Technology and Health Care 10 (2002) 383–390
IOS Press

Application and development of palm print research

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Received 6 July 2001

Abstract. The palm print contains a great deal of information which is of great research and application value. This paper provides palm print research methods, application, and the relationship between the palm print and cancer.

Keywords: Dermatoglyphics, personal identification, topology, *Atd* angle

1. Introduction

Dermatoglyphics studies dermatoglyphic pattern configurations which includes the finger print, palm print and toe print. This science is both old and young. The Chinese used the finger print for signature a few thousand years ago. Toe print has been so far studied little. Several decades of finger print study has helped people understand more on this subject. Meanwhile, automatic recognition of finger prints has become more mature. However, the information finger prints provide is not sufficient. Palm prints include much more information than the finger print. It is therefore used to compensate finger print deficiency. Chinese traditional medicine has long found that the palm print is linked with health and characters, which is being recognized by more and more dermatoglyphic experts. After extensive studies researchers have recently found that the palm print is somewhat related with nationality, geological distribution, character, temperament, health, intelligence and heredity etc. [1]. The study on the relationship between palm print and disease (especially cancer) has shown great prospects, which may provide a foundation for conquering cancer.

2. Methods

2.1. Quantitative analysis

Many dermatoglyphic characteristics can be described quantitatively, e.g., by counting the number of triradii or ridges within a pattern and measuring distances or angles between specified points [1]. The following are some often used parameters (Fig. 1).

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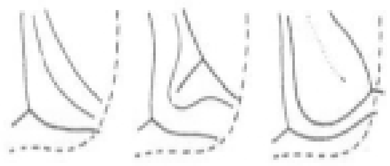

a b c

a. simple arch b. tented arch
c. loop arch

Fig. 1. Some types of patterns in the hypothenar area.

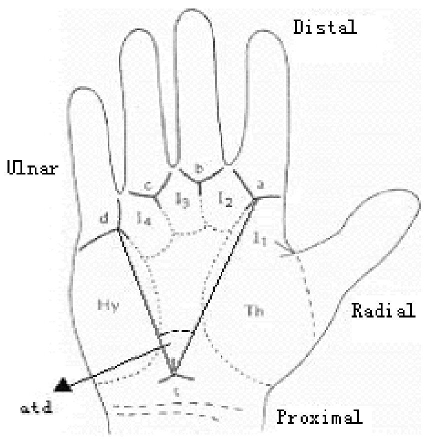

Fig. 2. Diagram of a palm showing the dermatoglyphic pattern areas. Th, thenar; Hy, hypothenar; I_1–I_4, first to fourth interdigital areas.

2.1.1. Pattern intensity

Pattern intensity refers to the complexity of ridge configurations. It can be expressed by counting the number of triradius present. According to the number of triradius, a digit can have a pattern intensity 0–3. The simple arch, which lacks a triradius, is assigned the number 0, the tented arch and the loop are both assigned 1, as each has one triradius, similarly, the pattern intensity of the palm can be expressed as the sum of all triradius present.

2.1.2. Ridge counts

Ridges of the digital areas of the palms are often counted between two digital triradius. The most frequently obtained ridge count is between triradii a and b and is referred to as the a-b ridge count. Counting is carried out along a straight line connecting both triradial points. The count excludes the ridges forming the triradii. Otherwise, the counting is done according to the same principles as applied in ridge counting on the digits.

Counting ridges between b and c and between c and d triradii is sometimes difficult because of the direction of some ridges forming the interdigital patterns. These ridges may lie almost parallel instead of perpendicular to the line of counting and are therefore not crossed by the line between triradii. The b–c and c–d ridge counts are rarely used in dermatoglyhpic analysis for medical purposes.

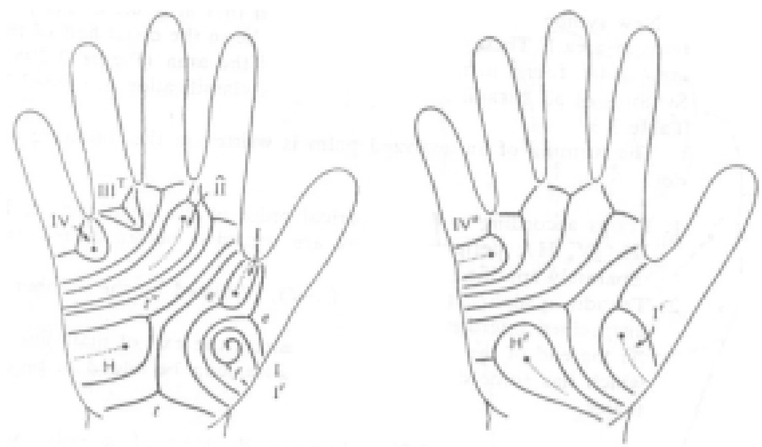

Fig. 3. Numerical values used to designate termini of palmar main lines in the main-line formula(a) and in deriving the main-line index (b).

2.1.3. Ridge counting in patterns lacking triradius

Once the core of point is located, counting ridges in technically good prints is quite simple. However, very large patterns may extend beyond the limits of the ridged skin areas, and the triradius may be absent. Such triradius are called "extralimital triradius". The site of an extralimital triradius can be approximated from the direction of ridge flow. The resulting ridge count, which is always high, can only be estimated. This approximate count is reported by listing the count number with a question mark or a $\sim$ sign before the number.

2.1.4. atd angle

Perhaps the most widely used method is based on the *atd* angle (Fig. 2). This angle is formed by lines drawn from the digital triradius a to the axial triradius t, and from this triradius t to the digital triradius d. The more distal the position of t, the larger the *atd* angle.

2.1.5. Measurement of distal deviation

Another method proposed for determining the position of the axial triradius uses the ratio between the length of the palm and the length of the distance between the wrist crease and the axial triradius t. The distance between the most distal wrist crease and the most proximal crease of the third digit is measured. The distance between the axial triradius and the distal wrist crease is also measured and expressed as a percentage of the length of the palm.

2.1.6. Ridge counting

Ridge counting between the triradius d and t has been proposed as yet another means of describing the position of the axial triradius. The most distal hypothenar triradius as the point from which the count could be specified. And the most medial triradius d as the point where the count terminates be mentioned. The resulting number is smaller when t is distally placed than when t is in a proximal position.

2.1.7. Breadth ratio

Breadth ratio is another method occasionally used to determine the t position. It is based on a measurement of the perpendicular distance from t to a line drawn between the a and d triradii. This measurement is expressed as a ratio of the a–d distance.

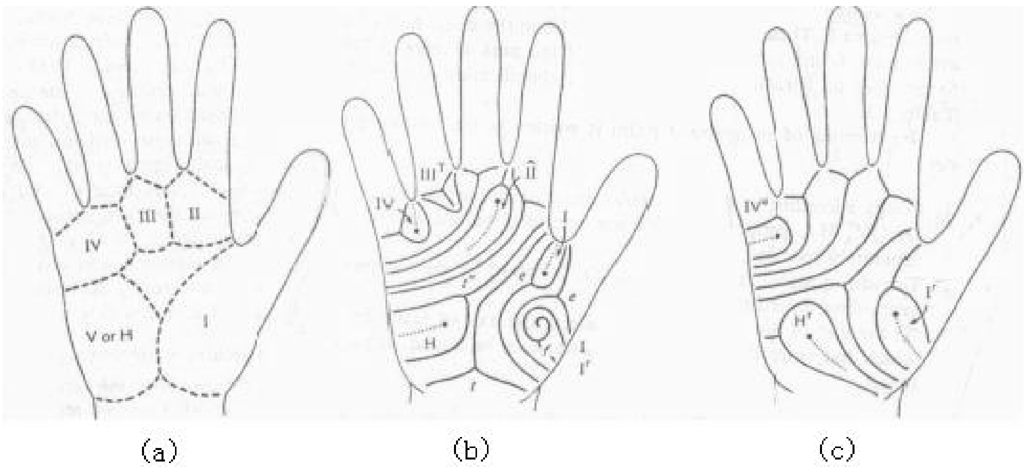

Fig. 4. Topological nomenclature of palm print. (a) Configurational areas on the palm as applied in topological nomenclature; (b) Palm with a central loop (II), peripheral lopps (I, I, IV, H), tented loop (IIIT), and a radial loop (Ir). Topological formula of the palm is I I Ir II IIIT IV H e e f t t ″ 4(4); (c) Palm with loops requiring separate classification (IVu Hr and Ir).

2.1.8. Main-line index

The main-line formula (Fig. 3) serves as an indication of the general direction of palmar ridge flow. The termini of two of the main lines, A and D, which may adequately reflect ridge direction is observed. From this observation a *main-line index* based on the sum of the two numbers corresponding to the ends of main lines A and D is proposed. The resulting value gives an estimate of palmar ridge transversality which may be of clinical significance. A low value for the index indicates vertical ridge alignment, whereas a high value reflects a tendency for the palmar ridge to be horizontal.

2.2. Topology

Single dermatoglyphic traits can be readily determined and used to compare the two hands, different individuals and various ethnic groups, as well as healthy individuals and individuals with medical disorders. However, the complexity of configurations present on the whole surface of the palms or soles are much more difficult to use in comparison, particularly because of the great variability of the pattern details and the difficulties in reducing them into statistically acceptable units. A topological approach to this problem is suggested. Topological classification is based on a description of all loops and the enumeration of all the triradius. Each whorl is rated as the equivalent of two loops, and arches, vestiges, and other ridge configurations, which are not considered as true patterns, are neglected. The resulting pattern intensity, as measured by the number of loops on the normal palm, is four less than the number of triradii. All loops and triradii, with the exception of digital triradii, are recorded in a formula. For classification purpose, the palm is divided into five configurational areas, more or less equivalent to those used in traditional dermatoglyphic analysis [1].

3. Applications of the palm print

3.1. Personal identification

Finger print identification is the most nature and the most extensively used technique in automatic personal identification based on biostatistics. However, automatic finger print identification is mainly based on finger print detail. Palm print includes much more information than the finger print. It is accordingly used to compensate finger print deficiency.

Palm prints have the following characters: 1) The most basic elements of the palm print and the finger print are the same. Therefore, palm prints are unique and will not change in life. They are impossible to fake. 2) The palm print is much larger than the finger print. Details can be easily obtained. 3) The palm prints include other characteristics(main palmar flexion creases, triradius) aside from its uniqueness and stableness. 4) Certain geometric characteristics can be obtained when palm prints are taken [2].

At the 2000 Sydney Olympics, a high resolution palm scanner was used as a safety measure. At the entrances of sensitive sites, people who enter must place their hands on a scanner which reads the hand print and identifies them.

3.2. The palm print in diagnosis

Using the palm print to diagnose certain diseases is an asset of Chinese traditional medicine. This method was formed after thousands years of clinical practice. Not only can it be used to diagnose physical disease, it can also be used for diagnosis of mental disease.

Research in recent decades has found that at least 50 diseases have palm print associations. They include single gene genetic disease, multi-gene genetic disease, chromosome disease etc. Chinese researchers have done much work in this filed. For instance, abundant material has been accumulated in case-control studies on acyesis and schizophrenia palm print characteristics. Examination for dermatoglyphic disorder has become a routine in diagnosis of abnormalities in chromosome number and structure.

3.3. Blood relation identification

Past research has demonstrated that the epidermal ridge patterns are under genetic influence. The hereditary basis of dermal patterns has been studied, which has since been confirmed by numerous genetic studies. A high degree of similarity of dermatoglyphic traits has been found between monozygotic twins, whereas considerably less agreement exits between dizygotic twins. These observations have been utilized diagnostically in determining zygosity of twins. Because of the closer resemblance of dermatoglyphics among close relatives than among unrelated persons, the possibility of using dermatoglyphic analysis as a complementary means in establishing paternity has been suggested [1].

Li Hui was the first to discover that dermatoglyphics of the palm print has something to do with health and intelligence. This is decided by a single gene. He summarized the evolution and causes of dermatoglyphics of primates and divided dermatoglyphics of interdigital areas into groups. He was the first to build a heredity model of the left and right asymmetry in humans which can be used to determine whether a person is the father of another [3].

Li Hui collected 1200 samples of the dermatoglyphics of interdigital areas and used them to analyze whether a person is another's father and obtained very valuable results: traditional blood typing can provide only 4 blood types, but interdigital area dermatoglyphics can provide as many as 15 different types. This method is not only non-invasive, but it is more accurate.

3.4. Selection of athletes

Dermatoglyphic studies in the field of sport at home and abroad has proved that dermatoglyphics can be regarded as a new genetic reference index in selecting athletes. Many researchers divide athletes into groups according their achievements and compare between athlete groups and the general population

Table 1
Various *atd* angles of athletes

Item		Male			Female			Study group
		Number	Mean value	Standard deviation	Number	Mean value	Standard deviation	
Track and field	Run	46	37.85	3.20	99	39.58	4.10	Top athletes
	Jump	35	37.82	3.92	76	38.75	3.85	
	Throw	24	39.24	5.72	44	41.20	3.99	
	Heel-and-toe	30	37.20	3.21	40	39.90	5.44	
Gymnastics		60	38.80	3.61	80	40.74	4.66	
Swimming		43	38.93	3.73	79	40.04	4.30	
Volley ball		102	37.59	3.30	71	39.69	3.93	
Soccer	1	33	37.81	3.52				
	2	107	38.12	3.57				
Table tennis	1	22	39.87	3.44	16	39.15	3.98	
	2				41	39.81	4.76	
Weight lifting		83	40.96	3.79				

to find differences. They found that the *atd* angles of exceptional athletes are significently smaller and the general population group's *atd* angles are normally between $41^\circ \sim 42^\circ$. Many types of hereditary cerebral agenesis in babies such as mongolian idiocy 21q3 sysndrome, 13q3 syndrome and XO syndrome, have a very big *atd* angle.,their mean may reach $60^\circ \sim 70^\circ$. Therefore, the *atd* angle can be used to a certain degree to judge whether a person is agile [4].

4. The relation between palm print and cancer

Cancer is one of the most serious diseases that threat human beings in the world. It is becoming more and more life threatening and kills about 6 million persons, puts 10 million persons on the verge of death every year and brings a loss of several hundred billion dollars per year.

The World Health Organization forecasts that cancer will be the greatest killer in the 21th century. Researchers and experts in China and abroad have done much research, some of which have studied the relationship between cancer and dermatoglyphics [5–7] with much achievement.

Basauri et al. stated in their study that among the first-degree relatives of cancer patients, this illness is two or three times more frequent than that among the general population. Dermatoglyphic characteristics are determined by heredity. They no longer change after the third or fourth month of intrauterine life [8]. Therefore, some dermatoglyphic characteristics make it possible to identify a high-risk group for breast cancer. They studied certain dermatoglyphic characteristics of patients and normal people.

No significant differences were found in the hypothenar pattern distribution in either hand between the two comparison groups. No proof has been found of a different distribution of the main lines' terminal fields in the right hand, as between the control and mammary neoplasia groups. In the left hand, a statistically significant difference was found in the terminal field distribution of lines A and B. In line A, terminal field 2 is more frequent in the mammary neoplasia group at the expense of terminal field 3. Besides, in line B of the cancer patients, there is a diminution in terminal field 5, partially balanced by an increase in terminal field 6. Neither group showed statistically significant differences in MLI. The TI in both groups show a significantly greater difference. This asymmetry is significantly greater in the mammary neoplasia group (Table 2). The median a–b ridge count in the mammary neoplasia group is significantly lower than in the control group.

Table 2
Data on the comparisons of different quantitative parameters of mammary neoplasia and control groups [8]

Parameters	Comparison groups*	n	X	s^2	p
MLI (3)	Control groups (12)	200	16.45	15.68	> 0.1
	Mammary neoplasia	86	15.95	15.12	
Asymmetry in palmar					
Main lines	Control (10)	219	1.24	2.22	< 0.025
Transverseness	Mammary neoplasia	86	1.76	3.7	
Total finger	Control (11)	200	127.9	2,151.03	< 0.0005
Ridge count (3)	Mammary neoplasia	77	103.545	1,454	
IPI(3)	Control (11)	200	11.82	11.97	> 0.6
	Mammary neoplasia	82	11.64	9.638	
a-b ridge count	Control (8)	200	84.04	106.58	< 0.0005
	Mammary neoplasia	86	77.76	100.22	

P was calculated according to Welch's estimate.
*Numbers in parentheses refer to references listed.

The dermatoglyphic study whose results we have reported above, allows the supposition that among the female population there is a high-risk group for mammary neoplasia and that such a group can be detected by means of dermatological patterns. The results suggest that dermatoglyphic investigation may be a valuable aid for screening campaigns and the early diagnosis of mammary neoplasia [8–10].

Ciovirnache et al studied dermatoglyphics in thyroid cancer (34 males, 59 females) of which 87.1% had folliculo-papillar adeno carcinoma. The control groups consisted of 100 normal males and 100 normal females.

Their results found that: Both males and females of thyroid cancer have a reduced number of ridges between the *ad* triradus which distinguish them from normals or subjects with other thyreopathies. Compared to normal males, thyroid cancer males have a more marked transversality of the A line, and thyroid cancer females have a greater obliquity of the same line. Qualitatively, the thyroid cancer subjects have a higher incidence of typical and atypical forms of sulcus transverses and patterns in the second interdigital space than the controls [11].

Ciovirnache et al. studied dermatoglyphics in virilizing polycystic ovary (VPO) syndrome. The study was carried out on 33 VPO women(mean age 24.6 years). The control group was made up of clinically healthy 100 women and 100 men. Their results reveal that the following peculiarities can define VPO: a) Quantitatively, there is a lower number of digital ridges, fewer ridges between the triradius at the bases of the fingers, higher *atd* values, a more marked tendency to obliquity of the B line. b) Qualitatively, there is a higher incidence of digital loops oriented radially and of patterns located unilaterally in the interdigital area II. As for the incidence of flexion creases, there is a predominance of the 2, 3 and 4 variant of the classical simian lines [12].

From the above, we can see that many types of cancers have something to do with palm prints. According to palm print characteristics we can forecast to a certain degree whether cancer will occur.

Present scientific techniques have no way of stopping cancer from occurring and the increase in death rate will continue. Early diagnosis and early treatment are essential on in dealing with cancer. Dermatoglyphic pattern configurations are completed after the sixth prenatal month and will no longer change. So if the relationship between palm print pattern and disease can be acertained, it will be helpful in the study of etiology and latent period of disease, even pre-clinical checks will be made possible. Proper prevention and protection measures can be used in early childhood.

5. Conclusion

With the development of biological techniques, more and more research has been done on the relation between dermatoglyphics and cancer, including Neurofibromatosis von Reckinghausen etc. Certain finger print techniques are becoming more mature, such as finger print identification. Some finger print techniques can be used for palm print research. But there is a great difference between finger prints and palm prints. Therefore techniques for palm print research are very different from that for finger print research.

At present, a lot of work on palm print is done manually and the degree of automation is low. This makes computation complex, inaccurate and slow. Computation of most statistics on palm prints still use ordinary methods such as percentage, mean average, standard deviation, t distributed test and X^2 test. Many up to date methods such as multi-variate analysis, regression analysis, and cluster analysis have been seldom used.

Because there is no large and complete palm print reference database, palm prints cannot be utilized as an index to describe medical disorders. Many papers have shown that different nationality, different geological position and sex etc. can cause outstanding differences. Therefore we require a broad dermatoglyphic analysis method to deal with different races, different nations and different sexes. That is to say, a good expert system with study function.

With the development of biology techniques, pattern recognition, neural networks and computer technique, we can build a large palm print reference database and form expert systems with study function. Much progress will be made in the fields linking palm print and heredity, palm print and disease, palm print and intelligence, palm print and growth and palm print identification.

Acknowledgements

This project is supported by the Beijing Education Committee Foundation.

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