

# Dermatoglyphics in the Hallucal Area of the Sole A Mother/Child Correlation

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## Introduction

Since the turn of the century the dermatoglyphics of the fingers and palms have been very thoroughly studied, and several investigations of both a systematic and a genetic character have been carried out (e. g. Holt, 1955, 1958, and Penrose, 1954). On the other hand, only a few articles — predominantly with a systematic emphasis — have been published on plantar dermatoglyphics.

As early as 1902 Wilder developed his sole formula, which subsequently formed the basis for his own later work (e. g. Wilder, 1916 and 1922) and for that of other investigators (e. g. Wichmann, 1956). Investigations of twins (Geipel, 1952) and of families (Lehmann, 1954) have also been conducted. In his material consisting of 40 monozygotic twin pairs, Geipel has shown that a homolateral similarity of pattern in the hallucal area existed in 80% against 42,4% for 19 dizygotic twin pairs and 6 sibling pairs; whereas Lehmann dealt with a family with multiple malformations of the extremities, where he showed the occurrence of dermatoglyphic hereditary transmission, but was unwilling to implicitly draw any definite conclusions. Studies of hallucal dermatoglyphics were undertaken also as aids in the diagnosis of mongolism (e. g. Smith, 1963) and of phenylketonuria (Hirsch, 1963).

A common feature of practically all these works is, that the dermatoglyphics in the hallucal area of the sole are divided into a certain number of main types of pattern (see fig. 1), but with a varying number of subgroups and side-groups.

Wichmann (1956) mentions only four main types: D, W, Tsl, and O; he regards the fibular loop as a special case of the distal loop. Walker (1957) also has these main types, but she considers the tibial arch as a special type of distal loop. S. A. Eriksson and R. Posener (1962) have developed a somewhat different systematics with whorl, loop, and open-field patterns as the main types, and with subgroups in accordance with fig. 1.

## Methodology

The systematics developed by the author in this article differs from those in previous works in this field, inasmuch as it is based on pattern direction instead of pattern type. This new classification is based on a hypothesis which was actually put for-

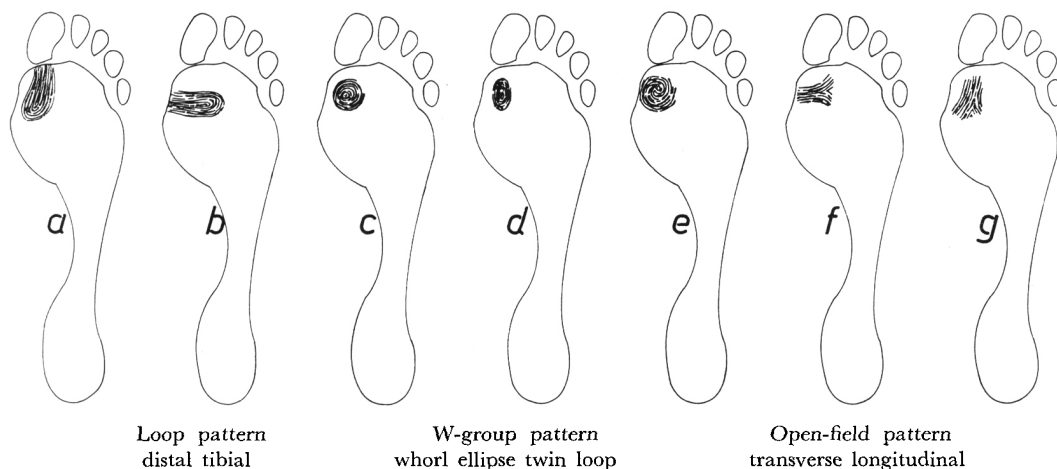


Fig 1. After S. Eriksson & R. Posener (1962)

ward by Wilder as early as 1904, namely, that the hallucal dermatoglyphics are developed from a primary pattern with three triradii to those with two or only one triradius. This idea has been remodeled and the systematics simplified so that the hallucal dermatoglyphics can be studied separately, without having to take into account the plantar dermatoglyphics. This is most desirable from an anthropological point of view because it affords not only a rapid method but, compared with Wilder's sole formula, also one which is much more convenient for determining the character of that part of the plantar dermatoglyphics which is most interesting anthropologically. This systematics is divided into the following four pattern directions:

1. *Whorl pattern* (W)

The primary pattern with three triradii which has a circular character. This pattern develops into types 2 and 3 (e. g. fig. 1, *c* and *e*).

2. *Longitudinal pattern* (I)

It opens out or "is in the process" of opening out (the upper triradius is extant, but the pattern is elliptic and has a distinct longitudinal character) through the upper triradius. Moreover, to this group are assigned patterns of an open-field type with a definite longitudinal character (e. g. fig. 1, *a*, *d* and *g*).

3. *Transverse pattern* (—)

It opens out or "is in the process" of opening out (elliptic pattern of transverse character) through the inner triradius. In this group are placed also patterns of

an open-field type with a definite transverse character. The very rare pattern with fibular loop formation is regarded as a special case belonging to this group (e. g. fig. 1, *b* and *f*).

#### 4. *Pure open-field pattern* (o)

Both the upper and the lower triradius are lacking. It is developed from patterns of type 2 and 3.

### Material

The material, which consists of plantar prints from 324 men, 219 women, and 247 children, was collected in connection with anthropological paternity investigations at the Government Institute for Forensic Medicine, Stockholm during the years 1958-61. Only such cases are examined anthropologically where the blood-group report does not afford any indication for determining paternity. That the material is selective on this account, from the standpoint of hallucal dermatoglyphics, must be regarded as extremely improbable. At the same time as paternity investigation is carried out a routine maternity investigation is also made. Since all cases which arise in Sweden are investigated by the Institute, the material is instead more likely to represent a normal Swedish population.

### Frequency determination

The discrepancy in some tables (tables 1 and 2) between the number of plantar prints for the right and for the left foot is due to the fact either that one foot was amputated or injured, or that the prints were illegible (the latter consideration applied only to children). As this refers only to a few cases, it does not affect the results of the investigation.

The distribution of the pattern directions for the analysed material is shown in tables 1 and 2.

Tab. 1

	Left	W	I	—	o	
Men	n	108	160	45	10	323
	%	33.4	49.6	13.9	3.1	100.0
Women	n	69	109	25	13	216
	%	31.9	50.5	11.6	6.0	100.0
Boys	n	51	72	20	3	146
	%	34.9	49.3	13.7	2.1	100.0
Girls	n	22	56	22	1	101
	%	21.8	55.4	21.8	1.0	100.0
Total	n	250	397	112	27	786

Tab. 2

	Right	W	I	—	o	
Men	n	91	176	41	16	324
	%	28.1	54.3	12.7	4.9	100.0
Women	n	52	126	25	16	219
	%	23.7	57.6	11.4	7.3	100.0
Boys	n	43	83	16	4	146
	%	29.5	56.8	11.0	2.7	100.0
Girls	n	18	58	19	6	101
	%	17.8	57.5	18.8	5.9	100.0
Total	n	204	443	101	42	790
	%	25.8	56.1	12.8	5.3	100.0

On comparing the distribution of patterns between the right and the left foot for the entire material analyzed, the right foot is found to have a 6% lower frequency in the W-group pattern and a 5.5% higher frequency in the longitudinal pattern than the left foot. For the two remaining pattern types — the transverse and the open-field — the difference is considerably less (not exceeding 2%). However, these variations in the pattern distribution between the two feet are not significant. The calculation of significance gives the following confidence interval for:

right foot: W 21.1-30.5%; I 50.8-61.4%;  
left foot: W 26.8-36.8%; I 45.3-55.9%;

In connection with this, another aspect appears — namely, whether or not the hallucal dermatoglyphics occur independently of each other on both feet.

The correlations were calculated in tetrachoric tables with:

- a) remaining pattern types / W-pattern gave  $r = 0.52 \pm 0.03$
- b) remaining pattern types / I-pattern gave  $r = 0.66 \pm 0.02$
- c) remaining pattern types / --pattern gave  $r = 0.65 \pm 0.02$
- d) remaining pattern types / O-pattern gave  $r = 0.55 \pm 0.02$

The results show a high correlation between the pattern types of the right and the left foot. With regard to what has been previously stated concerning the development of the different pattern directions, with the whorl pattern as the most primitive type, it is interesting to note that this correlation is somewhat more evident in the longitudinal and transverse patterns than in the whorl and open-field patterns. If this working hypothesis is correct, then this relationship is precisely what could be expected, viz. that the linkage of the pattern direction between the two feet would be strongest for the two "intermediate groups", the longitudinal and the transverse patterns, each representing different lines of development.

In view of the fact that pattern distribution is the same for the right and the left foot, it is possible to combine the values for both feet. At the same time the respective values for men and boys and for women and girls have been grouped together, since the respective pairs did not show any significant difference in pattern distribution. The results are presented in tab. 3.

Tab. 3

		W	I	—	o	
Male	n	293	491	122	33	939
	%	31.2	52.3	13.0	3.5	100.0
Female	n	161	349	91	36	637
	%	25.3	54.7	14.3	5.7	100.0
Total	n	454	840	213	69	1576
	%	28.8	53.3	13.5	4.4	100.0

The table shows that the pattern distribution for the two sexes is similar. In respect of the W-pattern, however, there is a difference in frequency of 5.9% between the sexes. The calculation of significance, however, resulted in the following confidence intervals:

men: 26.7-35.7%;  
women: 20.1-30.5%;

This shows that there is no sex linkage.

Consequently the following conclusions can be drawn from the analyses:

1. Pattern distribution is the same for both the right and the left foot.
2. A definite correlation exists between the pattern in the right and the left foot of the same person.
3. There is no sex difference in pattern distribution.

#### *Calculation of correlations*

The material which consisted of women and children was subjected to  $\chi^2$ -analysis in order to ascertain whether there was any correlation between mothers and children, and, if this was the case, to determine its value and possible significance. With this purpose in view tab. 4 was compiled.

In those cases where a mother had more than one child to be investigated, these were also included in the tabulation. Hence 23 mothers with two or more children recur twice in the calculations, but since the pattern distribution of these mothers did not differ significantly from that of the other mothers, this does not affect the

results. The calculations, which were carried out in tetrachoric tables, gave the following results:

1. I/—  $\chi^2 = 49.0$  ( $r = 0.47 \pm 0.05$ )
2. I/W  $\chi^2 = 12.3$  ( $r = 0.19 \pm 0.03$ )
3. —/W  $\chi^2 = 6.3$  ( $r = 0.23 \pm 0.04$ )

As is apparent, on contrasting the longitudinal patterns with the transverse patterns a very high correlation is obtained on the 99.9% level. The longitudinal patterns contrasted with the W-patterns also gave a value significant on the 99.9% level,

Tab. 4

Children	Mother			
	I	W	—	o
I	170	76	13	10
W	53	54	15	12
—	21	27	21	8
o	6	1	2	5

whereas the W-patterns set against the transverse patterns are significant on the 98% level. Consequently, these calculations indicate a high mother/child correlation. That this is so marked, especially with regard to the longitudinal/transverse pattern is, as was stated previously regarding the correlation between the right/left foot, entirely in agreement with what can be expected in view of the working hypothesis advances.

### Summary

The author has systematized the hallucal dermatoglyphics in accordance with the pattern direction in whorl, longitudinal, transverse, and open-field patterns. Neither sex difference nor any difference between the right/left foot could be demonstrated. A correlation with  $\chi^2$ -distribution mother/child gave for:

1. longitudinal/transverse pattern  $\chi^2 = 49.0$ ;
2. longitudinal/whorl pattern  $\chi^2 = 12.3$ ;
3. transverse/whorl pattern  $\chi^2 = 6.3$ .

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#### RIASSUNTO

Vengono sistematizzati i dermatoglifi della zona dell'alluce, secondo la direzione dei vortici e dei tratti longitudinali, trasversi e a campo aperto. Non si è potuta dimostrare alcuna differenza fra i sessi, né fra il piede sinistro ed il destro. Una correlazione fra madre e figlio con distribuzione mediante  $\chi^2$  ha dato i seguenti risultati:

1. Longitudinale/trasverso,  $\chi^2=49,0$ ;
2. Longitudinale/vortice,  $\chi^2=12,3$ ;
3. Trasverso/vortice,  $\chi^2=6,3$ .

#### RÉSUMÉ

L'Auteur systématise les dermatoglyphes de la région de l'hallux d'après la direction des tourbillons et des traits longitudinaux, transverses et « open-field ». Il n'a été possible de démontrer une différence ni entre les sexes ni entre le pied droit et le gauche. Une corrélation entre mère et fils moyennant une distribution par le  $\chi^2$ , a donné les résultats suivants:

1. Longitudinal/transverse,  $\chi^2=49,0$ ;
2. Longitudinal/tourbillon,  $\chi^2=12,3$ ;
3. Transverse/tourbillon,  $\chi^2=6,3$ .

#### ZUSAMMENFASSUNG

Der Verf. teilt die Hautleisten der Grosszehengegend nach Richtung der Wirbel und der Längs—, Quer— sowie « openfield » — Leisten ein. Es konnte dabei kein Unterschied zwischen den Geschlechtern, noch zwischen rechtem und linkem Fuss gefunden werden. Eine Korrelation

zwischen Mutter und Sohn mit Distribution mittels  $\chi^2$  ergab folgende Resultate:

1. Längs/Querleiste,  $\chi^2=49,0$ ;
2. Längsleiste/Wirbel,  $\chi^2=12,3$ ;
3. Querleiste/Wirbel,  $\chi^2=6,3$ .