Original Article

Effectiveness of Dermal Indices in Detecting Down Syndrome

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Abstract

Background: *Dermatoglyphics is the study of epidermal ridge patterns of the fingers and palms and has been recognized as a useful anatomical marker of genetic disorders. Down syndrome (DS), caused mainly by trisomy 21, is associated with characteristic dermatoglyphic alterations. This study assessed the effectiveness of selected dermal indices in distinguishing individuals with DS from normal controls.*

Objectives: *To compare true palmar patterns in interdigital areas and palmar crease patterns between individuals with DS and normal controls and to assess their potential usefulness as preliminary indicators of DS.*

Materials and Methods: *A comparative study was conducted among 40 diagnosed individuals with DS, aged 6–16 years, and 40 normal controls. Participants with DS were selected from Society for the Welfare of the Intellectually Disabled, Bangladesh (SWID, Bangladesh) and the Down Syndrome Society of Bangladesh, Dhaka. Dermatoglyphic prints were obtained using the ink-and-paper method. True palmar patterns in five areas and the presence of normal, Sydney, and Simian creases were recorded. Data were analyzed using SPSS version 20, and groups were compared using the proportion test.*

Results: *True palmar patterns in interdigital area IV were significantly lower in the DS group, while patterns in area V were significantly higher in both hands ($p<0.05$). Normal palmar creases were significantly less frequent among individuals with DS than controls (71.2% vs. 100%, $p=0.0003$). Simian creases were significantly more frequent in DS (20% vs. 0%, $p=0.003$), whereas the difference in Sydney lines was not statistically significant when both hands were considered (8.8% vs. 0%, $p=0.057$).*

Conclusion: *Characteristic differences in true palmar patterns and palmar creases demonstrate that dermatoglyphics may serve as a simple, non-invasive, and cost-effective preliminary screening tool for identifying individuals suspected of having DS and referring them for confirmatory genetic analysis.*

Keywords: *Dermatoglyphics, Down syndrome, Dermal ridges, True palmar pattern, Interdigital areas, Palmar crease patterns.*

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Introduction

Dermatoglyphics came from ancient Greek words which is the scientific study of the pattern configurations of finger and palm prints.[1] The science of dermatoglyphics, began with Sir Francis Galton. Dermal ridges originate from volar pads composed of mesenchymal tissue in 6-7 weeks of development. The size and position of the volar pads are responsible for formation of different type of ridge patterns for example small volar pads produce arches and larger pads produce loops and whorls and lateral displacement of the volar pad creates asymmetry of the pattern.[2] At the 10th week, embryonic volar skin consists of the layered epidermis on top of the more amorphous fibrous dermis. The innermost layer of the epidermis at the interface to the dermis is called the basal layer and consists of columnar cells and its axis is perpendicular to the skin surface.[3] It is then observed in embryos of the 10th to 13th week that the basal layer becomes undulated at the dermo-epidermal junction and thus the primary dermal ridges and grooves begin to differentiate. These undulations quickly become more prominent and form folds of the epidermis into the dermis called primary ridges. Then the summits of the primary dermal ridges begin to be subdivided into double parallel ridges; the secondary dermal ridges which form the furrow from about 18th to 19th week. In the 7th month, differentiation and development of dermal papillae take place on the secondary dermal ridges.[4]

Ridges become visible by the 12th weeks of intrauterine life which become complete by the 24th week.[2] The ridges form first in the fingers then differentiation spreads proximally from fingertip to palm and in radio ulnar sequence. Dermatoglyphic

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patterns remain unchanged throughout life after its formation except in the dimension in proportion to the growth of an individual and hence are used for personal identification.[5] Dermatoglyphic patterns are influenced by environmental agents like rubella, thalidomide during early pregnancy. These factors may change the dermatoglyphic patterns during intrauterine life.[1] Patterns are influenced by genetic disorders like Down syndrome, Klinefelter syndrome. The presence of an extra chromosome in Down syndrome dramatically alters prenatal development and have varying effects on each organ system. The nervous system is the most sensitive organ during prenatal development and any alteration causes mental retardation for in Down syndrome people. Dermatoglyphics also influenced by induction fields, positioning of the volar pads and nerve vessel pairing.[6]

In 1866, John Langdon Down first time described the clinical features which was subsequently given his name.[7] The terms "mongols", "mongoloid" and "mongolism" were widely adopted in nineteenth century because the condition reflected oriental cast of countenance produced by the characteristic features.[8] The face is flat, broad and destitute of prominence. The cheeks are roundish and extended laterally. The eyes are obliquely placed and the internal canthi more than normally distant from one another. The palpebral fissure is very narrow. The forehead is wrinkled transversely. The lips are large and thick with transverse fissures. The tongue is long, thick and is much roughened. The nose is small.[9] The term is now considered inappropriate, abandoned and replaced by DS.

In the normal individuals following palmar creases are found:

a) Proximal transverse palmar crease: Cummin and Midlo stated that according to the palmist the other name of this crease is 'heart line'. This crease is located just distal to the middle of the palm. It starts at the radial border of the palm and ends at the radial side of the hypothenar eminence.[10]

b) Distal transverse palmar crease: The palmist called this crease as 'head line'. This crease located between the proximal transverse crease and the heads of the metacarpal bones. This crease begins at the ulnar border of the palm and ends after traversing two third transverse distance of the palm.[10]

c) Radial longitudinal palmar crease: The palmist also called this line as 'life line'. Thenar or longitudinal palmar crease begins near the proximal part of the middle of the palm area, after encircling the thenar eminence, it ends at the radial border of the hand. Thenar crease usually joins with the proximal transverse crease at the radial border of the hand.[10]

The abnormal palmar flexion creases considered in the present study were the Simian line and the Sydney line(figure-1).

Simian Line: The proximal and distal horizontal creases are fused to form a single horizontal crease.[10]

Sydney line: It means the continuation of the proximal transverse crease until the ulnar border of the palm.[11]

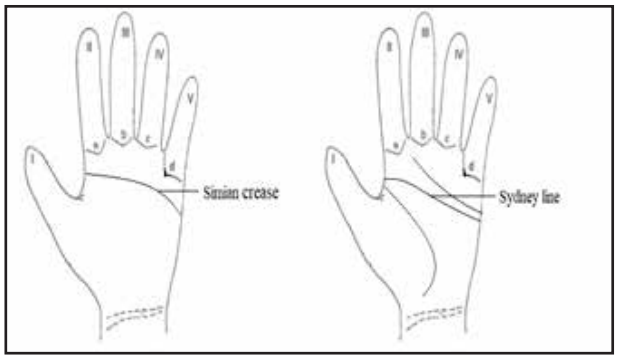


Figure 1: Different palmar creases (Simian crease, Sydney line)

Palmer patterns
To describe the palmar dermatoglyphics, the palmar area is divided into different Interdigital areas. These areas are5 (Figure-2)

1. Thenar or I.
2. II (area between index and middle finger).
3. III (area between middle and ring finger).
4. IV (area between ring and little finger).
5. Hypothenar area.

Thenar area: Occupies the proximo-radial quadrant of the palm. The elevation of this area is formed by muscle of this region, which controls movement of the thumb.[5]
Hypothenar area: It is the elongated and elevated area lies in the ulnar side of the palm. Muscle of this area controls movement of the little finger.[5]

Types of palmar pattern:
- Whorls, loops and tented arches are true palmar pattern (TPP) or 'Pattern present'.
- Other primary configurational types likes plain arches, open fields vestiges are known as no palmar pattern (NPP).[12]

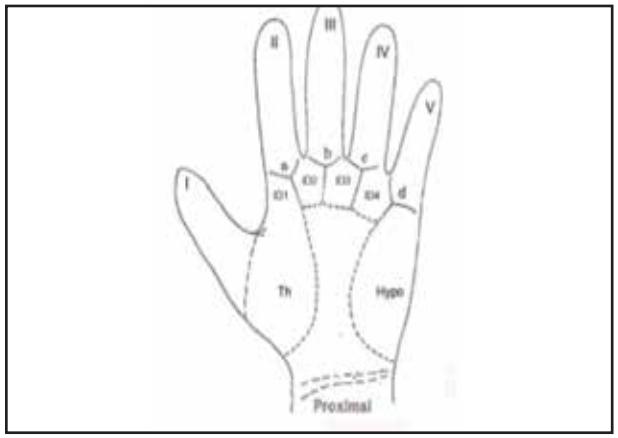


Figure 2: Interdigital areas over palm. Th/ID I=Thenar zone, ID 2= interdigital area 2, ID 3= interdigital area 3, ID 4= interdigital area 4 and Hypo= Hypothenar zone

1. Whorl pattern: The whorl is distinguished by its concentric design (Figure-3). Majority of ridges make circuits around the core.1

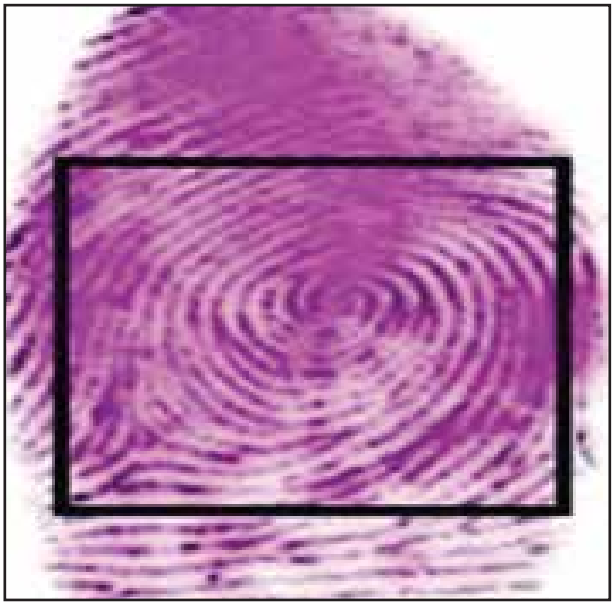


Figure 3: Whorl pattern

2. Arch pattern: In arches, the dermal ridges pass from one margin of the digit to the other margin with a gentle distally bowed sweep.12 (Figure-4)

Simple arch: The simple arch has no tri radius and is composed of a series of gently curving ridges with the convexity directed distally.

Tented arch: Included with simple arches, have more acutely curved dermal ridges and atri radius in the center of the pattern.

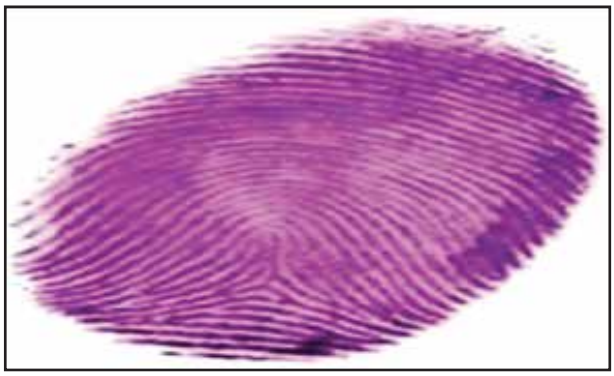


Figure 4: Arch pattern

3. Loop pattern: In loops, the ridges curve around the core starting from and ending at the same margin (Figure-5). Loops can be divided further into ulnar and radial types: When the loop opens to the ulnar margin of the hand and radial loop when the loop opens to the radial margin.[1]

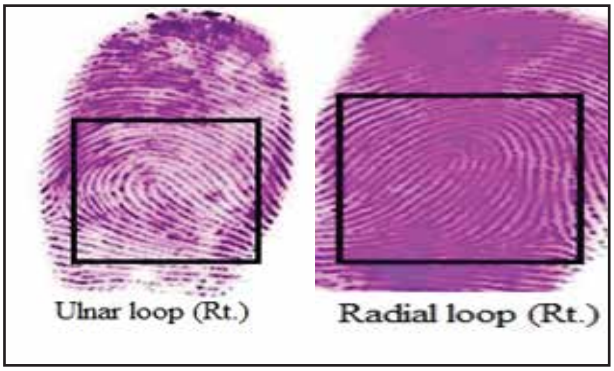


Figure 5: Different types of loop

Material and Methods

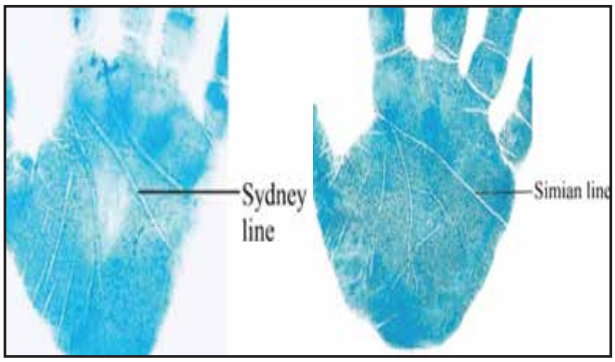
40 diagnosed Down syndrome subjects were selected from schools of mentally retarded children such as Society for the Welfare of the Intellectually Disabled, Bangladesh (SWID) and Down Syndrome Society of Bangladesh (DSS) from Dhaka city and compared with the 40 controls. The confirmation of Down syndrome was based on chromosomal analysis report which was available from their parents or from school records. Data were collected with due permission of the concerned school authorities. Informed written consent were taken from the guardians of Down syndrome group and normal group members. Dermatoglyphic prints were taken by the "Ink & paper Method" as described by 'Cummin.[13] Material used were double plain paper, printing ink, a roller for spreading the ink, a table, a scale, a pointed H.B Pencil, metallic needle with a sharp point, calculator, soap for washing hands and a good quality magnifying lens. Hands of the individual were washed with liquid soap before inking. Both hands were painted with the help of the roller. The thin film of ink was applied on the palm by using an inked roller uniformly over the palm and digits. First of all, the palmer aspect of the wrist was placed and then slowly the palm and fingers were placed on the paper from proximal to distal end. The hand was then lifted from the paper in reverse order. Normal individuals were grouped in A and Down individuals were grouped in B. Painted papers were coded with side e.g. Rt. for right side and Lt. for left side. For identification of Down syndrome subjects, number was given as follows; e.g. DS-1 for Down syndrome subjects-1 and for normal group e.g. N-1 for normal-1.

True Palmar pattern in interdigital areas

There are five inter digital areas on the palm of the hand. At first thenar/I, interdigital area II,III,IV and hypothenar/V area were found out by using magnifying lens. Then only the presence of true palmar pattern on thenar/I, interdigital area II, interdigital area III, interdigital area IV and hypothenar/V areas of palm of both hands were noted separately in the data sheet.

Palmar creases

The presence or absence of Simian, Sydney and normal palmar creases on each palm was observed and recorded in data sheet separately. (Photograph-1).



Photograph 1: Showing Sydney line and Simian line

Results

After collection of data, they were analyzed with the help of SPSS version 20 (Statistical Package for Social Science).

Comparison of true palmar patterns of hands in normal and Down Syndrome group

Table 1 showed that in right hand percentage of true palmer pattern in interdigital area I, II, III, IV and V were 19%, 77%, 38.5%, 36.5% and 15.4% in group A respectively. On the other hand, true palmer pattern were 0.0%, 4.84%, 45.16%, 11.3% and 38.71% in group B respectively. Statistically significant difference was observed in interdigital area IV (p=0.0086) and V (p=0.0197). True palmar pattern was lower in interdigital area IV in group B than A. True palmar pattern was higher in interdigital area V in group B than A. No significant difference were found in interdigital area I, II, III between two groups. (Figure 6)

In left hand percentage of true palmer pattern in different interdigital areas such as I, II, III, IV and V were 6.5%, 4.3%, 26.1%, 39.1% and 24% in group A respectively. At the same time true palmer pattern were 1.85%, 0.0%, 33.3%, 16.7% and 48.15% in group B respectively. Statistically significant difference was observed in interdigital area IV (p=0.0265) and V (p=0.0254). True palmar pattern was lower in interdigital area IV in group B than A. True palmar pattern was higher in interdigital area V in group B than A. No significant difference was found in interdigital area I, II, III between two groups. (Figure 6)

Table 2 showed that total percentage of true palmar pattern in both hands were respectively 4.1%, 6.1%, 32.7%, 38.0% and 19.4% in group A and were 0.86%, 2.6%, 39.7%, 13.8% and 43.1% in group B respectively. Significant difference was observed in interdigital area IV (p=0.0141) and V (p=0.0231). True palmar pattern was lower in interdigital area IV in group B than A. True palmar pattern was higher in interdigital area V in group B than A. No significant difference were found in interdigital area I, II, III between two groups. (Figure 7)

Table I: Comparison of true palmar pattern (TPP) in inter digital areas of hands between Group A (Normal) and Group B (Down syndrome)

TPP in inter digital areas (%)	Group A (n=40)	Group B (n=40)	p value
Right hand			
I (Thenar)	1.9	0	0.384 ns
II	7.7	4.84	0.600 ns
III	38.5	45.16	0.548 ns
IV	36.5	11.3	0.008*
V (Hypothenar)	15.4	38.71	0.019*
Left hand			
I (Thenar)	6.5	1.85	0.302 ns
II	4.3	0	0.188 ns
III	26.1	33.3	0.484 ns
IV	39.1	16.7	0.026*
V (Hypothenar)	24	48.15	0.025*

Comparison of TPP in inter digital area between Group A and Group B done by Proportion test, ns = not significant. * = significant, n = number of study subjects.

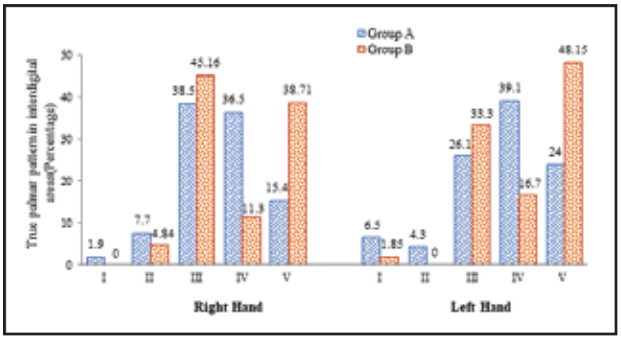


Figure 6: True palmar pattern (TPP) in interdigital areas of right and left hand in group A and B

Table II: Comparison of true palmar pattern (TPP) in inter digital areas of both hands between Group A (Normal) and Group B (Down syndrome)

TPP in inter digital areas (%)	Group A (n=40)	Group B (n=40)	p value
I (Thenar)	4.1	0.86	0.355 ns
II	6.1	2.6	0.446 ns
III	32.7	39.7	0.517 ns
IV	38	13.8	0.014*
V (Hypothenar)	19.4	43.1	0.023*

Comparison of TPP in inter digital areas between Group A and Group B done by Proportion test, ns = not significant. * = significant. n = number of study subjects

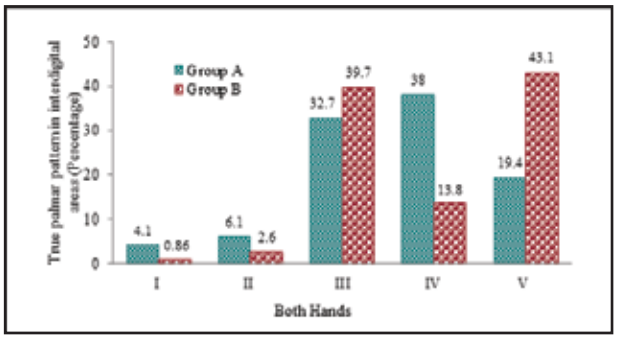


Figure 7: True palmar pattern (TPP) in interdigital area of both hand (right + left) in group A and B

Comparison of palmar creases of hands in normal and Down Syndrome group

In right hand

Table III showed that in group A, the normal crease, Sydney line & Simian crease pattern of right hand was 100%, 0.0% and 0.0% respectively and in group B it was 75%, 10% and 15% respectively. Significant difference was found in normal crease (p=0.0008), Sydney line (p=0.041) and Simian crease (p=0.011) between group A and B. Normal crease was lower in group B than A. Sydney line and Simian crease were higher in group B, whereas they were found absent in group A. (Figure 8)

In left hand

Table 3 also revealed that the normal crease, Sydney line and Simian crease pattern of left hand was 100%, 0.0% and 0.0% in group A respectively and in group B it was 67.5%, 7.5% & 25% respectively. Significant difference was found in normal crease (p=0.0001), Sydney line (p=0.079) & Simian crease (p=0.0008) between group A and B. Normal crease was lower in group B than A. Sydney line and Simian crease were higher in group B, whereas they were found absent in group A. (Figure 9)

In both hands

Table IV showed in group A, the normal crease, Sydney line and Simian crease pattern of both hands were 100%, 0.0% and 0.0% respectively and in group B it were 71.2%, 8.8% and 20% respectively. Significant difference was found in normal crease (p=0.0003) and Simian crease (p=0.003) between group A and group B. No significant difference was found in Sydney line between group A and B (p=0.057). Normal crease was lower in group B than A. Sydney line and Simian crease were higher in group B and found absent in group A. (Figure 10)

Table III: Comparison of palmar creases of hands between Group A and Group B.

Palmar creases (%)	Group A (n=40)	Group B (n=40)	p value
Right hand			
Normal	100	75	0.001*
Sydney	0	10	0.041*
Simian	0	15	0.011*
Left hand			
Normal	100	67.5	0.0001*
Sydney	0	7.5	0.079 ns
Simian	0	25	0.001*

Comparison between study groups done by Proportion test, * = significant, ns = not significant, n = number of study subjects

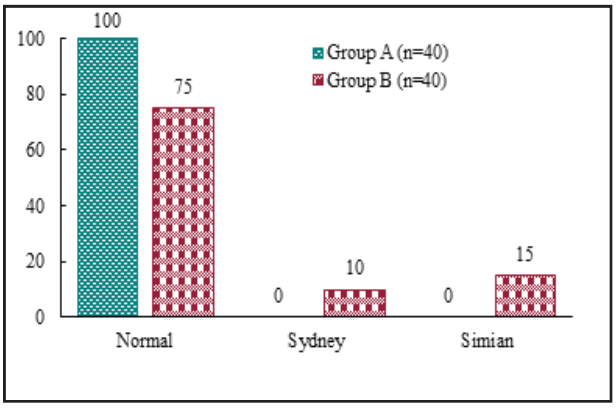


Figure 8: Palmar creases (%) of right hand

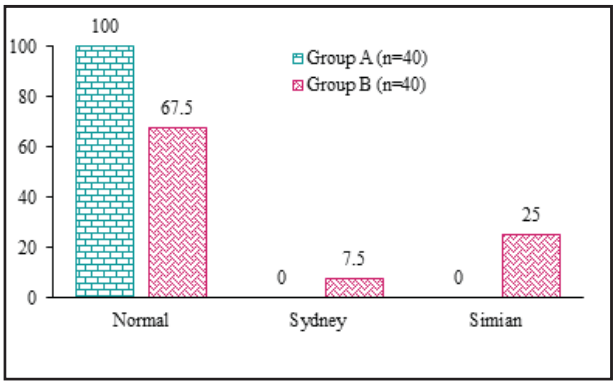


Figure 9: Palmar creases (%) of left hand

Table IV: Comparison of particular palmar creases of both hands between Group A and Group B

Palmar creases (%)	Group A (n=40)	Group B (n=40)	P value
Normal	100	71.2	0.0003*
Sydney	0	8.8	0.057 ns
Simian	0	20	0.003*

Comparison between study groups done by Proportion test, * = significant, ns = not significant, n = number of study subjects

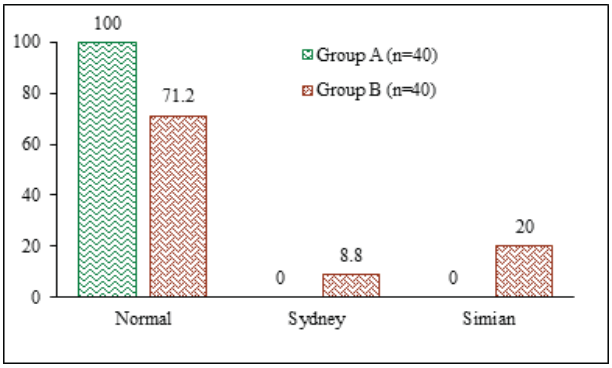


Figure 10: Palmar creases (%) of both hands

Discussion

Human identification is necessary for personal, social and legal reasons. The dermatoglyphics were known since ancient times as personal identification procedure and were used for criminals identification. The dermal ridges of the palm start to appear early in the intrauterine life and are genetically determined. They do not change over a person's lifetime. The present study was undertaken to determine the difference of dermatoglyphic patterns in Down syndrome group and normal healthy subjects. A comparative discussion of results is shown between the present study with that of different researchers of abroad.

Observed results of different variable showed some similarities as well as dissimilarities with the available information present on different publications. The similarity may due to the fact that palmar dermatoglyphic and Down syndrome both are genetically determined and once established, dermatoglyphic patterns remain unchanged throughout life. Dissimilarities can be due to use of excess soap and different sampling techniques.

Percentage of true palmer pattern in five interdigital areas of hands was counted in this study. No significant difference ($p>0.05$) was observed in the percentage of true palmer pattern of right and left hands in I (Thenar), II and III interdigital areas between two groups. But there was significant difference in area IV and in area V($p<0.05$). Dissimilar findings revealed a study that in right and left hands no significant differences present in area II($p>0.05$), but significant differences present in area I, III IV and V between both groups($p<0.05$).[11] Another studies revealed that the true palmar pattern in interdigital area III was significant ($p=0.042$) in Down syndrome[14] but there is significant difference in inter digital area V in Down syndrome people than control group.[15]

In the present study, in right hand normal pattern of palmar crease in the normal group was found 100% and in Down syndrome group, normal palmar crease was observed 75%. Percentage of normal palmar crease was found lower ($p<0.001$) in Down syndrome group than normal. Sydney line and Simian crease was not found in normal group. But in right hand the percentage of Sydney line and Simian crease was higher in Down syndrome. In left hand and both hands the percentage of Sydney line was not significant, but percentage of Simian crease was higher ($p<0.001$) in Down syndrome.

A study showed that Simian crease was higher ($p<0.05$) in Down syndrome people than control group, but dissimilarity in Sydney line was observed. They stated that Sydney line was higher ($p<0.05$) in both hands of Down syndrome than normal group.[11] Another study revealed that percentage of Simian crease was significantly ($p<0.001$) higher in Down syndrome than the control group.[14] Other studies revealed that Simian creases are present only in Down patient's hand[7] Simian creases are significantly higher in Down people than controls[8] and Simian crease is a common phenomenon in Down syndrome.[15]

Conclusion

In the present study dermatoglyphic features of 40 males having Down syndrome were studied and results were compared with controls. The present study revealed that true palmar pattern in area V in Down syndrome was significantly more($p<0.05$) as compared to normal group in both hands. On the other hand true palmar pattern in area IV in Down syndrome was significantly ($p<0.05$) reduced. Normal palmar crease pattern was significantly lower ($p<0.001$) in Down syndrome group than normal group. But Simian crease pattern was higher ($p<0.05$) in Down syndrome, whereas Simian crease was absent in normal group. True palmar pattern in interdigital area I, II and III, and Sydney palmar crease showed no significant difference in both hands.

The expenses involved in conducting chromosomal analysis is more, whereas dermatoglyphics can be used as an extremely useful tool for preliminary investigations in a suspected person.

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