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Palmar Dermatoglyphics, a Possible Screening Tool among Some Egyptian Children with Acute Lymphoblastic Leukemia

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Abstract Study of dermatoglyphics has a great importance in judicial and criminal researches. Nowadays its relation to some genetic diseases has an immense application. The patterns of dermatoglyphics have been studied in various congenital disorders like Down syndrome, Klinefelter's syndrome and also in chronic diseases like hypertension, diabetes mellitus etc.

The present study was carried out to demonstrate the association between acute lymphoblastic leukemia among children and palmar dermatoglyphics to assess the possibility of using this association as a screening tool for early prediction of leukemia. The study was conducted on 50 children suffering from acute lymphoblastic leukemia who attended at the Hematology and Oncology Unit, Pediatric Department, El-Shatby Hospital, Main Alexandria University Hospital. Matched healthy controls were selected within the same age group. The dermatoglyphic features (ab-ridge count, atd, tda and dat angles) were measured.

Results: The present study showed a significant relation between palmar dermatoglyphics and childhood acute lymphoblastic leukemia. The patients group had significantly lower atd, tad and ab-ridge with no significant difference as regards adt angle than control group as regards the right hand measurements. On the other hand the patients group had significantly lower atd, adt angles and ab-ridge count and significantly greater tad angle than the control group as regards the left hand measurements. The present study developed an equation for prediction of acute lymphoblastic leukemia in children with an accuracy of 66.7%.

Conclusion: palmar dermatoglyphics can represent non-invasive anatomical marker of acute lymphoblastic leukemia risk facilitating its early detection among children.

Keywords Palmar dermatoglyphics. Acute lymphoblastic leukemia

Introduction

Dermatoglyphics is the study of friction ridge pattern on the skin of the palm, fingers, sole and toes. The ridge configurations are formed early during embryonic development, so they are genetically determined but can be influenced or modified by environmental factors. After birth it persists throughout the whole life unchanged (Cowger, 1993 and Seiger et al., 2008).

The study of dermatoglyphics was commonly used in judicial and criminal researches (Cole, 2001)., Researches had been made to link dermatoglyphics to anthropology and medical diseases based on genetic aberrations. The specific dermatoglyphic traits were claimed to be inherited as dominant, incompletely dominant, recessive, single gene or polygenic with complete or incomplete penetrance and as a variable expression of genes. Dermatoglyphics has been studied in certain clinical disorders which are associated with chromosomal and developmental defects like mongolism, Turner's syndrome, cardiovascular disease, diabetes mellitus, schizophrenia and ischaemic heart disease (Barbosa et al., 2009, Oladipo et al., 2007, and Wang et al., 2008).

Acute lymphoblastic leukemia represents a malignant disease of unknown origin in which there is uncontrolled proliferation of white blood cell

precursors. The cells may be B-cell precursors (~80 to 85% of cases) or T-cell precursors (~15 to 20% of cases) (Conter et al., 2004 and Kern, 2002).

Acute lymphoblastic leukemia (ALL) accounts for 75% of all cases of childhood leukemia. The peak incidence of ALL occurs between age 2 and 5 years with slight male predominance (Gordijn et al.,2012).

Diagnosis of ALL is established by bone marrow biopsy, which shows the leukemic cells infiltration and immunophenotyping performed by flow cytometry on either blood or a bone marrow aspirate (Caroll and Loh, 2011).

Most of the cases of ALL show genetic abnormality, the first fusion gene described in ALL was the Philadelphia (Ph) chromosome which has been demonstrated in about 25% of adult ALL cases and 3% to 5% of paediatric ALL cases (Ravandi and Kebriaei, 2009).

This work was carried out to study the relation between ALL among children and palmar dermatoglyphics to assess the possibility of using the later as a forensic screening tool for early prediction of leukemia.

Methodology

Subjects

The study was conducted on 50 Egyptian children aged between 2-10 years old, diagnosed as acute lymphoblastic leukemia who attended during the study period for treatment and follow up at the Hematology and Oncology Unit, Pediatric Department, El-Shatby Hospital, Main Alexandria University Hospital. Diagnosis of the disease was confirmed by bone marrow biobsy, cytochemistry and immunophenotyping.

The study also included a control group composed of 50 aged and sex matched, apparently healthy children. Children with evidence of any other malignancies, congenital diseases, hand deformity, hand cannulated children.

Materials and methods

Fingerprint inked strips 6 x 10 inches, soap and dry towel, white paper A4. Fingerprint inked strips are specially designed for child palm prints identification programs because the ink is easily washable, non-toxic and hypo-allergenic.

Informed consents had been taken from the children's parents or caregivers before obtaining their palmprints.

I- Technique used for taking child's palmprint

Each child was asked to wash his hands with soap and water. The fingerprint inked strips were pulled apart to expose the ink then the child's palm was placed on the opened strips and pressed firmly especially at the center. This helps to flatten the palm and open much of folds and creases. The inked hand was placed on the white paper and fingers of the hand and the center of the palm were pressed firmly then the printed hand was rotated to the outside, until it is approximately vertical and lifted to obtain the full ridge pattern of the palm (Cowger, 1993).

It was difficult to take palmprint of children less than 2 years. They have relatively small sized hands which will make their palmprint parameters analysis inaccurate. The absence of their cooperation to open their hands to take their palmprints was another cause to exclude this age group from the present study (Wertheim, 2011).

II- Examination and analysis of printed palmprints

The paper having the child's palmprint was scanned immediately (to eliminate the possibility of being changed by environmental factors) with resolution 600 dots per inch (dpi) and analysis of the dermatoglyphics parameters had been done using AutoCAD classic program, version 2007.

Quantitative analysis of the following palmprint dermatoglyphics was done:

1- The triradii (a, d, b, and t) were identified. (figure 1a and 1b) (Barbosa et al., 2009). The triradial point is the meeting point of three ridges that form angles of approximately 120 degrees with another (Schauman B and Alter M 1976).
2- Three lines were made to connect the three triradii ‘a’, ‘d’ and ‘t’. (figure2)
3- The angles at triradii ‘a’, ‘d’ and ‘t’ were measured.
4- Another line was drawn between triradii ‘a’ and ‘b’ where ab- ridge count (number of ridges crossing the line drawn between triradii ‘a’ and ‘b’) had been counted. (figure3)

When two ‘a’ or two ‘d’ triradii were encountered, the more radial and more ulnar triradius, respectively, were considered. When more than one ‘t’ triradius was encountered in a single print, the more proximal triradius was used in angle measurement.

AutoCAD classic program was used for measuring the atd, adt, tad angles. ab-ridge count was counted better and more easily by zooming in the scanned photo.

III- Statistical parameters

Data were subjected to statistical analysis using the SPSS software package version 20.0. Statistical analysis was done to obtain the mean, the standard deviation; the standard error of each mean and for comparison between the different groups involved in this study. A high value of the standard error of estimate (SEE) indicates a low degree of accuracy. Coefficient of correlation for measurement of the strength of the association between two variables is calculated by Pearson’s product-moment coefficient of correlation (r) (Chan, 2004).

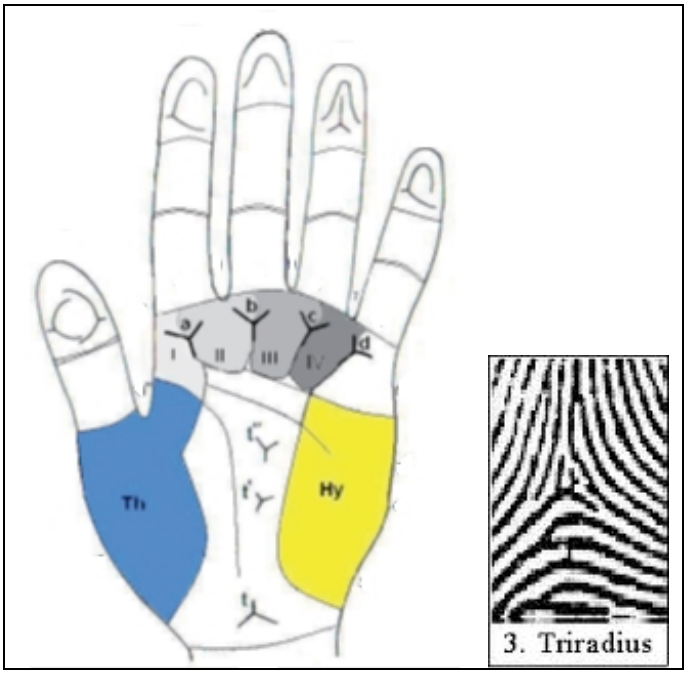

Figure 1a: Diagram showing the main triradii of the palm: a, b, c, d and t. Axial triradius can be t, t' and t" according to its position. (Barbosa et al., 2009).

Figure 1b: Scanned palmprint photography of a child showing Triradii 'a', 'd', 'b' and 't'.

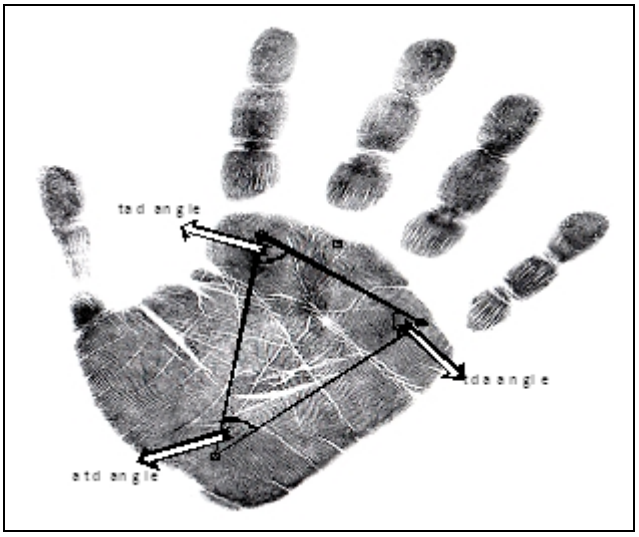

Figure 2: Scanned palmprint photography of a child showing three lines connecting triradii 'a', 'd' and 't' forming three angles ; atd, tad and tda.

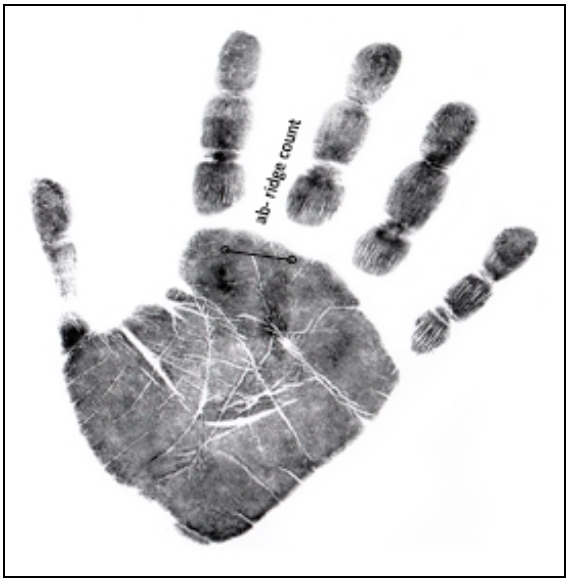

Figure 3: Scanned palmprint photography of a child showing the line connecting triradii 'a' and 'b'. The number of ridges crossing this line was counted (ab- ridge count).

Results

The age of the studied patients and control groups ranged from 2.5 to10 years with a mean of 6.0±2.3 years. 30% of them aged from 4- 6 years. As regards sex of the studied groups, 68.0% of them were males (n=34) and 32.0% were females (n=16).

Table (1) and (2) showed no significant differences between both hands as regards the mean atd, tad, adt angle measurements and ab-ridge count in the control and patients groups ($p \geq 0.05$).

Table (3) shows that angles atd and tad, and ab- ridge count were significantly greater among the control group, while no significant difference was noted as regards adt angle where p= 0.030, 0.032, 0.036 and 0.0494 respectively.

By comparing the same parameters between patients and control groups in the left hand, it was found that angles atd, adt and ab-ridge count were significantly greater in the control group (where p= 0.01, 0.04, 0.03 respectively). Angle tad was noted to be greater among the patients group than the control group where p= 0.02 (table 4).

Multivariate analysis (ANOVA) was done to select the variable that can be used in developing an equation a screening tool for early prediction of leukemia. It is as follows:

Y = 0.789 + (0.002 * Left atd) + (0.014* Left tad) + (0.002 * Left ab-ridge count) + (0.005 * Right atd) - (0.015 * Right tad) + (0.009 * Right ab- ridge count).

If Y < 1.500 the disease not found, If Y > 1.50 the disease present.

Accuracy 66.7%.

Table (1): Student "t" test showing comparison between the right and left hand measurements among the control group (n=50).

	Right hand	Left hand	p
Angle atd (°)			
Range	36 – 65	39 – 71	0.121
Mean	47.4	49.3	
S.D.	7.5	8.8	
Angle tad (°)			
Range	38 – 78	35 – 67	0.070
Mean	58.7	54.6	
S.D.	9.5	7.7	
Angle adt (°)			
Range	56 – 89	68 – 91	0.131
Mean	77.2	78.6	
S.D.	6.6	6.0	
ab- ridge count			
Range	32 – 55	33 – 52	0.148
Mean	42.1	41.1	
S.D.	5.0	3.9	

**P ≤0.05: significant; P≥0.05: non-significant.*

Table (2): Student "t" test showing comparison between right and left hand measurements among patients with acute lymphoblastic leukemia (n= 50).

	Right hand	Left hand	p
Angle atd (°)			
Range	31 – 61	28 - 72	0.271
Mean	44.6	45.5	
S.D.	7.1	7.6	
Angle tad (°)			
Range	38 – 64	41 - 74	0.062
Mean	55.5	57.6	
S.D.	7.2	6.4	
Angle adt (°)			
Range	66 - 94	54 - 89	0.292
Mean	77.2	76.6	
S.D.	5.7	5.6	
ab-ridge count			
Range	32 – 50	22 - 54	0.180
Mean	40.2	39.1	
S.D.	5.3	6.2	

**P ≤0.05: significant; P≥0.05: non-significant.*

Table (3): Student "t" test comparison between right hand measurements among patients and control groups (n=50 each).

	Patients (n=50)	Control (n=50)	P
Angle atd (°)			
Range	31 - 61	36 - 65	0.030*
Mean	44.6	47.4	
S.D.	7.1	7.5	
Angle tad (°)			
Range	38 – 64	38 – 78	0.032*
Mean	55.5	58.7	
S.D.	7.2	9.5	
Angle adt (°)			
Range	66 – 94	56 – 89	0.494
Mean	77.2	77.2	
S.D.	5.7	6.6	
ab- ridge count			
Range	32 - 50	32 - 55	0.036*
Mean	40.2	42.1	
S.D.	5.3	5.0	

**P ≤0.05: significant; P≥0.05: non-significant.*

Table (4): student" t" test showing comparison between left hand measurements among patients and control group (n=50 each).

	Patients (n=50)	Control (n=50)	p
Angle atd (°)			
Range	28 - 72	39 – 71	0.01*
Mean	45.5	49.3	
S.D.	7.6	8.8	
Angle tad (°)			
Range	41 - 74	35 – 67	0.02*
Mean	57.6	54.6	
S.D.	6.4	7.7	
Angle adt (°)			
Range	54 - 89	68 – 91	0.04*
Mean	76.6	78.6	
S.D.	5.6	6.0	
ab- ridge count			
Range	22 - 54	33 - 52	0.03*
Mean	39.1	41.1	
S.D.	6.2	3.9	

**P ≤0.05: significant; P≥0.05: non-significant.*

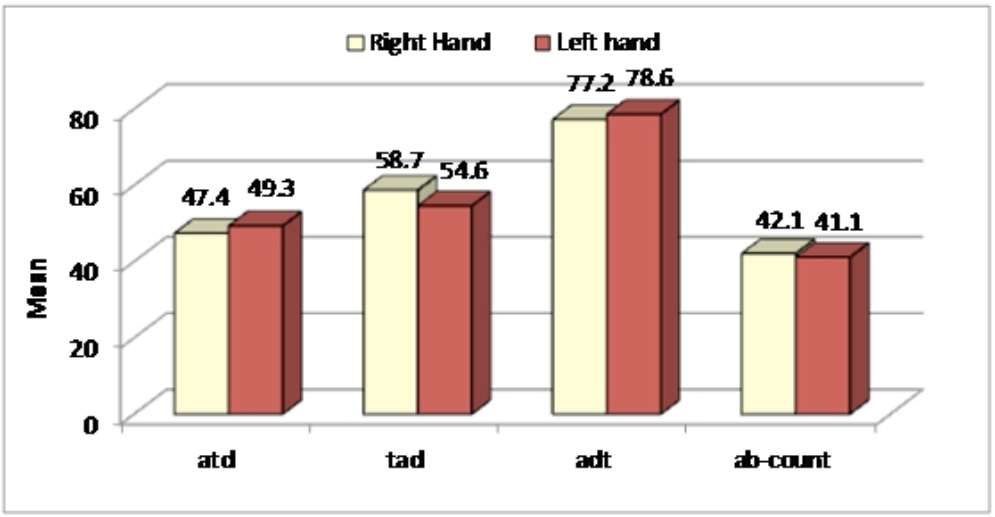

Figure 4: Histogram comparison between right and left hand mean measurements among the control group (n=50).

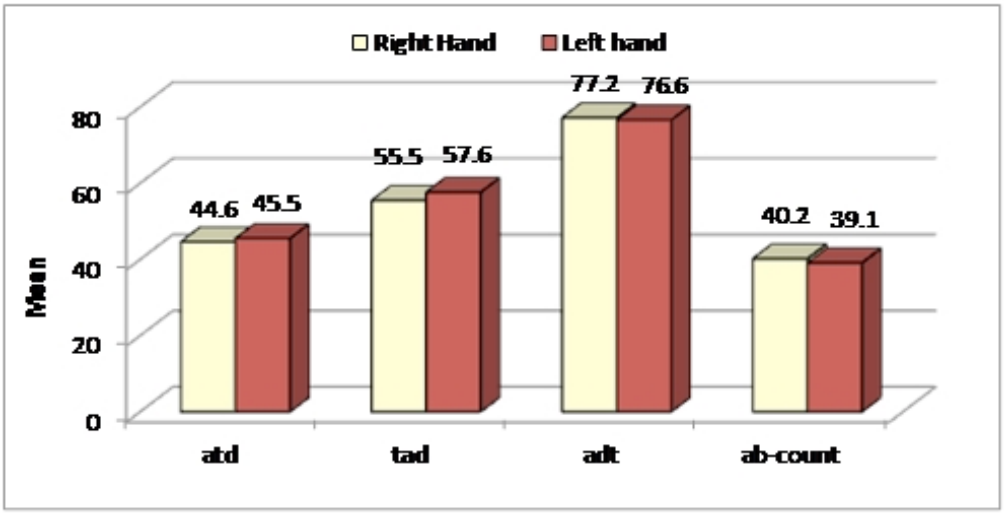

Figure 5: Histogram comparison between mean right and left hand measurements among patients with acute lymphoblastic leukemia (n= 50).

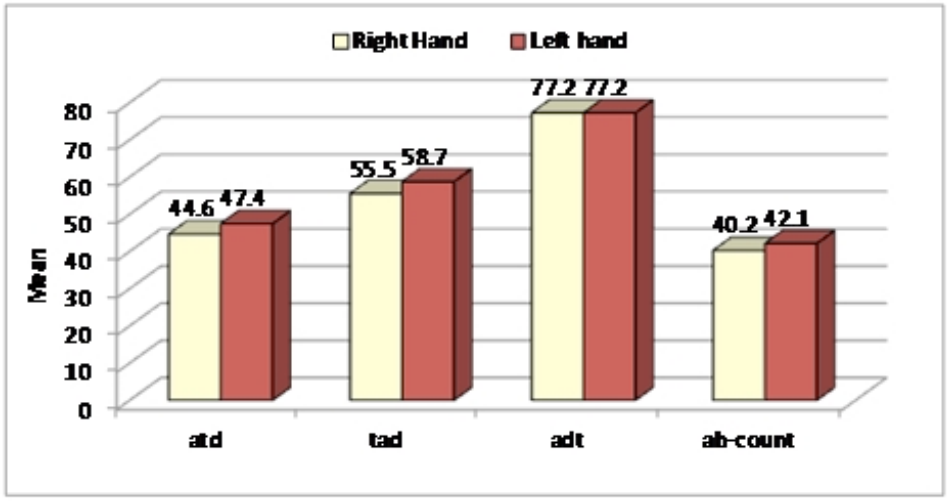

Figure 6: Histogram comparison between mean right hand measurements among patients and control groups (n=50 each).

Discussion

A remarkable understanding of dermatoglyphics has been gained and analysis of dermal ridges could be used in diagnosis of some diseases. Since it was found that patients with chromosomal anomalies have uncommon fingerprints, this science was focused on genetic diseases and made enormous progress (Kelliher et al., 2005 and Nousbeck et al., 2011). The use of analytical methods and computer in analysis of dermatoglyphics has increased utilization of dermatoglyphics in medicine (Nezhad and Shah, 2010).

The relation between characteristic dermatoglyphics and medical genetically based diseases could be explained by the fact that dermal ridge differentiation takes place in the first trimester of fetal development and its configurations are genetically determined. Although ridge configurations can be modified or influenced by environmental factors, yet they remain unchanged throughout the whole life (Karmakara et al, 2008). This relation can also be considered as a window of congenital abnormalities and a sensitive indicator of intrauterine anomalies (Cowger, 1993).

This was the explanation of relating characteristic dermatoglyphics with certain medical genetically based diseases e.g. Kleinfelter's syndrome (Cowger, 1993), cerebral palsy (Proloscic et al. (2009), Down syndrome (trisomy 21) (Barbosa et al., 2009), diabetes mellitus (Nezhad and Shah, 2010) and bronchial asthma (Maceo, 2011).

These studies tried to add dermatoglyphics as logical extension of the physical examination of the patient, where it can be an easy, cheap, noninvasive method to predict a certain disease (Sridevil et al,. 2010)

The present study is concerned with acute lymphoblastic leukemia, which is proved to be based on a genetic factor (e.g. aberration of Philadelphia chromosome). Cellular aberration in cases of leukemia is mesodermal in origin and its development occurs from the third to eighth week of fetal development, known as an embryonic period.

Dermatoglyphics development begins nearly at the same time (fifth to sixth week of fetal development). It originates as an interaction between ectoderm (skin) and mesoderm (dermis and subcutaneous tissue) (Wertheim, 2011). Therefore any aberration in cellular structure of blood forming cells may also leads to change in dermatoglyphics of the same person.

The aim of the present work was to find a relation between acute lymphoblastic leukemia and characteristic dermatoglyphics among the Egyptian children. This can help many children through early diagnosis of the disease and consequently early treatment that almost affect their prognosis.

Dermatoglyphics parameters had been measured by multiple studies using ruler and protractor with the aid of magnifying glass. Some of them recommended using software programs for more accurate results (Sridevil et al, 2010 and Wertheim, 2011).

In the present study certain palmprint dermatoglyphics parameters were measured in patients and control groups. These parameters are: atd, adt, tad angles, and ab-ridge count.

No statistical significant difference was found between the right and left hands in both patients and controls. Similar results were obtained by Bukelo et al, (2011).

Measurements of angle (atd) took much concern from researchers in palmprint analysis, especially in studies correlating palmprint with medical diseases. In the current work, statistical significant difference was found between patients and control group as regards this angle where it was higher among the control group. However Bukelo et al., (2011) found that mean (atd) angle was higher among children with (ALL) patients than the control group. This difference could be contributed to racial and environmental factors.

Angle (atd) was found to be greater in other diseases as in cases of turner syndrome (45, XO) (Maskey et al , 2007), Kleinfelter syndrome (47, XXY) (Sontakke et al. , 2010), Down syndrome (trisomy 21) and diabetes mellitus (Wertheim, 2011). While it was found to be smaller in cases of cancer cervix (Inamdar et al., 2006) and prostate cancer (Oladipo et al., 2009). Researches done on breast cancer showed that atd angle is not significantly different between patients and control groups (Sridevil et al., 2010).

The results of this work also demonstrated that the mean tad angle in the right hand of the control group was greater than that of patients group. While the (tad) angle of the left hand of the patients group was greater than that of the control group. Bukelo et al., 2011 found that this angle (tad) is apparently marginal between the cases and control groups in both hands, but their results were not based on statistical analysis. Measurement of angle (adt) was found to have no significant difference between patients and control groups in the right hand while in the left hand, it showed to be significantly greater among the control group. The same was recorded by Bukelo et al., 2011 where they found that (adt) angle was greater among the control group in both hands.

In this work, ab- ridge count was significantly greater among the control group in right and left hands than the patients group. In contrast to the finding of this study Bukelo et al., 2011 found that mean ab-ridge count was greater among the patients group.

Studies concerned with palmar dermatoglyphics found ab- ridge count greater in cases of breast and prostate cancer (Oladipo et al., 2009). Others demonstrated that it is significantly smaller in cases of diabetes mellitus (Fogle, 1990), and rheumatoid arthritis (Wertheim, 2011), while it was shown to be non-significantly different in cases of cancer cervix (Inamdar et al., 2006).

Trial was made to develop an equation to be used for prediction of acute lymphoblastic leukemia where significant parameters in the study were taken in consideration.

$$Y = 0.789 + (0.002*Lt.\ atd) + (0.014*Lt.tad) + (0.002*Lt.ab\text{-}ridge\ count) + (0.005*Rt.\ atd) - (0.015*Rt.tad) + (0.009*Rt.\ ab\text{-}\ ridge\ count).$$

If $Y < 1.500$: the disease not found, if $Y > 1.50$: the disease present.

The overall accuracy in disease prediction was 66.7%.

Recommendations

Based on the present study, the following recommendations are proposed:

- The study of dermatoglyphics can be applied as a routine clinical screening method for the early diagnosis of certain diseases resulting from genetic aberrations.
- The use of software programs for analysis of palmprint measurements gives better and accurate results than using magnifying glass and protractor.
- Similar studies are suggested on other types of leukemia.
- Other parameters of the palmprint and fingerprint patterns among acute lymphoblastic leukemic children could be considered, to find any relationship between them. In trial to estimate different equations helping in prediction of the disease.
- Further studies should be done to assess the validity of this equation in other sectors of Egyptian population.

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الملخص العربى

دراسة تقاطع النهايات الجلدية فى راحة اليد كأداة محتملة بين الأطفال المصريين المصابين بابيضاض الأورمات الليمفاوية الحاد

نجلاء سلامة[1] و سمية مدكور[1] و أمينة الحلواني[2] و نرمين عبد الحق[1]

البصمات هى دراسة نمط الأحرف الاحتكاكية بجلد راحة اليد و الأصابع وأخمص القدم و اصابع القدم. يتم تكوينها في وقت مبكر أثناء الحياة الجنينية وعلى الرغم من إمكانية تأثرها أو تغيرها بالعوامل البيئية إلا انها تبقى بعد الولادة دون تغيير مدى الحياة.

استُخدمت دراسة طبيعة الأنماط في [illegible] بالأنثروبولوجيا وبعض الأمراض الطبية الناتجة عن الانحرافات الجينية.

أجريت هذه الدراسة لتوضيح تقاطع النهايات الجلدية براحة يد الأطفال الذين يعانون من ابيضاض الأورمات الليمفاويه الحاد وبيان العلاقة بين هذا المرض وبصمات راحة اليد.

تم الحصول على الموافقة المسبقة من الآباء أو الأمهات عن الأطفال. أجريت هذه الدراسة على 50 طفلا مصابا بابيضاض الأورمات الليمفاويه الحاد من المترددين على وحدة أمراض الدم و الأورام، قسم طب الأطفال، مستشفى الأطفال الجامعي بالشاطبي، مستشفي جامعة الإسكندرية. واشتملت الدراسة على مجموعة ضابطة مكونة من 50 من الأطفال الأصحاء. تراوحت أعمار المجموعتين بين 2.5 و 10 سنوات بمتوسط قدره 6.0 ± 2.3 سنوات و قد بلغت نسبة الذكور 68% بينما الإناث بلغت نسبتهم 32%.

تم الحصول علي بصمات راحة اليد من كلا المجموعتين باستخدام شرائط الحبر المخصصة للبصمات و ورق أبيض مقاس A4 ثم تم المسح الضوئي للورق المحتوي علي بصمات راحة يد الاطفال (معدل التمييز 600 نقطة لكل بوصة). بعدها تم تحليل المقاييس المختلفة باستخدام برنامج AutoCAD classic ، الإصدار 2007.

وقد تم دراسة زوايا atd و tad و adt و عدد الأحرف a-b لبصمات راحة اليدين اليمني واليسرى من كلا المجموعتين. وأظهر التحليل الإحصائي عدم وجود فروق ذات دلالة إحصائية بين الأيدي اليمنى واليسرى في كلا المجموعتين.

بعد المقارنة بين المرضى و المجموعة الضابطة فيما يتعلق باليد اليمني تبين أن زوايا atd و tad و عدد الأحرف a-b كانت أكبر لدى المجموعة الضابطة، و قد كان هذا الاختلاف ذا دلالة إحصائية، في حين لوحظ أنه ليس هناك فرق كبير فيما يتعلق بزاوية adt.

فيما يتعلق باليد اليسرى، هناك اختلاف ذو دلالة إحصائية بين القياسات المختلفة، حيث أن زوايا atd و adt وعدد الأحرف a-b أكبر لدى المجموعة الضابطة. ولوحظ أن زاوية tad أكبر لدى مجموعة المرضى عن المجموعة الضابطة.

واستخلصت من هذه الدراسة معادلة تساعد على التنبؤ بابيضاض الأورمات الليمفاويه الحاد عند الأطفال:

ذ = 0.789 + (atd اليسري * 0.002) + (tad اليسرى * 0.014) + (عدد الأحرف ab اليسرى) + (atd اليمنى * 0.005) + (tad اليمنى * 0.015) + (عدد الأحرف ab اليمنى)

إذا كانت قيمة ذ ≥ 1.500: غير محتمل وجود المرض، و إذا كانت قيمة ذ < 1.50 : يُحتمل وجود المرض.

دقة المعادلة 66.7 ٪.

و نخلص من هذه الدراسة بالتوصيات التالية:

1. امكانية تطبيق دراسة تقاطع النهايات الجلدية كوسيلة من وسائل الفحص الإكلينيكي الروتيني للتشخيص المبكر لبعض الأمراض المترتبة على الانحرافات الجينية.
2. استخدام برامج الحاسب الآلي لتحليل قياسات بصمة راحة اليد تعطي نتائج أفضل وأدق من استخدام العدسة المكبرة ومنقلة.
3. هناك حاجة لدراسات علي عينة أكبر مع مزيد من الفئات العمرية وفى محافظات مختلفة لتأكيد النتائج التي توصلت إليها الدراسة الحالية.
4. يوصى بإجراء دراسات مماثلة على انواع اخرى من سرطان الدم.
5. يوصى البحث بإجراء المزيد من الدراسات باستخدام قياسات اخري لبصمات راحة اليد وطراز بصمات الأصابع بين الأطفال المصابين بابيضاض الأورمات الليمفاويه الحاد لإيجاد علاقة بينهم فى محاولة لاستخلاص معادلات مختلفة تساعد على التنبؤ بحدوث المرض.

1 قسم الطب الشرعي والسموم الإكلينيكية كلية الطب جامعة الإسكندرية

2 قسم طب الأطفال كلية الطب جامعة الإسكندرية