a significant difference (p<.01), except between the male groups, but the difference on the left side in all were insignificant. The 'tda' and the 'tad' angles which were observed in present study were not studied by any other author.



[Table/Fig-7]: Showing the measurement of the Angles in palm



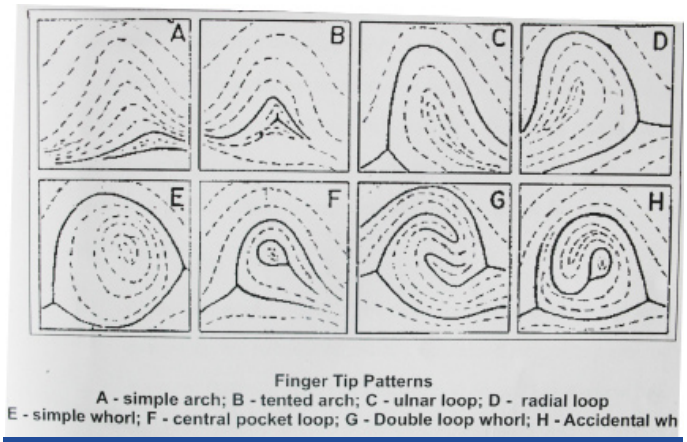
[Table/Fig-8]: Showing the principal palmer triradii (a, b, c, d & axial triradius) and six dermatoglyphic areas (I, II, III, thenar & hypothenar)

The results of this study may be naturally distorted by the dermatoglyphic abnormalities which were associated with normal persons who were prone to develop diabetes at a later date.

The dermatoglyphic features of the present study may be used as a suggestive diagnostic tool to make a provisional diagnosis and to identify the persons who are at risk, but it requires more extensive studies in a large number of patients.

REFERENCES

[1] Cumins H, Midlow C. Palmer and planter epidermal ridge configuration in European Americans. *American Journal of Physical Anthropology* 1926;9:471-502.
[2] Cumins H, Midlow C. *In finger prints, palm and soles; an introduction to dermatoglyphics*. Dover Publication Inc , New York 1961.
[3] Bhu N, Gupta SC. Study of palmer dermatoglyphics in diabetes mellitus. Journal of the Diabetes Association of India 1981; 21: 99-107.



[Table/Fig-9]: Showing various types of finger tip patterns

[Table/Fig-10]: Showing absent type of C-line pattern and distally placed axial triradius (t") in left hand of diabetic

[4] Galton F. *Finger print directories*, London, Macmillan (cited by Cumins and Midlow, 1961) vide supra 1985.
[5] Walker NF. An inkless method of finger, palm and sole printing. *J. Pediat* 1957;50: 27-29.
[6] Macarthur JW, Ford N. A Biological study of the dionne quintuplets all Identical Set. Univ. Toronto Studies, *Child Development Series*, Univ. Toronto Press. 1937; 11: 49.
[7] Ahuja YR, Khub Chand J, Plato CC, Sahay BK. *Dermatoglyphics of diabetes mellitus*. Revised in Human Biology–Recent advances, 1981;21-24, New Delhi, India. Today nasd tomorrow's printers and publishers.
[8] Iqbal MA, Sahay BK, Ahuja YR. Finger and palmer ridge count in diabetes mellitus. *Acta Anthropogenetica* 1978;2(3):35-38.
[9] Barta L, Vari A, Susa E. Dermatoglyphic pattern of diabetic children. Acta Pediatrica, *Academic Scientiarum of Hungrarical* 1970;11: 71-74.

[10] Ravindranath R, Thomas IM. Finger ridge count and finger print pattern in maturity onset diabetes mellitus. *Indian Journal of Medical Sciences* 1995; 49(7):153-56.
[11] Zeigler AG, Mathies R, Ziegelmayer G, Baumgarti HJ, Rodewald A, Chopra V , Standi E. Dermatoglyphics in type I diabetes mellitus. *Diabetic Medicine* 1993;10(8):720-24.
[12] Sant SM, Vare AM, Fakhurudin S. Dermatoglyphics in diabetes mellitus. Journal of the Anatomical Society of India 1983;32:127-30.
[13] Vera M, Cabrera E, Guell R. Dermatoglyphics in insulin dependent diabetic patients with limited joint mobility. *Acta Diabetologica* 1995; 32(2):78-81.
[14] Verbov JL. Dermatoglyphics in early onset diabetes mellitus. *Human Heredity* 1973;23(6):542-53.
[15] Eswariah G, Bali RS. Palmer flexion creases and dermatoglyphics among diabetic patients. *American Journal of Physical Anthropology* 1977;47(1):11-13.
[16] Platilova H, Pobisova Z , Zamrazil V, Vondra K. Dermatoglyphics-an attempt in predicting diabetes mellitus. *Vnitr Lek* 1996;42(11):757-60.
[17] Rajnigandha V, Mangala P, Latha P, Vasudha S. The digito-palmar complex in non insulin dependent diabetes mellitus. *Turk. J. Med. Sci* 2006;36(6):353-55.

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