Dermatoglyphic Assessment in Male Down Syndrome

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Abstract

Down syndrome (DS) is the most common chromosomal disorder which causes intellectual disability. It is mainly because of the presence of extra copy of chromosome number 21. Dermatoglyphic has been well established as a diagnostic aid in number of diseases having hereditary basis. Dermatoglyphic data was obtained by the use of ink and prints on a paper. This cross-sectional, analytical type of study was performed at the Department of Anatomy, Dhaka Medical College, Dhaka from January 2017 to December 2017 on 40 Down syndrome subjects (age ranged from 6 to 16) selected from Society for the Welfare of the Intellectually Disabled, Bangladesh (SWID, Bangladesh) and Down Syndrome Society of Bangladesh (DSS) and compared with 40 controls for the establishment of comparison between two groups. Dermatoglyphic prints were used to evaluate the difference in 'atd' 'dat' 'adt' angles and pattern intensity between the control and the DS individuals. The results showed that 'atd' angle was significantly higher ($p<0.05$) in Down males than the controls. The dactylography study also revealed lower 'dat' 'adt' angles ($p<0.05$) and pattern intensity ($p<0.001$) in both hands of Down syndrome group. This method is non-invasive and cost effective. The observed changes in the 'atd' 'dat' and 'adt' angles plus the patterns intensity in the dermatoglyphic study proved that this simple technique could be a valuable tool for selecting individuals of DS for cytogenetic analysis.

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Introduction

Dermatoglyphics came from ancient Greek derma (skin) and glyph (carving). It is the scientific study of the pattern configurations of finger and palm prints.[1] The science of dermatoglyphics, began with Sir Francis Galton in the late 1800s. His classification scheme for fingerprints was later adopted by Sir William Herschel in the late 1890s, as a new tool for individually identifying workers in India. By the beginning of 20th century, dermatoglyphics had been adopted for forensics by Scotland Yard. And by 1960's there was considerable research interest in the relationship between genetic abnormalities and dermatoglyphic pattern. Dermal ridges originate in the 6-7 weeks of development from volar pads composed of mesenchymal tissue. Ridges become visible by the 12th weeks of intrauterine life when volar pad begin to regress. By the 24th week, development of the dermal ridge pattern is largely complete.[2]

The fingers are the earliest sites of ridge formation. Ridge differentiation spreads proximally from fingertip to palm and in radio ulnar sequence. Once established, dermatoglyphic patterns remain unchanged throughout life except in the dimension in proportion to the growth of an individual and

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hence are used for personal identification.[3] Dermatoglyphic patterns are also influenced by non-genetic environmental agents (e.g. Rubella, thalidomide) during early pregnancy, an important time window for tissue differentiation and organogenesis. These factors may change the dermatoglyphic patterns during intrauterine life.[1] Down syndrome is one of the most common chromosomal disorder. John Langdon Down, an English physician in 1866 first time described the clinical description which was subsequently given his name.[4] 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.[5] 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.[6] The term is now considered inappropriate, abandoned and replaced by DS.

The dermatoglyphic (pattern of the ridged skin) is highly characteristic in Down syndrome individuals. The dermatoglyphic features commonly noted in the hands of Down's syndrome individuals include, wide ‘atd’ angle of both hands, distal digital loops, simian crease which are significantly higher in Down people than controls. The ‘adt’ angle of both hands, distal digital whorls are significantly lower in Down syndrome cases than control group.[5] Radial C-line patterns are maximum in Down syndrome individuals, simian creases are present only in Down person’s hand and distal deviation of axial tri radius is statistically significant in Down syndrome people than controls.[4] There is higher incidence of ulnar loops and increased ‘atd’ angle averaging 81 degree in Down individuals.[2] Dermal and palmar ridges are highly useful tools in medical studies including autosomal and sex chromosomal anomalies.[5,7-10] Their notably variable characteristics are not duplicated in other people, even in monozygotic twins.[2] Dermatoglyphic abnormality indicate the possibilities of having Down syndrome and may indicate the need of chromosome analysis in suspected Down syndrome subjects.[5] In this study, we assessed the dermatoglyphic results of Down syndrome and compared with normal individuals.

Material and Methods

This cross-sectional, analytical type of study was carried out at the Department of Anatomy of Dhaka Medical College, Dhaka from January 2017 to December 2017 and was ethically cleared by Ethical Review Committee of Dhaka Medical College, Dhaka. 40 diagnosed Down syndrome subjects were selected from 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 done due to physician’s advice 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 both the guardians of Down syndrome group and normal group members. Dermatoglyphic prints were taken by the “Ink & paper Method” as described by ‘Cummin (1936)’.[7] 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, a protractor, 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 (Photo 1). The thin film of ink was applied on the palm by passing the inked roller uniformly over the palm and digits. First of all, the palmer aspect of the wrist was placed on the paper. 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, from distal to proximal end. 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. Normal individuals were grouped in A and Down individuals were grouped in B.

Dermatoglyphic Patterns: Core is the epidermal ridge, which is present in the center of any pattern. A tri radius is formed by the confluences of three ridge systems (Photo 2). The 'a' 'b' 'c' 'd' and 't' tri radiuses present respectively at the base of the index finger, middle finger, ring finger, little finger and near the proximal margin of the palm (Photo 3).[11]

Photo 1 Showing step of painting of hand with a hand roller

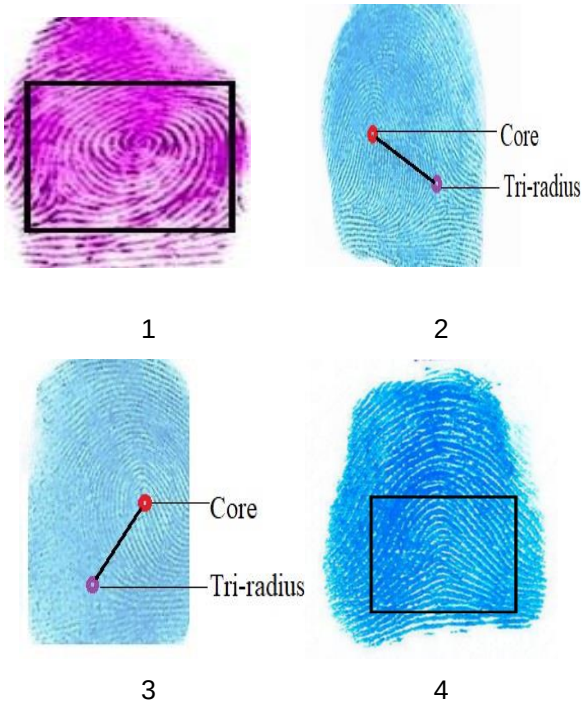

Photo 2 Whorl (1), radial loop (2), ulnar loop (3), arch (4)

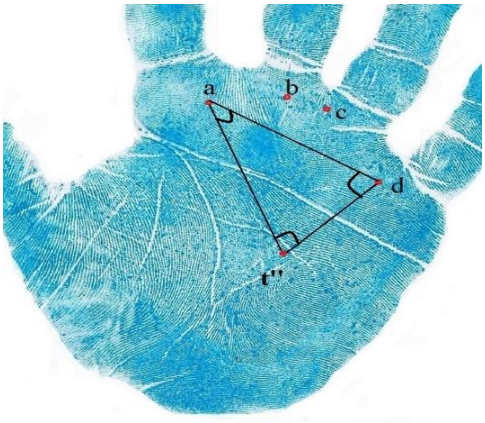

Photo 3 Showing process of measurement of 'atd', 'dat' and 'adt' angles. (a= 'a' triradius, b= 'b' triradius, c= 'c' triradius, d= 'd' triradius, t"=distal tri radius)

The 'atd''adt' and 'dat' angles were formed by the lines joining the 'a' and 'd' tri radius with the most distal axial tri radius. The position of axial tri radius was identified first and then 'a' and 'd' tri radii were located by the hand lens. Then 'a' to 't' and 'd' to 't' lines were drawn by joining the tri radii respectively (Photo 3). 'atd' 'adt' and 'dat' angles were measured with the help of a

protractor. This angles were measured on right hand and left hand separately and noted on data sheet.[2]

According to the number of tri radii, a digit can have a pattern intensity that ranges from zero to two. Considering two hands together, the number of tri radii in ten fingers of an individual ranges from zero to twenty. The whorl typically possesses two tri radii and was assigned the number 2. The loop and the tented arch both were assigned the number 1, as each has one tri radius. The simple arch, which lacks a tri radius, was assigned the number 0 (Photo 2).[1] Pattern intensity was counted by taking the number of tri radii in each finger, then summation of five fingers of each hand was recorded on data sheets separately. Tri radial point was identified by magnifying lens. The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

Results

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

In Table I, it was found that mean±SD of 'atd', 'dat' and 'adt' angle in right hand were 39.23±2.19, 59.63±2.08, 81.15±2.32 in group A and 81.83±5.03, 35.98±3.03, 20±3.92 in group B respectively. 'atd' angle was raised in group B and this difference was highly significant ($p<0.001$) (Fig. 1). Also highly significant ($p<0.001$) difference were observed in 'dat' and 'adt' angle between two groups. 'dat' and 'adt' angle was lower in group B (Fig. 2).

Table I, showed that mean±SD of 'atd', 'dat' and 'adt' angle in left hand were 39.33±2.56, 59.63±2.08, 80.9±3.08 in group A and 83.20±3.60, 35.98±3.03, 61±2.50 in group B respectively.

Table I: Comparison of 'atd', 'dat' and 'adt' angles of hands between Group A (Normal) and Group B (Down syndrome)

Angles in degree (Mean±SD)	**Group A** (n=40)	**Group B** (n=40)	**p value**
Right hand			
'atd' angle (Mean±SD)	39.23±2.19 (37.04 - 41.42)	81.83±5.03 (76.80 - 86.86)	0.000*
'dat' angle (Mean±SD)	59.63±2.08 (57.55 - 61.71)	35.98±3.03 (32.96 - 39.01)	0.000*
'adt' angle (Mean±SD)	81.15±2.32 (78.84 - 83.47)	20.00±3.92 (58.28 - 66.12)	0.000*
Left hand			
'atd' angle (Mean±SD)	39.33±2.56 (36.77 - 41.89)	83.20±3.60 (79.59 - 86.80)	0.000***
'dat' angle (Mean±SD)	59.63±2.08 (57.55 - 61.71)	35.98±3.03 (32.96 - 39.01)	0.000***
'adt' angle (Mean±SD)	80.93±3.08 (77.85 - 84.01)	61.00±2.50 (58.49 - 63.50)	0.000***

Figures in parentheses indicate range. Comparison between Group A and Group B done by unpaired Student's 't' test, SD=Standard deviation. * = significant. ns = not significant. n = number of study subjects

'atd' angle was raised in group B and this difference was highly significant (p<0.001) (Fig. 1). Also highly significant (p<0.001) difference were observed in 'dat' and 'adt' angle between two groups. 'dat' and 'adt' angle was lower in group B (Fig. 2).

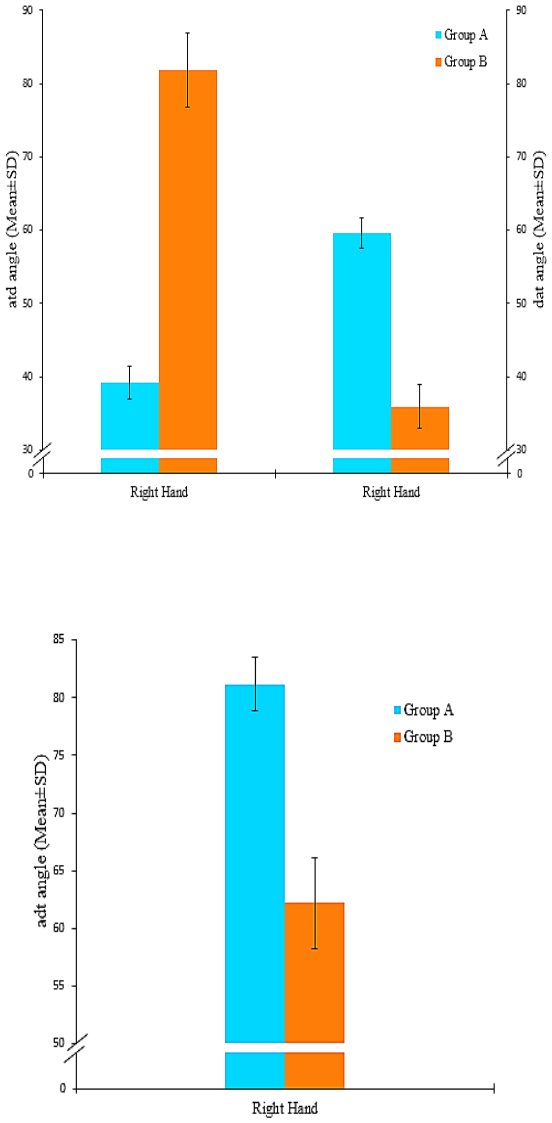

Fig. 1 'atd', 'dat' and 'adt' angle of right hand in group A and B

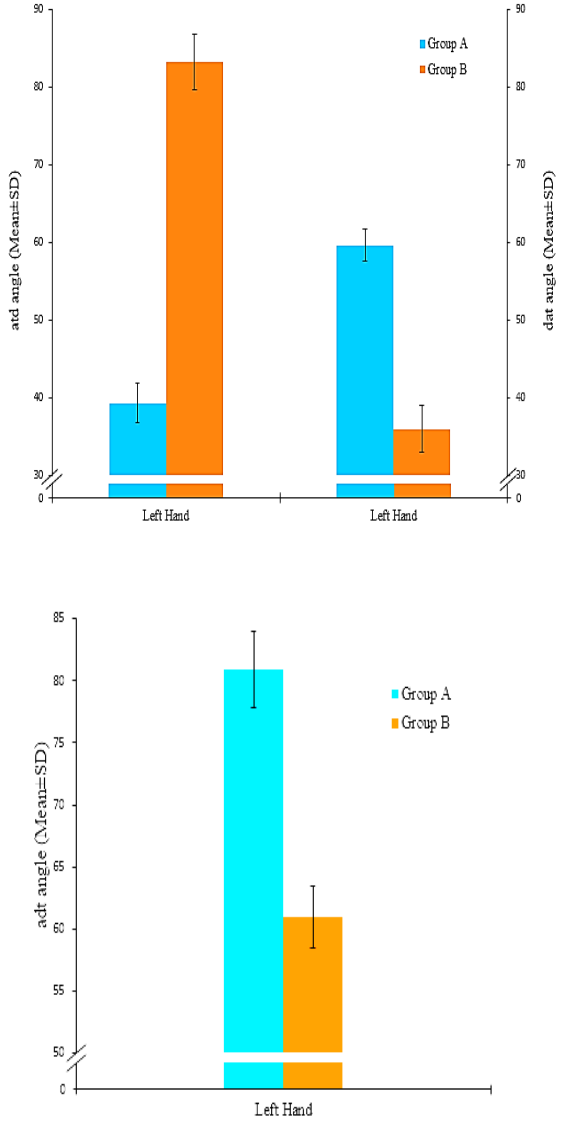

Fig. 2 'atd', 'dat' and 'adt' angle of left hand in group A and B

Table II showed that in both hands 'atd', 'dat' and 'adt' angles mean±SD were 80.30±4.77, 119.38±2.96, 162.08±4.38 in group A and 166.05±6.98, 71.70±4.56, 123.48±5.08 in group B respectively. 'atd' angle was raised in group B and this difference was highly significant (p<0.001) (Fig. 3). Also highly significant (p<0.001) difference was observed in 'dat' and 'adt' angle between two groups. 'dat' and 'adt' angle was lower in group B (Fig. 3).

Table II: Comparison of 'atd', 'dat' and 'adt' angles of both hands between Group A and Group B

Angles in degree (Mean±SD)	Group A (n=40)	Group B (n=40)	p value
'atd' angle (Mean±SD)	80.30±4.77 (75.53-85.07)	166.05±6.98 (159.07-173.03)	0.000*
'dat' angle (Mean±SD)	119.38±2.96 (116.42-122.34)	71.70±4.56 (67.14-76.26)	0.000*
'adt' angle (Mean±SD)	162.08±4.38 (157.70-166.46)	123.48±5.08 (118.40-128.56)	0.000*

Figures in parentheses indicate range. Comparison between Group A and Group B done by unpaired Student's 't' test, SD= Standard deviation. * = significant. ns = not significant. n = number of study subjects.

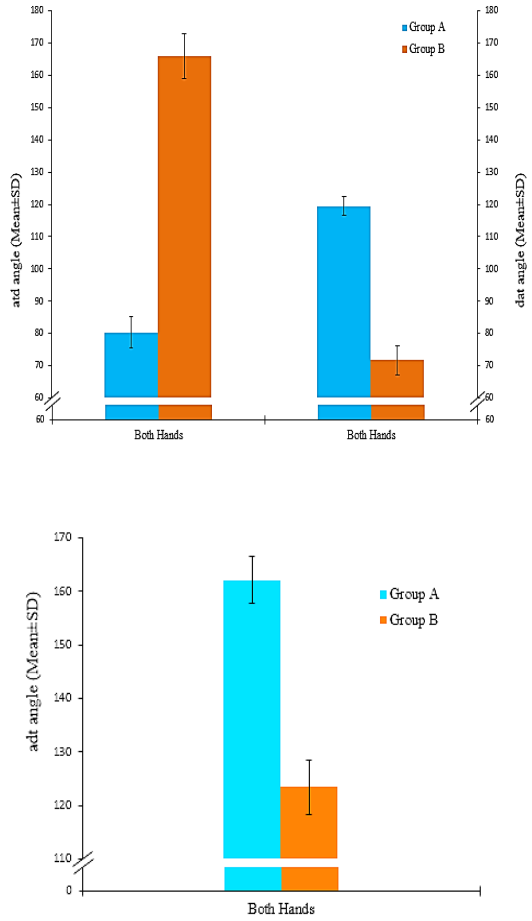

Fig 3 'atd', 'dat' and 'adt' angle of both hands in group A and B

Table III revealed that in group A, the mean±SD of pattern intensity were 6.85±1.61, 6.75±1.65, 13.65±3.1 in right hand, left hand and in both hands respectively. In group B it was 5.55±0.88, 5.63±1.33, 10.85±2.70 in right hand, left hand and in both hands respectively. Difference was highly significant between two groups (p<0.001). Pattern intensity was lower in group B.

Table III: Comparison of pattern intensity of both hands between Group A (Normal) and Group B (Down syndrome)

Pattern intensity (Mean±SD)	Group A (n=40)	Group B (n=40)	p value
Right hand (Mean±SD)	6.85±1.61 (5.24 - 8.46)	5.55±0.88 (4.67 - 6.43)	0.000*
Left hand (Mean±SD)	6.75±1.65 (5.10 - 8.40)	5.63±1.33 (4.30 - 6.96)	0.001*
Both hands (Mean±SD)	13.65±3.10 (10.55 - 16.75)	10.85±2.70 (8.15 - 13.55)	0.000*

Figures in parentheses indicate range. Comparison between Group A and Group B done by unpaired Student's 't' test, SD=Standard deviation. * = significant, ns = not significant, n = number of study subjects.

Discussion

Human identification is the recognition of an individual based on some physical characteristics unique to the individual. Many criteria were used for the purpose of identification like race, sex, age, height, complexion, scar, hair, dermatoglyphics, DNA fingerprinting, blood groups, tattoo and occupation marks but dermatoglyphics is found to be the most oldest, reliable and mature biometric technologies and is considered as one of the best, cheapest and legitimate proofs of identification. The dermal ridges of the palm start to appear early in the intrauterine life and are genetically determined.

They do not change over the course of person's lifetime and are individualistic. A comparative discussion of results of present study with that of different authors and researchers of abroad were mentioned. In 'atd', 'dat' and 'adt' angle significant difference was observed in the present study between normal and Down syndrome group in right hand, left hand and both hands ($p<0.001$). Mean±SD of 'atd' angle of right hand and left hand in Down syndrome was higher ($p<0.001$) than the normal group in the present study. In a study mean±SD of 'atd' angle was highly significant ($p<0.001$) in both right hand and left hand between normal and Down syndrome group.[5] The mean±SD of 'dat' angle of right hand and left hand in Down syndrome was lower ($p<0.001$) than the normal group in the present study. Another study results showed that mean±SD of 'dat' angle was not significant both in right and left hand between normal and Down syndrome group. The mean±SD of 'adt' angle of right hand and left hand in Down syndrome was lower ($p<0.001$) than the normal group in the present study. Similar result found in a study.[5]

Pattern intensity (number of tri radii in all fingers) was also considered for comparison in the present study. It was noticed that pattern intensity was found to be more in normal individual than Down syndrome group in right hand, left hand and both hands. This difference was highly significant ($p<0.001$). After reviewing the available literatures, the association between pattern intensity and Down syndrome was not found.

Conclusion

In the present study dermatoglyphic features of 40 males having Down syndrome were studied and the findings were compared with 40 normal healthy males. The present study revealed that the 'atd' angle was significantly higher ($p<0.05$) in both hands of Down syndrome group. Pattern intensity, 'dat' and 'adt' angles were significantly lower in both hands of Down syndrome group ($p<0.05$). Given the expenses involved in conducting analysis of chromosomes themselves, dermatoglyphics can prove to be an extremely useful tool for preliminary investigations into conditions with a suspected genetic base.

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