

Dermatoglyphics in Children Having Congenital Talipes Equino Varus

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Research Article

Abstract: Introduction: Dermatoglyphics is study of integumentary features showing skin patterns on fingers. It is important for medicolegal purpose as well as in clinical medicine due to its association with genetic disorders. CTEV is one of the common disorder with single gene mutation and dominant inheritance. Hence in this study we evaluated the dermatoglyphics in CTEV children as compared to normal counterparts. **Material and Methods:** Material required for standard ink method was collected and implemented for data collection of both the hands. Oral consent of the parents was obtained. Study was carried out in Department of anatomy, in D Y Patil medical college during January 2008 to June 2009. Total 50 CTEV and 50 normal children were included in study. **Results:** In CTEV whorls were highest while in normal children Ulnar loop were maximum. Hypothenar pattern is more while thenar pattern is less in CTEV children. Simian lines and Sydney lines were seen only in CTEV male children. Additional lines were less in CTEV male while more in CTEV female children. CTEV female has less frequency of t and higher frequency of t' while CTEV male children shows decreased frequency of t and increased frequency of t' as compare to normal counterparts. CTEV children have higher TFRC count, AB Ridge count and Atd angle as compare to normal counterparts. **Conclusion:** Dermatoglyphics in CTEV shows significant variation as compare to normal children. It strengthen the family and genetic association in the disease and warrant further research in the same direction.

Key Words: CTEV Children, Dermatoglyphics.

Introduction

The word 'DERMATOGLYPHICS' is collective name for the integumentary features showing skin patterns of fingers, palms, toes and soles. In the word 'DERMATOGLYPHICS' derma means skin and glyphics means the carvings.¹ It was first introduced and coined by a well known anatomist, sir Harold Cummins, of Tulane University of United States in 1921.² The main varieties of existing ridges are Tension Lines, Wrinkle Lines, Flexure Lines (joint lines) and Papillary ridges (friction ridges).³

In man and his ancestors the skin on the palmar surface of the hands is not smooth and covered with the hornier type of skin.⁴ It shows corrugated appearance due to presence of continuous ridges, considered as the 'friction ridges' or the 'friction

lines' which are present in all the primates. These ridges are of great assistance in handling, grasping,⁵ and in reception of tactile stimuli.⁶

The study of dermatoglyphics has proved its importance in all the fields. Medicolegal importance is for the purpose of personal identification, which is known for centuries in India as the "Panja" and "Tep Sahi" as the seals of clay in 246-210 BC, In Egypt [Tuten -Khamen's Tomb] more than 3000 years back, in Japan [Law of Tainno] in 702 AD and Arabia in 851 AD.⁷

Dermatoglyphics is important in the clinical medicine, due to the fact that during development. Its formation is affected by the maternal environment, gene deviants, chromosomal aberrations, etc.⁸

Dermatoglyphics is widely used in chromosomal disorders⁹ and is based upon two facts:^{5, 10}

1. The patterns of ridges differ from person to person and even they are different on each finger.
2. The ridges remain though out the life and survive superficial injury.¹¹

The dermatoglyphics is considered as a somatic genetic trait, showing sexual and racial differences. The sexual differences have been suggested as the physiological variation. The bimanual differences indicating handedness and the cerebral dominance have also been reported.¹²⁻¹⁴

Congenital Talipes Equino Varus is a common disorder which can impart a lifetime deformity and disability to an individual. The incidence is 1 to 2 per 1000 live births. Single gene mutation with dominant inheritance is most commonly accepted causative theory by most of the workers. The dermatoglyphic patterns of an individual are based on heredity with complete or incomplete penetrance and variable expressions.

However there is not much relevant work on dermatoglyphics in Congenital Talipes Equino Varus despite of common occurrence and genetic

association of this disease. Therefore we evaluated association between dermatoglyphic patterns in Congenital Talipes Equino Varus.

Material and Methods:

Materials:-

The materials used to take the dermatoglyphic patterns of the palms were: - Wooden table of suitable height, Porcelain tile, “Camlin” duplicating ink, A rubber roller, White executive bond paper of 15 x 20 cms size, Sponge of 30 cms x 20 cms size, Spirit, Soap, towel and water, Cotton, Magnifying lens, Pencil pen, Protector to measure ‘atd’ angle, Scale, Needle with sharp point for ridge counting

Methods:-

As procedure was non interventional and non harmful, oral consent of the parents, of the children suffering from Congenital Talipes Equino Varus was taken. For collecting the data for present study, the method used is of standard ink method. The children, whose finger and palmar prints were to be taken, made to wash both the hands, with soap and water and dried by towel. The porcelain tile was kept on the table. A small amount of camlin’s duplicating ink was spread over it by means of rubber roller to obtain a thin uniform film of ink on the tile.

Prints of the finger tips: -

The distal phalanges of person’s right hand were inked over the tile by a firm pressure starting from the thumb. Executive bond paper kept over the wooden pad was used for recording the finger print patterns. Rolled finger prints were obtained from thumb to little finger. The prints were numbered as digit number I, II, III, IV and V from thumb to the little finger.

The same procedure was done for recording the finger prints of the left hand. Thus rolled finger prints of both hands were obtained and recorded in the Performa.

Prints of the palms: -

The palm of the person’s right hand was inked over the tile by applying firm even pressure over the dorsum of hand and if necessary it is again inked with the help of rubber roller.

A executive bond paper of size 15 x 20 cm was kept on the wooden pad and the right hand of the person was pressed firmly on the paper using even pressure on the dorsum of the hand and a palm print was obtained. The same procedure was used to gain the print of same palm again but instead of wooden pad paper was kept on the sponge to enable to reach the hollow of the palm so as to obtain a good palm print. The above procedure was followed again to print left palm. The prints taken were immediately examined

by using a magnifying hand lens and care was taken to include all essential details.

Place of Study, Collection of the data and Sample size

The study has conducted at D Y Patil medical college and hospital, Kolhapur from January 2008 to June 2009. By using above mentioned method, finger and palm prints of 50 children suffering from Congenital Talipes Equino Varus and 50 normal children was collected. The following parameters were studied and analyzed for Right and Left hands of all the subjects.

Results:

In present work 50 CTEV children (including 20 female and 30 male) were compared with normal control group of 50 children (20 female and 30 male).

1. Qualitative Parameter

1.1. Finger patterns

In Normal Male and Female children frequencies of ulnar loop were highest followed by whorls while in **CTEV Male and Female children** whorls were most frequent, followed by ulnar loops, in right hand, in left hand as well as in both hands. (Refer Table No. 1)

	Right hand	Left hand	Both hand
Normal female	Ulnar loops	Ulnar loops	Ulnar loops
CTEV female	Whorls	Whorls	Whorls
Normal male	Ulnar loops	Ulnar loops	Ulnar loops
CTEV male	Whorls	Whorls	Whorls

CTEV children both male and female have higher frequencies of whorls as compare to normal children. Frequency of ulnar loop and whorl shows the greater and significant variation in CTEV and normal children. CTEV male as well as female children show lesser frequency of ulnar loop and greater frequency of whorls as compare to normal children. (P < 0.05)

Frequencies of radial loops and arches show no significant difference in frequency among CTEV and normal children. (Refer Table No. 2)

	Both right and left hand			
	UL	RL	W	A
Normal male children	175.00 (50%)	8.00 (3.2%)	112.00 (44.8%)	5.00 (2.0%)
CTEV male children	121.00 (28.4%)	11.00 (4.4%)	167.00 (66.8%)	1.00 (0.4%)
Normal female children	127.00 (50.8%)	5.00 (2.0%)	64.00 (25.6%)	4.00 (1.6%)
CTEV female children	77.00 (30.8%)	7.00 (2.8%)	115.00 (46%)	1.00 (0.4)

1.2. Comparison Of Digit Wise Frequencies In Ctev And Normal Children

1.2.1.Ulnar Loop - The difference between the frequencies of ulnar loop is highest and statistically significant in 3rd digit. On 3rd digit frequency of ulnar loop is highest (significant) in normal children as compare to CTEV children. (Refer Figure 1)

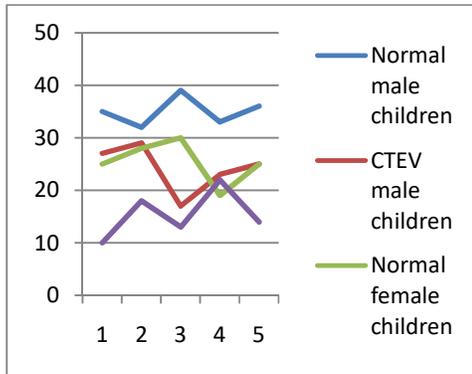


Figure 1: Frequency of Ulnar Loop

1.2.2.Radial loops - Frequency of radial loop is highly variable in both normal as well as CTEV children although over all frequency of radial loop is higher in CTEV children as compare to normal children. Radial loops were seen on all the digits of CTEV children while they were absent on 2nd digit of normal children (Refer Figure No 2)

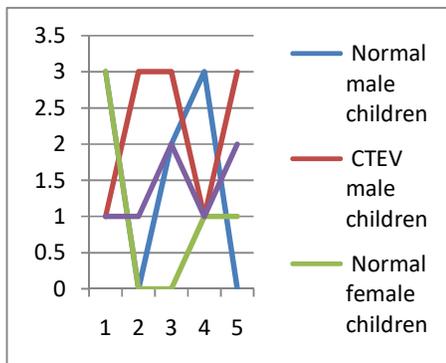


Figure 2: Frequency of Radial Loops

1.2.3.Whorls - Over all frequency of Whorls is higher in CTEV children as compare to normal children. The difference is highest on 3rd digit with highest frequency in CTEV children and minimum frequency in normal children. (Refer Figure No. 3)

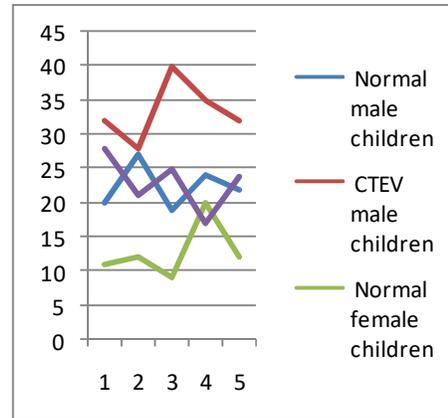


Figure 3: Frequency of Whorls

1.2.4.Arches - Arches were present on 3rd digit in CTEV male children while they were absent on 3rd and 4th digit in normal male children. Arches were present on the 1st digit in CTEV female children while they were present on 1st, 3rd and 5th digit in normal female children. Overall frequency of arches is lesser in CTEV female children as compare to normal female children. (Refer Figure No. 4)

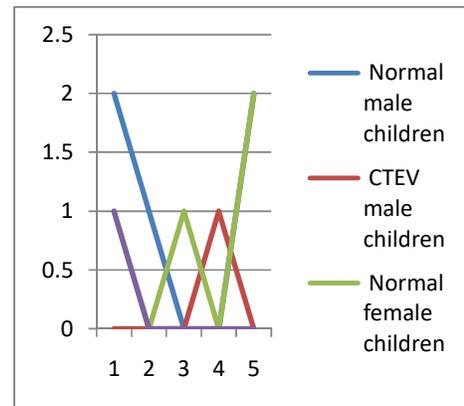


Figure 4: Frequency of Arches

1.3. Palmar Patterns (Refer Table No. 3)

1.3.1.Thenar area and Interdigital area 1 (Th and I1) Thenar area and interdigital area 1 is highest frequency of pattern in normal female considering both hand together, followed by CTEV male, CTEV female and then normal male. Thenar / I1 have shown no pattern in left hand of normal male and right hand of CTEV female. Frequency of Thenar / I1 pattern is more in right hand of normal as well as in CTEV male while in left hand in normal as well as in CTEV female. Over all

frequency of thenar pattern is more in normal children as compare to CTEV children.

	N O	HA ND	INTERDIGITAL AREAS				Hypot henar Hy
			TH/ I ₁	I ₂	I ₃	I ₄	
CTEV male	1	Rt	6.66	3.33	23.33	6.66	0.00
	2	Lt	3.33	0.00	26.66	3.33	6.66
CTEV female	1	Rt	0.00	5.00	15.00	0.00	10.00
	2	Lt	5.00	5.00	25.00	0.00	5.00
Normal male	1	Rt.	3.3	10.00	13.33	6.66	0.00
	2	Lt.	0.00	6.66	23.33	3.33	6.66
Normal female	1	Rt.	5.00	15.00	25.00	15.00	0.00
	2	Lt.	10.00	10.00	30.00	20.00	5.00

1.3.2. Interdigital area 2 (I2) - Interdigital area 2 (I2) has highest frequency of pattern in normal female considering both hand together, followed by normal male, CTEV female and then CTEV male. I2 has shown no pattern in left hand of CTEV male. Frequency of I2 pattern is more in right hand of normal as well as in CTEV male as well as in female. Overall of frequency of I2 pattern is more in normal children as compare to CTEV children.

1.3.3. Interdigital area 3 (I3) - Interdigital area 3 (I3) has highest frequency of pattern in normal female considering both hand together, followed by CTEV male, CTEV female and then normal male. I3 pattern was not absent in any of the group in any hand. Frequency of I3 pattern is more in left hand of normal as well as in CTEV female as well as in male. Overall of frequency of I3 pattern is almost equal in both normal as well as in CTEV children.

1.3.4. Interdigital area 4 (I4) - Interdigital area 4 (I4) has highest frequency of pattern in normal female considering both hand together, followed by normal male, CTEV male and then CTEV female. I4 has shown no pattern in left as well as right hand of CTEV female. Frequency of I4 pattern is more in right

hand of normal as well as in CTEV female while more in left hand of normal male. Overall of frequency of I4 pattern is more in normal children as compare to CTEV children.

1.3.5. Hypothenar area (Hy) - Hypothenar area has highest frequency of pattern in CTEV female considering both hand together, followed by normal male, CTEV male and then normal female. Hypothenar area has shown no pattern in right hand of normal female, normal male and CTEV male. Frequency of hypothenar pattern is more in left hand except in CTEV female where it shows highest frequency in right hand. Overall of frequency of hypothenar pattern is more in CTEV children as compare to normal children.

Over all frequency of Thenar, I2 and I4 pattern is less, I3 pattern is almost equal, Hypothenar pattern is more in CTEV children as compare to normal children. In CTEV children, Thenar pattern is consistently less while hypothenar pattern is consistently more as compare to normal children. (P <0.05)

1.4. Palmar Crease Patterns

1.4.1. Simian Lines - Simian lines were only present in right hand of CTEV male children. It was absent in all other groups. (Refer Table No, 4)

	Right	Left
CTEV male	3.33%	0%
Normal male	0%	0%
CTEV female	0%	0%
Normal female	0%	0%

1.4.2. Sydney Lines - Sydney lines were present in left hand of CTEV male children only. They were absent in all other children. (Refer Table No. 5)

	Right	Left
CTEV Male	0%	3.33%
Normal Male	0%	0%
CTEV Female	0%	0%
Normal Female	0%	0%

1.4.3. Additional Lines And Creases - Overall frequency of additional line is less in CTEV male children as compare to normal children. In right hand frequency is equal in both CTEV and normal children while in left hand frequency of additional line is less in

CTEV male as compare to normal male children. In CTEV female children overall frequency of additional line is more than normal children. It is more in both right and left hand as compare to normal children. (Refer Table No. 6)

	Right	Left
CTEV male	6.66%	3.33%
Normal male	6.66%	6.66%
CTEV female	2%	4%
Normal female	0%	2%

1.5. Axial Triradius

1.5.1. CTEV and Normal Female children -

CTEV female has less frequency of t and higher frequency of t' in both hands as compare to normal female children. (Refer Table No. 7)

NO	POSITION OF AXIAL TRIRADIUS	% OF CASES In normal Female children		% OF CASES In CTEV Female children	
		Rt. HAND	Lt. HAND	Rt. HAND	Lt. HAND
1	t	19 (95%)	18 (90%)	18 (90%)	17 (85%)
2	t'	1 (5%)	2 (10%)	2 (10%)	3 (15%)
3	t''	0	0	0	0

1.5.2. CTEV and Normal Male children -

CTEV male children shows decreased frequency of t and increased frequency of t' in both hands as compare to normal children. (Refer Table No. 8)

NO	Position	% OF CASES In normal Male children		% OF CASES In CTEV Male children	
		Rt. HAND	Lt. HAND	Rt. HAND	Lt. HAND
1	t	28 (93.33)	29 (96.66)	26 (86.66%)	28(93%)
2	t'	2 (7.66%)	1 (3.33%)	4 (5%)	2 (10%)
3	t''	0	0	0	0

2. Quantitative Parameter

2.1. **Total Finger Ridge Count** - CTEV female children as well as CTEV male children have higher TFRC as compare to normal counterparts. (Statistically significant $P < 0.05$) (Refer Table N. 9)

CTEV children female	127.6
Normal children female	119.2
CTEV children male	133.6
Normal children male	113.8

2.2. **A-B Ridge Count** - CTEV female children have higher frequency of A B ridge count in both hands as compare to normal children. (statistically significant $P < 0.05$) (Refer Table No. 10)

	Right	Left
CTEV children female	28.9	29.7
Normal children female	24.35	25.6
CTEV children male	27.8	29.3
Normal children male	22.16	22.3

2.3. Atd

Angle - In CTEV children both male as well as female, ATD angle was lesser in right hand while more in left hand. (statistically significant $P < 0.05$) (Refer Table No. 11)

	Right	Left
CTEV children female	46.80	48.90
Normal children female	47.43	48.56
CTEV children male	47.80	49.53
Normal children male	48.38	48.78

Discussion:

It is accepted now without doubt that CTEV is inherited, though mode of the inheritance is not clear. We also know that development of dermatoglyphics pattern is under the genetic control. No relevant work has been done on dermatoglyphics studies in CTEV since 1862 though studies have been conducted for role of foot prints in management of CTEV by Kumar et al 1974.¹⁵

In 1994 S kumar¹⁶ has studied the dermatoglyphics in CTEV with Karyotyping. Pratima Kulkarni¹⁷ et al in 2006 had conducted the study on dermatoglyphics in CTEV children as compare to normal children.

Frequency of ulnar loop is reduced in both right as well as in left hand of CTEV male as compare to normal male children in study by S. Kumar et al 1994, P. Kulkarni et al 2006 as well as in present study. In present study frequency of ulnar loop is 42.66% in CTEV male as compare to 58.00% in normal male children in right hand. In left hand frequency of ulnar loop is 38.00% in CTEV male as compare to 58.88% in normal male children in present study. The findings are in accordance to the previous workers.

Frequency of Ulnar loop is more in both the hands in study by S. Kumar et al 1994 while it is reduced in both the hand of CTEV female as compare to normal female in study by P. Kulkarni 2006 as well as present study. In present study frequency of ulnar loops in right hand was 36.00% in CTEV female as compare to 62.00% in normal female. Reduced frequency of ulnar loops in right hand of CTEV female is in accordance to the work of S kumar et al

1994 and of P kulkarni et al 2006. In left hand frequency of ulnar loop was 41.00% in CTEV female as compare to 65.00% in normal female children. Reduced frequency of ulnar loops in left hand of CTEV female is in accordance to the work of S kumar et al 1994 and of P kulkarni et al 2006.

Frequency of Whorls is more in both right as well as in left hand of CTEV male as compare to normal male children in study by S. Kumar et al 1994, P. Kulkarni et al 2006 as well as in present study. In present study frequency of whorls are 53.33% in CTEV male as compare to 37.33% in normal male children in right hand. In left hand frequency of whorls is 58.00% in CTEV male as compare to 37.33% in normal male children in present study. The findings are in accordance to the previous workers.

In CTEV female, frequency of whorls is more in right hand and less in left hand as compare to normal female children in study by S. Kumar et al 1994, while it is increased in both the hands in study by P. Kulkarni et al 2006 as well as in present study. In present study, in right hand frequency of whorls are 58.00% in CTEV female as compare to 31.00% in normal female. Increased frequency of whorls in right hand of CTEV female was also found in study by P. Kulkarni et al 2006 and S. Kumar et al 1994. In left hand, frequency of whorls was 57.00% in CTEV female as compare to 33.00% in normal female. Increased frequency of whorls in left hand of CTEV female is also found in study by P kulkarni et al 2006.

Frequency of Arches is reduced in both right as well as in left hand of CTEV male as compare to normal male children in study by S. Kumar et al 1994, P. Kulkarni et al 2006 while in present study there is no difference in right hand while arches are absent in left hands of CTEV male as compare to normal male. In present study frequency of arches is 0.67% in CTEV male as well as in normal male in right hand and showed no difference. While in study by S kumar et al 1994, P. Kulkarni et al 2006 showed the reduced frequencies of arches in right hand of CTEV males. In present study arches are absent in left hand of CTEV males while 2.67% in left hand of normal male. Reduced frequency of arches in left hand of CTEV male as compare to normal male children is in accordance to the previous workers.

In CTEV female, frequency of arches is reduced in both the hands as compare to normal female children in study by S. Kumar et al 1994 as well as in present study. In our study arches were absent in left hand of CTEV female. A study by P. Kulkarni et al 2006 showed no difference in frequency of arches in left

hand while increased frequency in right hand of CTEV female as compare to normal female children. Frequency of Radial loop is reduced in both right as well as in left hand of CTEV male as compare to normal male children in study by P. Kulkarni et al 2006 while increased in right hand in study by S. Kumar et al. In present study frequency of radial loops are reduced in right hand while increased in left hand of CTEV male as compare to normal males. In present study frequency of radial loop is 3.33% in CTEV male as compare to 4.00% in normal male in right hand. Reduced frequency of radial loop in right hand of CTEV male is also found in study by P kulkarni et al 2006. While S Kumar et al 1994 has reported the increased frequency of radial loops in right hand of CTEV male as compare to normal male children. In left hand, frequency of radial loops in CTEV male is 4.00% as compare to 1.33% in normal male children. Increased frequency of radial loop in left hand in CTEV children as compare to normal male children has been reported in present study only.

As compare to normal female children, Right hand of CTEV female shows higher frequency of radial loops in present study while frequency was reduced in study by S. Kumar et al 1994 and P. Kulkarni et al 2006.

As compare to normal female children, Left hand of CTEV female shows higher frequency of radial loops in present study as well as in study by S. Kumar et al 1994. P. Kulkarni et al 2006 observed no radial loops in left hand of CTEV female as well as in normal female children.

In present study, ATD angle in right hand of CTEV male was 47.80 as compare to 48.38 in normal male children. In CTEV male children ATD angle is less in right hand in present study while it is more in study by S. Kumar et al 1994 as well as by P. Kulkarni et al 2006.

In present study, ATD angle in left hand of CTEV male was 49.53 as compare to 48.78 in normal male. In left hand ATD angle is more in CTEV male as compare to normal children in present study as well as study by S. Kumar et al 1994 and P. Kulkarni et al 2006.

In present study, in right hand of CTEV female children ATD angle is 46.80 as compare to 47.43 in normal female children. Reduced ATD angle in right hand of CTEV female children is seen in present study as well as study by S. Kumar et al 1994 while it is more in study by P. Kulkarni et al 2006.

In present study, atd angle in left hand of CTEV female was 48.90 as compare to 48.56 in normal female children. In left hand, ATD angle is more in present study, shows no difference in study by P.

Kulkarni et al 2006 while reduced in study by S. Kumar et al 1994 as compare to normal male children.

Conclusions:

This work may throw light on possibility of family and genetic association in the disease and stimulate other workers to do further research in the same direction. In present study we studied the dermatoglyphics patterns in CTEV children. Conclusions of the present study are as follows-

Qualitative Parameters

1. **Finger Patterns** - CTEV children both male and female have higher frequencies of whorls and lower frequencies of ulnar loops as compare to normal children.
2. **Palmar Patterns** - In CTEV children Thenar pattern is consistently less while hypothenar pattern is consistently more as compare to normal children.
3. **Palmar Crease Patterns**
 - a. **Simian lines** - CTEV male children simian line in right hand while absent in others.
 - b. **Sydney lines**- Sydney lines were only present in left hand of CTEV male children.
 - c. **Additional lines and creases** - Additional lines are less in CTEV male while more in CTEV female children as compare to normal children.
4. **Axial Triradius** - CTEV male and female children show less frequency of t and higher frequency of t' as compare to normal children.

Quantitative Parameters

1. **Total Finger Ridge Count** - CTEV children have higher TFRC as compare to their normal counterparts.
2. **A-B Ridge Count** - CTEV children have higher frequency of AB ridge count as compare to normal children.
3. **Atd Angle** - In CTEV children both male as well as female, ATD angle was lesser in right hand while more in left hand.

We compared the findings with normal children and found significant variation and differences in CTEV children. There is a need to compare the dermatoglyphics of their parents too which may play a role in genetic counseling in future.

References:

- [1] Cummins H. and Midlo C., Finger prints ,palms and soles. Dover publication, Newyork, cited by Schumann and Alter 1976, 1961.
- [2] Penrose L. S., Medical significance of fingerprints and related phenomena, British Medical Journal, vol. 2, 321-325, 1968.
- [3] Gray's Anatomy, 38th Edition, edited by Peter L. Williams, Mary Dayson page no. 80, 1995.
- [4] Lambourne G., The fingerprints story Publisher Harrap Ltd., London, 1984.
- [5] Montagu Ashley M.F., Finger, Palm, Toe and Sole prints – An introduction to physical Anthropology 3rd edition, Charles. C., Thomas Publisher, 581-5821, 1960.
- [6] Hooton E.A., Up from Ape The Mac. Millan company, 2nd edition , New York, 1960.
- [7] Shaha K. C., Dermatoglyphics Journal of Indian Medical Association, vol.54, 248, 1970.
- [8] Pal G. P & Routal R., Dermatoglyphics studies of Gujrati Hindus, Journal of Anatomical Society of India, vol.31, 30, 1982.
- [9] Achs R. and Harper R., Dermatoglyphics, Am. J. Obstet. Gynecol, vol. 101,1006-1023, 1968.
- [10] Mukherjee D.P. a Shaha K.C., Dermatoglyphics in normal Bengalee population Journal of Indian Medical Association, vol. 54, 405-511, 1970.
- [11] Penrose L.S and Ohara P. T., The development of epidermal ridges, Journal of Medical Genetics, vol. 10, 201-208, 1973.
- [12] Verma K. C et. al., Dermatoglyphics in Psoriasis Indian Journal of Dermatology venerol leprosy, vol.4, 28-30, 1980.
- [13] Schaumann B. And Alter M., Dematoglyphics in Medical Disorders, Springler –Verlag, New York, Heidelberg, Berlin, 1976.
- [14] Vaidya R. B., Dermatoglyphics in Schizophrenia, Dissertation for M. S. Anatomy, submitted to Shivaji University, Kolhapur, 1979.
- [15] Kumar S. et al., Dermatoglyphics in healthy Indian children, Indian Journal of Pedriatics, vol.41, 249-256, 1974.
- [16] S Kumar, JM Kaul, BK Dhaon, KK Jain .Dermatoglyphics in congenital talipus equinovarus, Proceedings of Anatomical society of India, 63:44, 1994.
- [17] Pratima R. Kulkarni, K.K. Gaikwad, Vaishali V. Inamdard, D. B. Devarshi, S. L. Tungikar, Shailesh Kulkarni J.Anat.Soc. India 55 (1) 50-51, 2006.