

RESEARCH ARTICLE



Study on Inheritance of Fingerprint Pattern and its Association with ABO Blood Groups at Nagaon, Assam

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Abstract

Objectives : To analyze the inheritance of fingerprints and blood groups and to finally trace (if any) the possible association between the inheritance of fingerprints and blood groups. **Methods:** A number of 100 students were randomly chosen from the campus of Nagaon College, Autonomous, Nagaon, Assam. A pre-designed form containing the required space for sample collection was made and distributed, explaining the procedure for thumb impression collection and blood groups. After collection, the prints were classified according to Henry's system, where fingerprints are classified into 3 groups- loops, whorls and arches. **Findings:** It was observed that Arches which is possibly a recessive trait is more prevalent in Blood Group O which is also the recessive blood type. And loops and whorls was more prevalent in blood types A and B which are co-dominant in nature **Novelty:** Arch patterns might be of a recessive nature, but the dominancy or recessivity of loops and whorls cannot be firmly determined.

Keywords: Dermatoglyphics; Fingerprint; Patterns; Blood group; Loops; Whorls; Arches; Thumb

1 Introduction

Dermatoglyphics is the study of ridge patterns found in the fingers, hands, palms, and feet and its applications. Dr. Harold Cummins is recognised as the father of dermatoglyphics. The impressions left by frictional ridges on fingers are called fingerprints. These are unique and no two individuals have the same pattern, even monozygotic twins. Interestingly, fingerprints have different types of patterns that are inheritable; they are genetically inherited. Individual details might differ, but their patterns match with either one of the parents. In the year 1897, Edward Henry recognized that fingerprints have three basic patterns: loops, whorls, and arches. The loop pattern recourses back on the same side of the print from which it entered. A characteristic feature of the loop pattern is the presence of one delta, a triangular-shaped structure. Whorls of fingerprints are like spiral whirlpools, which contain

characteristically 2 deltas. Arches are waves with no deltas. The loop type of fingerprint pattern is the most common type of fingerprint, as stated by Edward Henry in 1897. 60% to 70% of the total population has this pattern. Whorl fingerprints make up about 25% of the total population. The rarest type of fingerprint is the arch pattern. About 5% of the world's population has this pattern of fingerprint⁽¹⁾. Another genetically inherited component is the blood group. Blood groups were first discovered by Karl Landsteiner, and he classified them according to the presence or absence of an antigenic substance on RBCs. They are of four types: A, B, AB, and O. They can be further classified based on the presence or absence of another protein factor called the Rhesus factor (Rh). Rh blood types that are present are called positive types, and those that are absent are negative types. Since both fingerprint patterns and blood groups are inheritable, scientists have studied their inheritances, trying to find a link between them. The method applied is simple and without any complications, which has the benefit of avoiding any kind of complication and makes its conduction and analysis easier.

This survey stands apart from other similar published works as it studies the traits of fingerprint patterns, analyzing their possibility of being a recessive or dominant trait and their association with that of a blood group. Any possible association can be of great help in identifying genetically inheritable diseases with speed and ease. It will be of immense help to the health of the society, thereby limiting severe cases of health degradation due to long-term procedures. The majority of studies did not find dominant or recessive character in the distribution of fingerprint patterns. Previous research works were confined to certain regional populations, and to the best of our knowledge, no research study has been conducted in the Nagaon district till date. Hence, the present study was conducted to observe the predominant fingerprint pattern and identify the association between fingerprint patterns and ABO blood groups focusing on the Inheritance pattern which most of the works failed to show. This study will help in the identification of individuals and in creating local biometrics bank in the future.

Inheritance along with association of fingerprint with blood group will play critical importance in the prediction, diagnosis, and treatment of diseases that have a genetic component which majority of the previous studies failed to mention. This study brings a bright side to medical genetics.

The research gap in the survey is that although arch pattern could be stated as a recessive trait, it could not be concluded if whorls and loops are dominant or recessive traits.

1.1 Review of Literature

A review of the literature on the line of research followed in this study is presented here. Although the number of researchers engaged in the study of dermatoglyphics has significantly increased in recent years, as in the line of forensic studies, the study of fingerprint patterns has become a subject of various fields correlating it to other related subjects as in genetics, diseases, and other different research.

A study was conducted at Gandaki Medical College and found that the frequency of loops is highest in all blood groups, followed by whorls and arches, with whorls and arches being highest in blood type O+ and arches in blood type B+. They failed to find any association of blood group with fingerprint patterns⁽²⁾.

In another study, it was deduced that loops are the most common finger-print design and arches are the least common. Whorls and mixed were moderate, more number of loops originated in blood groups O, B related to A and AB. Blood group O+ is found in maximum number of samples, O and AB– in the least number of samples. Loops, whorls, mixed, and arches were predominant in females; Group A was the most common group among sampled males and Blood Groups O, B were usually seen in females. Any possible association between them was not clear in their study⁽³⁾.

A study examined a method for determining the accuracy of blood type prediction. They found that the blood group A, with 33.67 % of samples produces 95.01 % accuracy, similar blood B, AB and O having 25.51%, 13.26%, 27.55% of total samples produced 94.50%, 98.02%, and 93.55% accuracy respectively. The blood group O, highest in precision with 92%. followed by blood group AB with lower 88% precision. This method applied here, though has a high rate of accuracy, but is complex and not accessible to everyone. Professionals who knows a lot about CNN or has knowledge about related stuff can apply this. Individuals cannot relate or would find it hard apply this method in their study⁽⁴⁾.

A survey was conducted, and results indicated that loops are the most commonly found fingerprint patterns while, arches are the least common. Loops dominated in all the blood groups of both Rh positive and Rh negative individuals, whereas whorls were found to be dominant in only O negative blood group. The only correlation between gender and finger print patterns, in this study is that, loops and arches were found in higher frequency in females compared to males and whorls were found to be high in males as compared to females. Their study does not put clear relationship between Fingerprints and blood type let alone their association with inheritance⁽⁵⁾.

A study was done on the association of fingerprint patterns with blood group and gender. They found that the common distribution patterns of fingerprints demonstrated a high frequency (72.3%) of loops, whorls with a moderate (24.9%) and arches with the least (2.68%) frequency. Almost the same array was detected in both Rh positive and Rh negative individuals

and A, B, AB, and O blood groups. The chi-square test revealed that there was no association between fingerprint pattern and in A, B, AB, and O blood groups when results were combined between both genders. They did not study the inheritance of these two characters or the possible association between the dominant and recessive phenotypes⁽⁶⁾. A study explained that there was a significant correlation between the different fingerprint patterns and the groups of the blood. All three patterns were equally distributed in B (-), whorls were maximum in A (+) (44%), arches maximum in A (-) (100%), loop maximum in O (+) (45%)⁽⁷⁾.

In the recent years many studies has been done in this subject, to mention a few, Nandakumar found in his study that A, B and O blood groups were equally distributed with 31.5% each while AB blood type was present in the least (5.5%). Study showed that loop patterns were most common and arches were least in ABO and RH blood type. This survey didn't study the inheritance relationship between blood group and fingerprints⁽⁸⁾.

Another study by Yasmin Amir et.al found the incidence of blood group A, B, AB, and O to be 53 (29.8%), 31 (17.4%), 19 (10.7%), and 75 (42.1%) respectively, with finger pattern Loop being most common followed by Whorl and then Arch. The study never mentioned anything about the inheritance pattern though⁽⁹⁾.

Tarik Al Habsi along with his team studied the association between fingerprints and blood groups in the Omani population and found that loop fingerprint pattern was the most common in Omani subjects (49.4%), followed by whorl (44.9%) and arch (5.7%) pattern, loop occurring more in females than in males and the test also revealed a significant correlation between different fingerprint patterns and blood groups of the subjects but never mentioned about their inheritances relationship⁽¹⁰⁾.

A gender influence on the distribution of fingerprint pattern was observed by Anyanwu among the Esan ethnic group of Edo state Nigeria. He found whorl pattern dominating the males (50%) and Loop dominating the females (54.6%). This study studies only the finger dermatography not on their relationship with blood groups⁽¹¹⁾.

1.2 Objectives

With a view to connecting the dots between finger print patterns and blood groups in human beings, this survey was conducted. The prime objectives outlined to carry out the study were:

- To analyse the inheritance of fingerprint patterns.
- To analyse the inheritance of the blood group pattern.
- To trace (if any) possible associations between the inheritance between fingerprint patterns and blood groups.

The primary aim of this survey is to highlight the potentials of studying and conducting research on "dermatoglyphics" to determine various new aspects of inheritance and genetics related to fingerprints and blood groups.

2 Methodology

The study took place in the district of Nagaon in the state of Assam, India in the year 2022. A number of 100 students were randomly chosen from the campus of Nowgong College, Autonomous, Nagaon, Assam. A survey was conducted on both the students as well as their parents. Every student, along with their parents, participated in the survey and provided samples of their finger prints and data about their blood groups. Students taken into consideration belonged to the age group of 18 to 24. All the participants voluntarily participated in the survey. After obtaining their consent, the prints of the left hand thumbs were collected from the students and their parents through the survey.

A pre-designed form containing columns for thumbprints and students' names and a row for blood groups was provided to each student and their parents. Thumb pads were used to smear the thumb with color, and then the thumb was placed on the paper to collect the impression. The procedure for fingerprint collection and blood group identification was explained to the students before distributing the pre-designed paper for sample collection.

After the collection of fingerprints, the prints were analyzed using a magnifying glass. The patterns, or ridges, were recognized and marked accordingly. All students were asked to wash their hands thoroughly before smearing the thumb in the ink pad and placing the impression on the collection paper. The same method was asked for by their parents. In the study, the prints were classified according to Henry's system. In Henry's system, the patterns are classified on the basis of presence and position of 'Core' and 'Delta'. The core is the central position of the patterns while the delta is a triangular shape formed by the ridges of the print. Whorls were identified by the presence of the core in the middle formed by ridges in a whirlpool manner and two deltas on either side. Loop was identified with core in the middle formed by ridges that flow either towards the direction of the thumb (Radial Loop) or towards the direction of the little finger (Ulnar loop) with only one delta found at the base of the bend. Arches were identified with the ridges being in wave like pattern with the delta being at the core or being absent at all.

3 Results and Discussion

During the survey, the collected data was formulated into a master-sheet. Further interference were obtained from the master-sheet. The photographs of the fingerprints provided by all the participants have been documented below in Figures 1, 2 and 3.

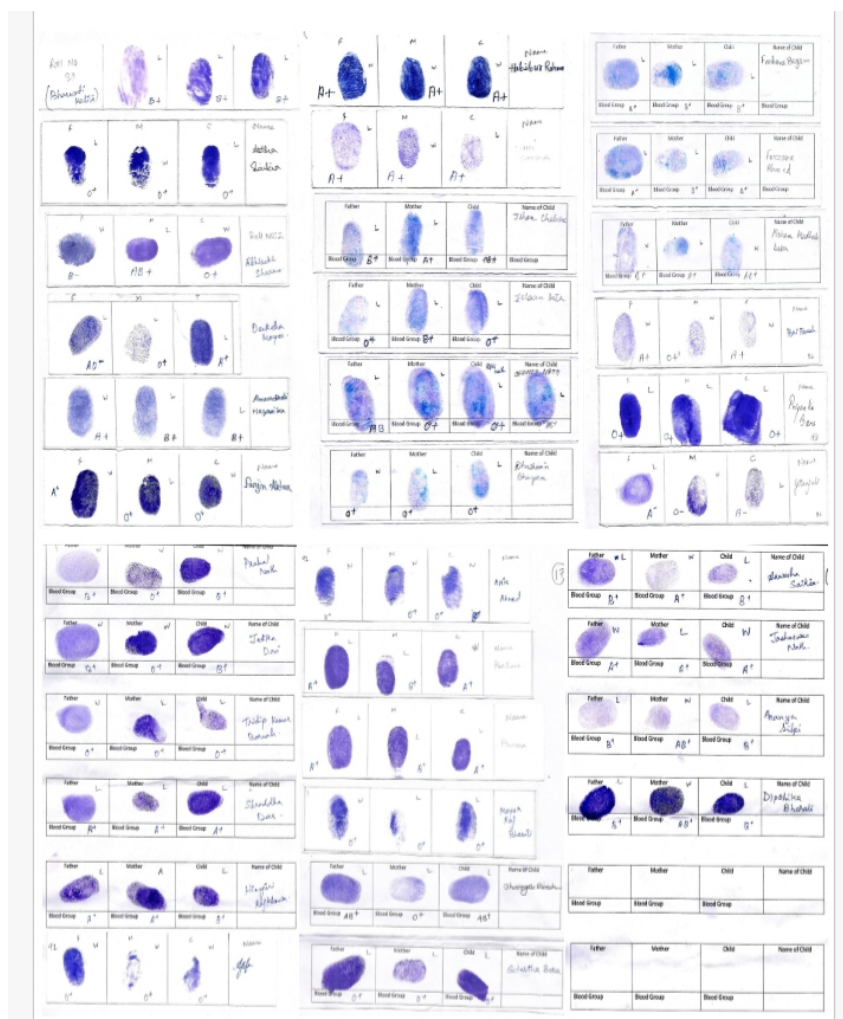


Fig 1. Resultant and Comparative images of the research work

Total samples collected were 300, out of which 100 were of students of which 50 were males and 50 females and the rest were parents. Out of these 300 fingerprints, number of loops are 201, number of whorls 95 and number of arches is 4. Out of 300 samples, 120 of them have blood group O which is the highest followed by blood group B (83), Blood group A (74) and lowest number of people has blood group AB (23). All these types and their frequencies of blood groups and fingerprint patterns are shown in Tables 1 and 2 respectively.

Table 1. Distribution of Blood Groups

Blood Group	A+	A-	B+	B-	AB+	AB-	O+	O-
Frequency	68	6	78	5	21	2	110	10

The Table 3 shows that the number of Loop pattern is highest in Blood Group O with a percentage of 25.3% followed by Blood Group B (20%). Blood group O has the highest numbers of whorls counting 13.67% followed by Blood Group A (8.43%).

Out of the total of 300 samples collected, 150 were males and 150 were females. The distribution of fingerprints and blood groups according to gender is shown in the figure below:

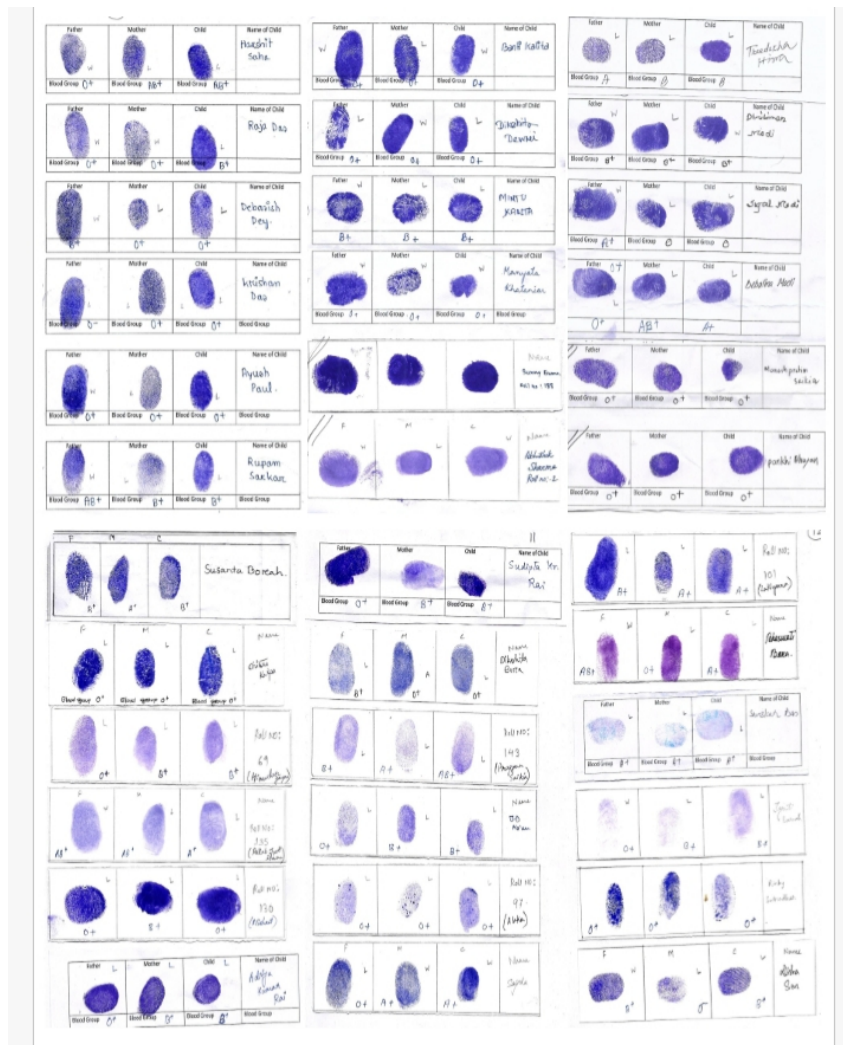


Fig 2. Resultant and Comparative images of the research work

Table 2. Distribution of Fingerprints

Sl.no.	Finger print pattern	Frequency
1.	Loop	201
2	Whorl	95
3	Arch	4
	Total	300

Table 3. Distribution of a particular Fingerprint in one Blood group

Blood GroupsPrint Pattern	Blood group A		Blood Group B		Blood Group AB		Blood Group O	
	Blood group A	%	Blood Group B	%	Blood Group AB	%	Blood Group O	%
1. Loop	48	16%	60	20%	17	5.67%	76	25.3%
2. Whorl	25	8.43%	23	7.6%	6	2%	41	13.67%
3. Arch	1	0.33%	0	N/A	0	N/A	3	1%

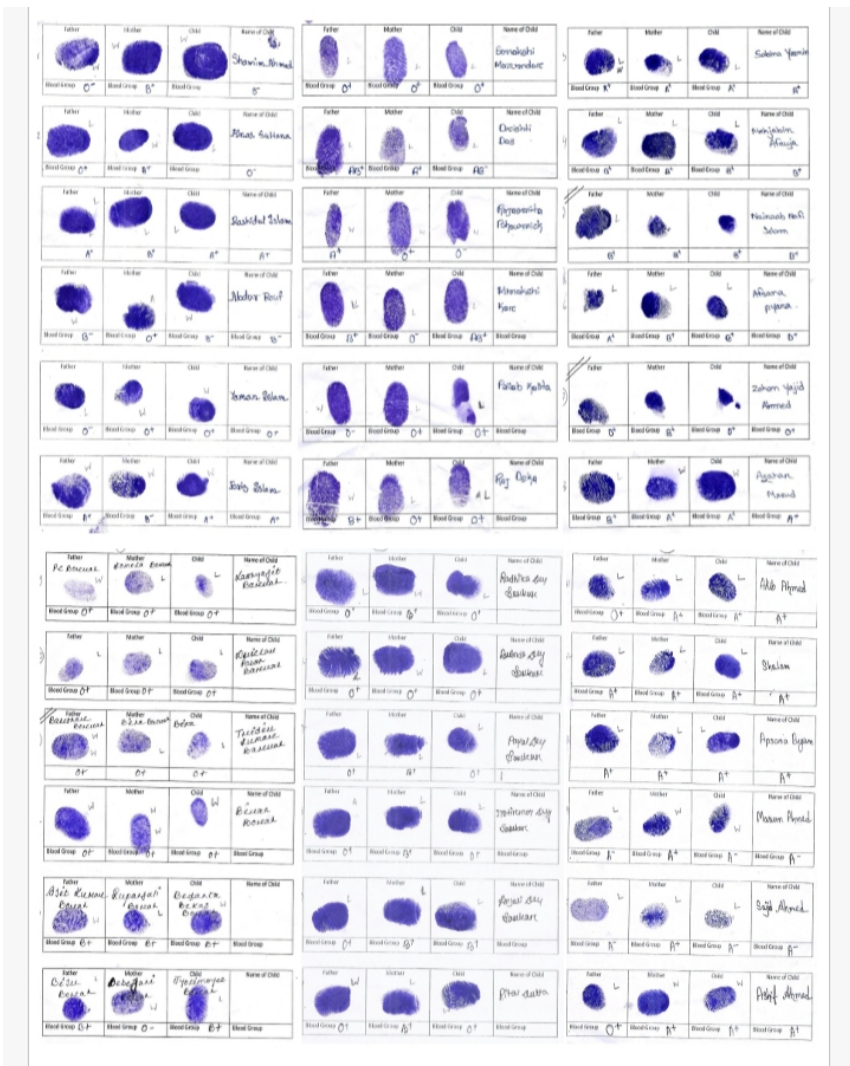


Fig 3. Resultant and Comparative images of the research work

Table 4. Distribution of Blood groups with respect to gender

Sex	A	B	AB	O	Total
Males	37	38	14	61	150
Females	36	46	9	59	150
Total	73	84	23	120	300

Highest numbers of loops were found in females (107) and highest numbers of whorls were found in males (54). Arches were found mostly in females (3) and least number of arches was found in Males (1). Out of the 100 families whose fingerprint samples were collected the inheritance of fingerprints from respective parents to the child was studied. The study revealed that the fingerprint patterns of 36% students are similar to their mother and 37.6% to their father. 25.7% students’ thumb impressions matched both the parents formulated in the table below. This indicated that 36% students inherited their mothers’ print patterns and 37.6% students inherited their print patterns from their father. The above data are summarized in the Table 5.

87 students out of 100 students have matching fingerprint as well as blood group with their parents. The distribution of loop pattern of fingerprint is the highest followed by whorls and arch at the least. (12,13) These results can be compared with the works of Shrestha and Kukadiya (2,5). Most of the people having O+ blood group has Loop pattern of fingerprint, that is loop print is prevalent in blood group O+ and is present in least numbers in blood group AB-. When compared, these results differed from

Table 5. Inheritance of Fingerprints

Sl.no	Inherited from	Frequency
1.	Mother to Daughter	34
2.	Mother to Son	42
3.	Father to Daughter	42
4.	Father to Son	32

the studies done by Singh and Kukadiya^(5,14).

Loop pattern prints were found most frequently in females and whorls were found most frequently in males. Females with a loop pattern finger print count 107 out of 300 (35.67%), followed by whorls 43 loops (14.33%) and an arch at the least counts 3 (1%). Whorls are found more predominantly in males counting 54 in number (18%). Males with loops as their print pattern are 92 (30.67%). Arches are highest in females (1%) and lowest in males (0.33%)⁽¹⁴⁾. This differs from the study conducted in Department of Forensic Medicine, S V Medical College, Tirupati⁽¹⁵⁾.

The study showed that the percentage of fingerprints inherited from mother to son and father to daughter is more in comparison to the inheritance of fingerprint pattern from mother to daughter and father to son. 28% of the fingerprint patterns from were inherited from mother to son and 28% from father to daughter and only 21.3% of the print patterns are inherited from mother to daughter and 22% from father to son. This study correlates with the findings of Professor T. Nataraja Moorthy⁽¹⁶⁾.

Dominance and recessive nature of fingerprint patterns when analyzed with blood groups, it was seen that Arches which is possibly a recessive trait is more prevalent in Blood Group O which is also the recessive blood type. And loops and whorls was more prevalent in blood types A and B which are co-dominant in nature. It was observed that arches (present in one of the parents) were not inherited by any children who participated in the survey. It was either loop or whorl that was observed to be expressed in the child. Thereby, it is quite possible that the arch pattern is a recessive trait. On the other hand, the dominance or recessive nature of whorls and loops could not be determined because, if any case of a family were to be considered, it was observed that if one parent had a whorl and the other a loop, their child inherited either of the two patterns without indicating the dominance of the patterns.

4 Conclusion

The present study shows that there may be an association between the inheritance of fingerprint patterns and blood groups. The maximum number of people in our study have blood group O, and the highest fingerprint pattern found among all the people is the Loop. Thus, this study maintains the universality of both blood group and fingerprint pattern. The most common pattern in people with blood type O is the loop. 87 out of 100 students have the same blood type and thumb impression as one of their parents. So we can conclude that there might be a possibility that there is an association between the inherited fingerprint and the blood group. There is a possibility of having a link between them. Fingerprints can also be used to identify gender. A link between them will be very helpful in the easy detection of diseases. Many manual attempts are being made to find out if there is an association between them. If there is any association, then it will provide great help to the anthropologist in identifying a person's common clinical diseases more easily than conventional pathological techniques. Identification of a person has no better method than the fingerprint pattern. Fingerprints have been in use since ancient times in forensic sciences and criminology. But this approach of associating fingerprints with blood type has immense significance in society. It will be of immense help to society in fighting genetically inherited as well as non-inherited diseases faster and with ease rather than having to go through long procedures of various tests and scans.

Novelty: Results from this study reveal that arch patterns might be of the recessive type, but the dominance or recessivity of loops and whorls could not be firmly determined. It can also be seen that there might be a possible association between the recessive traits of both the fingerprint patterns and blood group and the dominant traits.

Recommendation: An extensive study on dermatoglyphics using advanced tools and techniques should be carried out at a higher rate so as to collect a strong database on the common links of inheritance between fingerprints and blood groups. Future research in this field shall concern determining the dominance and recessivity of the fingerprint patterns.

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