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A Dermatoglyphic Study: Association of Fingerprint Patterns Among ABO Blood Groups

✉Tri Panjiasih Susmiarsih, M. Samsul Mustofa, Mirfat

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Departement of Biology, YARSI University, School of Medicine, Jakarta, Indonesia

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Abstract

Fingerprints are probably the most common biometric technique used in personal identification. The potential of fingerprints to determine sex and human identification has been well exhibited. However, very few studies have been conducted correlating finger prints with blood groups. The aim of this study was to investigate the distribution of fingerprint patterns based on ABO blood groups. The total sample consisted of 302 medical students of YARSI University Jakarta comprising of 187 females and 115 males. The fingerprint patterns were classified into arches, loops (ulnar and radial), whorls. counted and comprised triradius and total ridge count. The data analysis used Chi Square and Student-T test.The study results indicated that there were fourth especially pattern type. Significantly ($p<0.05$), frequency of loop types (60.36%) was highest in B blood, whorl type was highest in O blood (40.45%) and arches in AB blood was higher (5.12%) as compared to other groups. Dankmeijer indices of O and AB blood were 3.78 and 11.34, respectively. There were indicated significantly ($p<0.05$) difference of average ridge count total among ABO blood groups. This study implied an association between dermatoglyphics and blood groups.

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✉ Correspondence Author:
Jl.Letjen. Suprapto Kav. 13, Cempaka Putih Timur, Senen, Jakarta 10410
E-mail: susmiarsih@yahoo.com

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INTRODUCTION

Identification of humans is a prerequisite for personal, social and legal reasons. Methods of human identification include anthropometry, dermatoglyphics, DNA finger-typing, sex determination, post-mortem reports and differentiation by blood groups. Among these, dermatoglyphics are probably the most common biometric technique used in personal identification; these methods were fast and secure (Gondivkar et al., 2009; Rastogi & Pillai, 2010). The dermatoglyphic patterns have become increasingly important in medicine, particularly in chromosomal abnormalities and diseases which have strong hereditary basis, and this method is employed for screening for abnormal anomalies (Bath et al., 2014), and is used in forensic science for criminal identification.

Dermatoglyphics is the scientific study of the skin epidermal ridge patterns on the fingers, toes, palms of hands and soles of feet (Kucken & Newell, 2005). Dermatoglyphics, the study of fingerprints are constant, individualistic and no two fingerprints possess exactly the same characteristics. Therefore, fingerprints are the potential method for identify of personal. Fingerprint is a mature biometric technology that is the best, cheapest and legitimate proofs for identifying (Pillay, 2009; Kanchan & Chattopadhyay, 2006). Ridge patterns are inherited through polygenic and is affected by environmental factors such as external pressure on the fetal volar pads, because the ridge pattern is formed and developed at the site of the volar pads. Dermatoglyphic traits show a polygenic inheritance and complex. The development of the ridges is influenced by numerous factors emphasising the roles of different factors: the different growth factors, the thickness of the fetal epidermis, the prenatal maternal environment and the prenatal testosterone levels (see Nagy & Pap, 2005). The characteristic patterns of epidermal ridges are differentiated in their definitive forms during 10^{th} to 17^{th} week post conception. Epidermal ridge configurations are completed after the 6^{th} prenatal month and unchanged from birth till death, unless skin is damaged to depth of 1 mm (Yunyu et al., 2002; Vij, 2005; Bath et al., 2014).

Fingerprint patterns are classified into three basic patterns: whorls, loops and arches. Loops occur as radial loop (when the loop opens toward the thumb) and ulnar loop (when the loop opens toward the small finger). These ridge configurations are associated with triradius. A triradius is formed by the confluence of three ridge system converging to each other at an angle of roughly 120^{o}, and is located at the meeting point of three opposing ridgesystems (Kucken & Newell, 2005; Bath et al., 2014).

Blood grouping method is one of the most reliable traditional identification methods. There are 19 major groups of blood system that have identified, and vary in their frequency of distribution, among them only ABO and rhesus groups are major importance in health and disease (Mehta & Metha, 2011). ABO system is classified as A, B, AB, and O blood types according to present antigen in plasma. As the inheritance of dermatoglyphic patterns is a polygenic system, the genetics of ABO blood is also inherited by gene linkage with other characters which may affect clinical features, and is well established (Mehta & Metha, 2011; Kshirsagar & Fulari, 2013).

The potential of fingerprints to determine sex and identify personal has been extensively researched and documented. Independently, many studies have been carried out regarding dermatoglyphic and blood group system. However, very few studies have been done so far to study the correlation between the fingerprint patterns with the ABO blood group. The aim of this research was to study the distribution and the correlation of fingerprints among the subjects with ABO blood group.

METHODS

The present study was carried out in the Department Biology, School of Medicine, YARSI University Jakarta Indonesia. The total sample consisted of 302 medical students in which 115 were males and 187 were female. Informed written consent of all subjects was taken from the entire subject individually with proper procedure explained to the subjects.

The dermatoglyphic prints were taken by using Ink method described by Cummins and Midlo. The materials used were printers black ink, glass plate, roller, soap, white paper, scale, pencil, magnifying hand lens and soap. Students were instructed to wash their hands to remove sweat, oil, and dust from the skin surface by cleaning with soap and dry the hands with towel. Ink was applied and uniformly smeared using gauze pad. An imprint of five fingertips of right hand was recorded on white paper. The same procedure was repeated in left hand also. Prints were dried and studied using a magnifying lens to identify the pattern in both hands. Printed sheets were marked with name, identifity number of student, sex, age and blood groups. After taking the imprints of all fingers and palms, the ink was removed by

using soap and water.

Qualitative analysis of the fingerprints was done by classifying fingerprint patterns as follows: arches (plain arch, tented arch), loops (radial loop, ulnar loop) and whorls (Figure 1.). Loop patterns are started ridge's line from one side, move towards the center, curve, backwards and terminate on the same side. Whorls are circular or spiral arrangement of ridges in the center, and in arches, the ridge lines start from one side and end at the opposite end. The pattern type depends upon the number triradii, a triradius is defined as the center of a delta-shaped junction of three regions. The arch, the simplest configuration, does not have a triradius. The loop, designated ulnar or radial depending upon the margin of the hand to which it opens, has one triradius. The whorl, a generalized pattern, distinguished by a large concentric design, has two triradius. Distribution of fingerprint patterns was done by counting frequency from all pattern types. From the data obtained, indices were derived such as Cummins Midlo index (it combined value of the whorl and loop patterns), Dankmeijer's index (it compared the relative percentage of arches with the percentage of whorls), Furuhata's index (it compared the relative percentage of whorls with the percentage of loops), and Poll's index (it compared the relative percentage of arches with the percentage of loops).

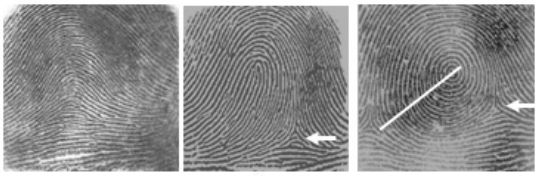

Figure 1. Fingerprint patterns. a. arch; b. loop; c. whorl. (arrow: triradius; line: a ridge count is made by counting ridge from triradius to the center of the pattern or core).

Quantitative fingerprint analysis was done by counting triradius and the dermal ridge. A ridge count is made by drawing a line from the triradius to the center of the pattern (core) and determining the number of intersected ridges between these two points (Figure 1c).Arches have no triradius and thus, there are no ridges to count, this pattern scores zero. A loop has one triradius and whorl has two triradius. TRC of whorl counts are made from each triradius and the larger one is used.A total ridge count (TRC) is the summation of the ridge count for all 10 fingers. It was assessed for increase or decrease in mean frequencies between the groups.

The frequency of fingerprint pattern was tabulated and the percentage of each pattern was calculated. The data was calculated by "mean" of each finger both in male and female for distribution of fingerprints in ABO blood system. The Chi square (X^2) was applied to be statistically significant and "p" value was noted for association of the fingerprint patterns among ABO blood groups.

RESULT AND DISCUSSION

This study was carried out to determine relationship of palmar dermatoglyphics with the ABO blood group. The distribution of A, B, AB and O blood groups among the subjects in the present study was as shown in Table 1. A total of 302 subjects participated in the study out of which 187 were females and 115 were males. Respectively, majority of the subjects in the study belonged to O blood group (48.55%) followed by B blood (23.58%), A (19.96%) and AB (7.91%).

Many criteria were used for the purpose of personal identification like DNA finger-typing, sex determination, anthropometry, dermatoglyphics, post-mortem reports and differentiation by blood groups but fingerprint is found to be the most reliable and cheaper. Dermatoglyphic has the advantage of remaining stable throughout life and it can be compared among individuals of different sex and ages. Dermatoglyphic makes a permanent and complete record providing both qualitative and quantitative data. Dermatoglyphic plays an important role in the diagnosis of

Table 1. Distribution of ABO blood groups according to gender

ABO blood groups	Males		Females		Total %
	number	Percentage	number	Percentage	
A	25	21.74	34	18.18	19.96
B	29	25.22	41	21.93	23.58
AB	9	7.80	15	8.02	7.91
O	52	45.22	97	51.87	48.55
Total	115	100	187	100	100

chromosome disorders and other diseases which have genetic background (Bath et al., 2014). The inheritance of fingerprint pattern is influenced by numerous factors apart from genes (polygenic) and a complex process. As the inheritance of dermatoglyphic patterns and also the ABO blood groups inheritance are polygenic traits because they are influenced by more than one allele at different loci. Majority of subjects in the study belonged to O blood, followed by B, A, AB blood groups.

Dermatogliphic patterns are analyzed in various ways like qualitative analysis and quantitative analysis. Qualitative analysis of fingerprint is classifying pattern i.e. loops, whorls, arches. Quantitative analysis of fingerprint is counting i.e. total finger ridge count (TRC), absolute finger ridge count (AFRC), total number of palmer triradius, a-b ridge count and ATD angle (Chimne & Ksheersagar, 2012; Bath et al., 2014).

In the study, qualitative analysis of fingerprint patterns have done. The fingerprint samples of all 10 fingers were classified into loops, whorls and arches (Figure 2.). Table 2 and Figure 3 showed frequency and percentage wise distribution of various fingertip patterns in ABO blood groups. It was observed that percentage of whorls was highest in O blood group (40.45%) and lowest in B blood group (33.06%). Also, percentage of arches in AB blood group was highest (5.12%; males 5.56% and females 4.67%), as compared tolowest in O blood group (1.52%; males 1.92% and females 1.13%).

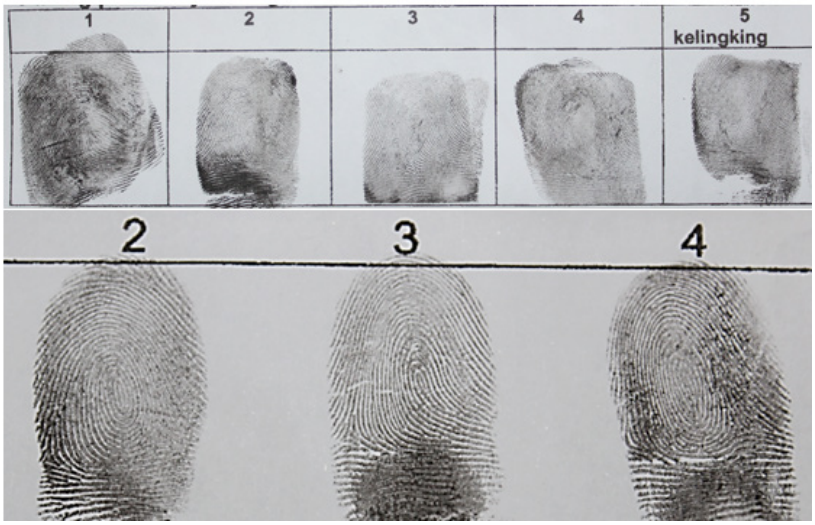

Figure 2. Fingerprint patterns. a. Fingerprint of right hand. 1. Thumb (loop pattern), 2. Forefinger (whorl pattern), 3. Middle finger (loop pattern), 4. Ring finger (whorl pattern), 5. Little finger (loop pattern).

Table 2. Distribution of fingerprint patterns according to gender and ABO blood groups

ABO blood	Gender	number	Fingerprint patterns of 10 fingers (left and right hands)							
			Arches	Arches	Loops Radial	Loops Radial	Loops Ulnar	Loops Ulnar	Whorls	Whorls
				%		%		%		%
A	Males	25	10	4.00	8	3.20	134	56.60	98	39.20
	Females	34	12	3.54	6	1.76	196	57.65	126	37.06
B	Males	29	7	2.42	11	3.79	158	54.48	114	39.31
	Females	41	15	3.66	13	3.17	243	59.27	139	33.90
AB	Males	9	5	5.56	2	2.22	54	61,11	29	32.22
	Females	15	6	4.67	3	1.33	78	52.00	63	42.00
O	Males	52	10	1.92	15	2.88	286	55.00	209	40.19
	Females	97	11	1.13	29	2.99	535	55.16	395	40.72

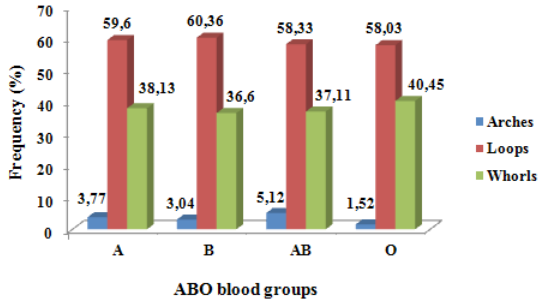

Figure 3. Graph showing distribution of fingerprint patterns according to ABO blood Groups.

In the study, the distribution of fingerprint pattern in ABO blood groups was high frequency of loops, moderate of whorls and low of arches. The frequency of loops is as high as 59%, whorls 38%, and arches 3%, which in turn is exhibited by high Cummins Midlo's and Furuhata's Index as well as low Dankmeijer's and Poll's Index. These findings are similar to those found by Manoranjitham et al. (2015) the commonest fingerprint pattern was ulnar loop (57.7%), followed whorls (33.9%), arches (6.9%), radial loops (1.5%). Generally, the frequency of fingerprint patterns in population is loops 60-70%, whorls 25-35%, and arches 5% (Jalali et al. 2002).

In Table 3. Chi square test of fingerprint patterns in ABO blood groups was done by countingX^2 value (15.10) > X^2 0.95 (12.59), these analysis shows significantly difference($p<0.05$) among ABO blood groups (Table 3.). Highest percentage of loops showed in B blood group, and lowest in O blood group. Contrary, the finding of Metha and Metha (2011) percentage of loops was highest in O blood and lowest in AB blood group; Khadri et al. (2013) the predominant pattern among both males and females was ulnar loop, followed by plain whorl, and least pattern was arches. Different observations were made by Kshirsagar and Fulari (2013) highest percentage of arches was observed in blood O while the percentage of arches was lowest in B blood group, then Koneru et al. (2014) frequency of loops wassignificantly higher in B blood group as compared to other groups. Different studies on dermal ridge in ABO blood groups have shown that the fingerprint ridges are in special pattern and unique based on the genetic characteristics of each individual.

O blood group showed highest Cummin Midlo's (14.09%) and Furuhata's index (69.70%) among in the ABO blood group which this O group indicated highest frequency of whorls and

Table 3. Chi Square test of fingerprint patterns according to ABO blood groups

ABO Blood		Fingerprint Patterns			Total
System		Arches	Loops	Whorls	10 fingers (RL)
A	n= 59				
	Obs	22	344	224	590
	Exp	18.85	345.99	229.16	
	Frequency (%)	3.77	59.60	38.13	
B	n= 70				
	Obs	22	425	253	700
	Exp	17.62	410.50	271.89	
	Frequency (%)	3.04	60.36	36.60	
AB	n= 24				
	Obs	11	137	92	240
	Exp	6.04	140.74	93.22	
	Frequency (%)	5.12	58.33	37.11	
O	n= 149				
	Obs	21	865	604	1490
	Exp	37.50	873.77	578.73	
	Frequency (%)	1.52	58.03	40.45	
Total	n=302	76(3%)	1771(59%)	1173(38%)	3020

Obs:observed; Exp: excepted; X^2 counted=15.10; X^2 table 0.95= 12.592; 15.10>12.592; $p<0.05$ is significant; n=sum of sample; R:right; L: left

loops than A, B, AB blood groups. Contrary, in blood group O, Dankmeijer's and Poll's indexs of fingerprint patterns were lowest percentage of arches. In this study, Dankmeijer's (11.34%) and Poll's index (8.78%) of AB blood group were highest among ABO blood groups which showed highest frequency of arches. The results showed the fingerprint patterns were separately correlated with ABO blood groups (Table 4).

The mean of triradial and total ridge count was calculated, and Table 5 showed that the mean of triradius was highest in O blood group, while lowest in AB blood group. Statistical analysis of triradius wasn't indicating significantly difference among ABO blood groups.

The mean total finger ridge counts of the ABO blood groups were highest in blood group O (148.53±3.56) and lowest in blood group AB (114.66±3.37). Ridge count calculation was done by calculating mean of all 10 fingers in ABO blood groups, and p value was significantly difference ($p=0.02$ ($p<0.05$).

Based on the ABO blood group, the total finger ridge count (TFRC) and patterns can be determined the highest in O blood and the lowest in AB blood group. TFRC in the ABO blood groups is statistical significant difference. The mean value of TFRC is highest in O blood group than others. Similarly, Patil et al. (2015) revealed that the total finger ridge count in all the ABO blood groups was statistically significant different ($p < 0.001$). Total finger ridge count in all the four blood groups in both male and female showed statistical significant different difference. Therefore, total finger ridge count was higher in males than in females. Total finger ridge count and total A-B ridge count appear to yield the most reliable dermatoglyphic differences between individuals with and without schizophrenia (Smith et al., 2012).

Dermal ridge differentiation takes place early in fetal development. The finger and palm prints are formed during 10^{th} to 17^{th} week post conception, and rigde configurations are completed after the 6^{th} prenatal month and unchanged from birth till death (Yunyu et al., 2002; Vij, 2005; Bath et al., 2014). Abnormalities in these areas are influenced by a combination of hereditary and environmental factors. In critical period of ridge formation, genetic and environmentfactor determined growth disturbances of the limbs, may also affect normal development of ridges and ridge patterns. The finger ridge count is one of the most heritable complex traits studied in humans and has been considered a model human polygenic trait, inheritance of finger ridge count was observed linkage chromosome 1, 5 and 15 (Medland et al., 2007). Dermatoglyphic traits are formed under genetic control early in development but may be affected by the environmental factors (such as : viral infection, radiation, alcohol and drug abuse) during the first trimester of pregnancy (Chintaman et al., 2007; Bramon et al., 2005). Epidermal ridges may form in some abnormal patterns, thus the ridge patterns can be used in etiology during the crucial period of diseases (Fearon et al., 2001). Dermatoglyphics serves as a window of congenital abnormalities and is a sensitive indicator of intrauterine anomalies (Matsuyama et al., 2006).

Table 4. Correlation indices of fingerprint patterns in ABO blood groups

ABO blood	Sample n	Cummins Midlo's index (%)	Danmeijer's index (%)	Furuhata's index (%)	Poll's index (%)
A	59	13.59	9.89	63.98	6.33
B	70	13.36	8.31	60.63	5.04
AB	24	13.46	11.34	63.62	8.78
O	149	14.09	3.78	69.70	2.62

Table 5. Showing triradius and total ridge counts in ABO blood groups

ABO blood groups	Sample number	Triradius Means	SD (±)	Total ridge Count (TRC)	SD (±)
A	79	13.55	2.70	122.40	4.10
B	70	13.33	1.78	129.97	2.81
AB	24	11.10	2.95	114.66	3.37
O	149	14.43	3.43	148.53	3.56

SD standart deviation; TRC $p=0.02$; $p<0.05$ is significant

CONCLUSION

Fingerprint is a biometric method that it can be used to identify human according to the ABO blood group. The study revealed the distribution of fingerprint patterns was frequency of arches 3%, loops 59%, and whorls 38%. AB blood group showed highest of Dankmeijer and Poll's index in the ABO blood groups which indices highest frequency of arches. Contrary, O blood group shows lowest of Dankmeijer and Poll's index which indices highest frequency of whorls in the A, B, AB blood groups.Total finger ridge count in all the four blood groups shows statistical significant different difference

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