Institute of Experimental Morphology, Pathology and Anthropology with Museum
Bulgarian Anatomical Society

Acta morphologica et anthropologica, 22
Sofia ● 2015

The Papillary Images as Part of the Twin Method

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The "Twin Method" is attempting to answer questions linked with the extent of influence of genetic information as opposed to the environment over various diseases, behaviors and level of intelligence. The material of the study included palm prints of both hands of 21 pairs of MZ twins and 22 pairs of DZ twins. Most data was collected in the area surrounding the town of Shumen, Bulgaria. Fingerprints and palms were obtained by a standard method. The distribution of ulnar loops on fingers in MZ and DZ twins shows that its frequency is the highest on the 5th distal phalanx (87.5% in MZ twins and 69.04% in DZ twins). The percentage of spirals compared to other fingerprint images is greater in DZ twins (40.47%) than in MZ twins (29.77%). The difference in zygosity can be observed in triradii t', t', 0.

Key words: monozygotic twins, dizygotic twins, papillary images, twin method, hypothenar image.

Introduction

In the past few years, the interest towards twin research has significantly increased. Almost 150 years have passed since Francis Galton expressed for the first time the necessity to study twins when studying their illnesses. He also found a correlation between hereditary factors and the environment, while researching the extent and duration of their influence. The "Twin Method", developed as a natural continuation of Galton's works, is still being perfected. This method is attempting to answer questions linked with the extent of influence of genetic information as opposed to the environment over various diseases, behaviors and level of intelligence. It is known that monozygotic twins (MZ) have 100% identical genetic information and thus environmental factors are predominant for such analysis. The dizygotic twins (DZ), on the other hand, have 50% genetic identity and thus the genetic information is the most important factor. The analysis of fingerprints requires the use of qualitative indicators more common. They are bound by specific genetic markers that define the form of papillary images. The implementation of dermatoglyphic analysis requires knowledge in various fields of science, such as ethnic anthropology, medical genetics, forensics and others.

A literature review shows that twin studies are not numerous, mainly due to the difficulties linked with the acquirement of anthropological material. Most of the re-

search is related to physical development and reasons of multiple pregnancies. The effect of parents' age and birth sequence over multiple pregnancies has been studied by J. Bertranpetit, A. Martin and Y. Imaizumi [1, 7]. They establish that with the age increase age of parents, there is also an increase in the percentage of twins being born as a result. Moreover, with every subsequent birth, the possibility of twin birth is increasing as well. In 1982 and 1987, Boklage et al. [2] researched the mortality rate of twins. They lay down that the twin mortality during the first labor is much lower than during second or third, taking into account also the age variation of mothers. Eriksson and Bressers [4] demonstrate that the twin birth rate also increases during wars and famines. It was also shown that in rodents (lemmings), type of food influences the birth of twins. The studies by Miara et al. [5] provide interesting data in relation to birth sequence and intervals between labors. Recently research shows the relationship between dermatoglyphic traits and the electrical activity in the brain of a healthy person [6].

Materials and Methods

The main place in the study is the dermatoglyphic morphology of the hands, represented in two groups: monozygotic twins (MZ) and dizygotic twins (DZ). The material of the study included palm prints of both hands of 21 pairs of MZ twins and 22 pairs of DZ twins. Most data was collected in the area surrounding the town of Shumen, Bulgaria. Fingerprints and palms were obtained by a standard method. Fingerprinting was done by covering the hand palmar surface with topographic ink, and by using a glass plate and a roller. The recording of fingerprinting was done in a passive way, as the researcher helped with the data collection. A rotary tool was used to cover palms and fingers, always starting from the 1st finger on the right hand and finishing with the 5th finger on the left hand. Palmar surface was greased with topographic ink and fingerprints were left on a white sheet of paper, placed on a convex cylindrical surface. Such method provided an accurate print of the palmar surface, including the central part of the palm. The establishment of dermatoglyphic differences was performed with the aid of a binocular loupe.

In this study we used the Galton's [8] classification scheme (1892) of the fingerprints. This classification includes three types of the terminal phalanges of the fingers images: whorls (W), loops (L) and arches (A).

Whorls are images that must have two triradii. They consist of a closed figure, in which the papillary lines run around the center of the image. Some whorls have two centers (**Fig. 1**). Loops represent a semi-closed figure. The loop, opened towards the radial direction is notated with the letter R, and the loop, pointing towards the ulnar direction is notated with the letter U. The T-shaped arch (T) has a triradius, the two proximal radiants of which are pointed in the ulnar (ulnaris) and radial (radialis) direction, and its distal radiant is interrupted and is accompanied by papillary lines, appearing as a distally convex arch.

Palmar images were recorded on the hypothenar (Hy) and on the thenar (Th) areas of the palm with 1st (Th/I), 2nd, 3rd and 4th interdigital fields [9]. The hypothenar (Hy) skin relief is normally presented with a system of arch-like papillary lines, arranged obliquely relative to the longitudinal axis of the hand and opened towards the ulnar side of the hand. They are noted as ulnar arches (Au). In rare cases, arches are opened in the radial direction (Ar) or in the carpal direction (carpalis) (Ac). Even rarer to be found are skin ripples, which form an image on the hypothenar, appearing as a whorl (W), a loop or a T-shaped image [3]. The presence of loops on the hypothenar, depending on the direction of opening, can be ulnar (Lu), radial (Lr), and carpal (Lc).

Fig. 1. Finger and palm prints; W – whorl; U – ulnar loop; A, B, C, D – types of triradii; t – axial triradius; Th – thenar; Hy – hypothenar

Images on the thenar and first interdigital area are always noted together. The lack of an image is marked with 0. When the papillary line ridges form an image, it is marked with symbols similar to those of the hypothenar. Traces of images are noted with the letter V. In the event of a double image, the result is noted first on the thenar, and then, separated by a slash, we record the image from the first interdigital area. When skin ripples do not form an image with a specific form on any of the interdigital fields, we record the result 0. Should there be a loop of not more than five papillary lines, we record the result "1". If the loop has more than five papillary lines, the observation is "L". The loop in the interdigital fields is always distally open. It is possible that the loop of the proximal ending finishes with a triradius, while spirals are rare.

The axial triradius is located on the second field of the palm, between the thenar and the hypothenar. To identify it, we used Gaipel's method [10]. There exist various forms of the axial triradius: carpal (t), intermediate (t') and central (t"). In rare cases, the palm surface may have two triradii (tt', tt" and t' t") and even more rarely three (tt't"). In the absence of an axial triradius, we write "0" in the formula.

Results

The qualitative analysis of fingerprints show that loops (L) are most frequently found in fingerprint images of MZ and DZ twins, whereby this frequency is more pronounced in monozygotic twins (62.27%) than in dizygotic twins (52,37%). Interesting results were

Table 1. Fingerprints at MZ twins

Type of fingerprints		Fingers of MZ twins														
		I			II			III			IV			V			
	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	
A + T	value	0	4		2	0		2	6		0	0		0	0	
	%	–	9.1	4.54	4.54	–	2.27	4.54	13.63	9.1	–	–	–	–	–	–
R	value	0	0		7	4		0	0		0	2		1	0	
	%	–	–	–	15.9	9.1	12.5	–	–	–	–	4.54	2.27	2.27	–	1.13
U	value	32	26		14	21		37	31		22	22		37	40	
	%	72.72	59.09	65.9	31.81	47.72	39.77	84.1	70.45	77.27	50	50	25	84.1	90.9	87.5
W	Value	12	14		21	19		5	7		22	20		6	4	
	%	27.27	31.81	29.54	47.72	43.18	45.45	11.36	15.9	14.77	50	45.45	47.72	13.63	9.1	11.36
DL10	%	12.72	12.27	24.99	14.31	14.31	28.62	10.68	10.22	20.8	15	14.54	29.54	11.36	10.9	22.26
L= R + U	%	72.72	59.09	65.9	47.71	56.82	52.27	84.1	70.45	77.27	50	54.54	27.27	86.37	90.9	88.63

LH – left hand
RH – right hand
BH – both hands

A – arcus
L – loops (R-radial, U-ulnar)
W – whorl

Table 2. Fingerprints at DZ twins

Type of fingerprints		Fingers of DZ twins														
		I			II			III			IV			V			
	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	LH n = 44	RH n = 44	BH n = 88	
A + T	value	2	3		6	6		5	3		2	1		0	2	
	%	4.76	7.14	5.95	14.28	14.28	14.28	11.9	7.14	9.5	4.76	2.38	3.57	–	4.76	2.38
R	value	1	0		4	1		0	0		0	0		0		
	%	2.37	–	1.19	9.1	2.27	5.95	–	–	–	–	–	–	–	–	–
U	value	17	20		13	17		26	25		19	19		31	27	
	%	38.6	45.45	44.04	30.95	40.47	35.71	61.9	59.52	60.71	45.23	45.23	45.23	73.8	64.28	69.04
W	value	22	19		19	18		11	14		21	22		11	13	
	%	50	43.18	48.8	45.23	40.47	44.04	26.19	33.33	29.76	45.23	50	51.19	26.1	30.95	28.57
DL10	%	14.1	13.18	27.27	13.09	12.85	25.94	11.16	12.61	23.77	14.52	15	29.5	12.6	12.6	25.14
L= R + U	%	41	45.45	45.23	40	42.74	41.66	61.9	59.52	60.71	45.23	45.23	45.23	73.8	64.28	69.04

LH – left hand;
RH – right hand;
BH – both hands;

A – arcus
L – loops (R-radial, U-ulnar)
W – whorl

Table 3. Axial triradii

		MZ			DZ		
		Left hand n = 44	Right hand n = 44	Both hands n = 88	Left hand n = 42	Right hand n = 42	Both hands n = 84
t	value	9	12		14	14	
	%	20.45	27.27	23.86	33.33	33.33	33.33
t’	value	19	23		19	20	
	%	43.18	52.27	47.72	45.24	47.62	46.42
t’’	value	4	5		3	2	
	%	9.1	11.36	10.28	7.14	4.76	5.95
tt’’	value	2	1		2	2	
	%	5.45	2.27	3.40	4.76	4.76	4.76
t’t’’	value	1	0				
	%	2.27	–	1.13			
tt’t’’	value	2	0		1	0	
	%	4.54	–	2.27	2.38	–	1.19
tt	value						
	%						
t’t’	value	2	0				
	%	4.54	–	2.27			
0	value						
	%	6.81	6.81	6.81			

t, t’, t’’ – different types of palm triradius

obtained for distribution of ulnar loops on fingers in MZ and DZ twins shows that its frequency is the highest on the 5th finger (87.5%; 69.04%) and lowest on the 4th finger in MZ (25%) and on the 2nd finger in DZ (35.81%). The radial loops dominate the left hand in both MZ and DZ twins (**Tables 1, 2**).

When conducting similar experiments on spirals, we established large differences between MZ and DZ twins. The percentage of spirals compared to other fingerprint images is greater in DZ (40.47%) than in MZ (29.77%) (**Tables 1, 2**).

From the results it is noticeable that the amount of arches (A + T) is significantly greater than that of loops and spirals (7.14% in DZ and 3.18% in MZ twins). Arches are found more frequently in DZ than in MZ (**Tables 1, 2**).

The study of palm prints (axial triradii and palm images) showed that triradii t, t’’ is present in DZ but absent in MZ twins. In regard to palm images variant Au/Ac has the highest percent probability of occurrence in both groups (38.63% in MZ and 32.14% in DZ twins). In MZ twins, possible combinations are more numerous than in DZ twins (**Table 3**).

Discussion

In order to use efficiently and correctly the "twin method", zygosity should be determined very precisely. There are a number of methods which aim to diagnose twins. The diagnosis of a physician during birth is one of the most widely used methods. It is based on the number of placentas. Such method, however, can be quite erroneous. To understand the high probability of errors during this diagnosis, one should look at the way twins are created. There are known to be three different ways: MZ I (dichorionic diamniotic) – the separation happens between 0 to 3 days after fertilization and the frequency of occurrence is approximately 28.3%); MZ II (monochorionic diamniotic) – the separation happens during the developed morula stage (from day 4-5 to day 7 after fertilization and the frequency is about 70%); MZ III (monochorionic monoamniotic) – the separation takes place after the 7th day following fertilization, which is when the embryo of the internal membranes (amnion) is already formed and the process of division stopped. MZ III type occurs rarely (1.2%).

The situational (distribution analysis) and diagnostic (analysis of relationships and dependencies between phenomena) statistical analysis were used. Many individual results were received as a product of the study. These have to be summarized in such a way as to appropriately suit the analysis. In such synthesis, one has to move away from information about the individual units to statistical data, which relates to the quality of homogeneous groups. It is important to note that one does not search for a specific numeric expression evaluation, but only checks whether the empirical data confirms or refutes the preliminary assumption (hypothesis) on some properties (parameters) of the distribution of random variables.

The results obtained from a qualitative analysis of fingerprints as we mentioned earlier show that loops (L) are most frequently found in fingerprint images of MZ and DZ twins. The ulnar loops prevail in both MZ and DZ twins, with the respective percentages: 59.09% and 50.95%. Radial loops (R) are less frequent than ulnar ones in terms of percentage. They are however more frequent in MZ twins than in DZ twins (3.18% and 1.43% respectively). When it comes to loops, there is an absolute difference of 10%, with 8% in ulnar loops and with radial – 2%. This difference demonstrates that there is a difference in zygosity to a small extent (refer to tables). Distribution of ulnar loops on fingers in both groups MZ and DZ twins shows that its frequency is the highest on the 5th finger (87.5% and 69.04% respect.) and lowest on the 4th finger in MZ (25%) and on the 2nd finger in DZ (35.81%). Radial loops in MZ and DZ twins with the highest percentage frequency are found on the 2nd finger (12.5% and 5.95%), while they are completely absent on the 1st and the 3rd fingers in MZ twins and on the 3rd, 4th and 5th fingers in DZ twins. The frequency of ulnar loops in MZ is almost identical on both hands with a slight preponderance on the left hand (64.55%) (On the right hand, the frequency is 63.63%). Similarly, in DZ twins there is also a little difference, but there is a slight preponderance on the right hand (50.10% and 51%).

From the data recorded in the results of this paper, it is clear that radial loops dominate the left hand in both MZ and DZ twins and large differences of the spirals between the same group of twins (40.47%) in MZ twins than (29.77%) in DZ twins. There is an absolute difference of 11%. In both experimental groups, this image is most frequently found on the 4th finger (MZ twins – 47.72% and 51.19%). Spiral images are almost equally distributed on the left and right hands in both MZ and DZ twins (**Table 1**, **Table 2**).

The amount of arches (A + T) are found more frequently in DZ than in MZ twins. There is an absolute difference of 4%. In MZ twins, arches are missing on the 4th and 5th fingers on both hands and are most numerous on the 3rd finger (9.1%). Arches in

DZ twins, though few in number, are located on all finger phalanges. They are most numerous on the 2nd phalanx (14.28%) and least numerous on the 5th phalanx (2. 38%). Arches in MZ twins prevail on the right hand, while in DZ twins they are almost equally distributed on both hands.

The data of frequencies of axial triradii are represented in **Table 3**. The research analysis concludes that the encounter of single axial triradii t, t' and t'' is the highest in both groups of twins. Triradius variant t, t is the only one, which is not to be found in both kinds. The difference in zygosity can be observed in triradii t', t'', 0 and only in MZ twins, while absent completely in DZ twins. Triradius variant t, t'' is present in DZ but absent in MZ twins. Most frequently found triradius is triradius t' and it is found in both kinds of twins (47.72% in MZ twins and 46.42% in DZ twins). The lower percentage probability is for triradius variant t, t' and t'' (2.27% in MZ twins and 1.19% in DZ twins).

The results obtained from a qualitative analysis of palm images (table 4) variant Au/Ac has the highest percent probability of occurrence in both groups (38.63% in MZ twins and 32.14% in DZ twins). This image is more pronounced on the left hand (40.9% in MZ and 38.1% in DZ twins). The difference between both hands is less significant in MZ twins (4%) and more significant in DZ twins (12%). From the images represented in the table, images Au/Lr and Lr/Lc are missing. In DZ twins there are five images that are missing: S, W/Lu, T, R and Au/Au/Ac. The least pronounced images are S, W, W/Lu, Ws, T and Au/Au/Ac (1.13% in DZ twins), and Ar, Au/Lu, Au/Lr, Lr/Lc, W (1.19% in MZ twins).

Conclusions

Based on the current research and after analysing the results, the following conclusions can be made:

1. The distribution of ulnar loops on fingers in MZ and DZ twins shows that its frequency is the highest on the 5th distal phalanx (87.5% in MZ twins and 69.04% in DZ twins). The percentage of spirals compared to other fingerprint images is greater in DZ twins (40.47%) than in MZ twins (29.77%).

2. The palm image Au/Ac has the highest percent probability of occurrence in both groups (38.63% in MZ twins and 32.14% in DZ twins). This image is more pronounced on the left hand (40.9% in MZ and 38.1% in DZ twins). The difference between both hands is less significant in MZ twins (4%) and more significant in DZ twins (12%).

3. In MZ twins the group variability of researched features is almost evenly distributed, while in DZ twins the variability is higher in the second-born twins.

4. The difference in zygosity can be observed in triradii t', t'', 0 and only in MZ twins, while absent completely in DZ twins. The lower percentage probability is for triradius variant t, t' and t'' (2.27% in MZ twins and 1.19% in DZ twins).

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