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Research Article

Dermatoglyphics of Children Diagnosed with Inguino-Genital Swelling Compared with their Biological Parents

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ABSTRACT

Inguino-genital swelling that are non-inflammatory may be hernias or hydroceles and are inheritable. This study was aimed at investigating dermatoglyphics as non-invasive screening tool for inguino-genital predisposition within families. Fingerprints of 27 affected children (AC) [25 males, 2 females], 34 parents of affected children [8 fathers, 28 mothers], 32 non-affected children (NAC) [22 males, 10 females], and 36 parents of non-affected children [6 fathers, 30 mothers] were obtained from the University College Hospital and Adeoyo Specialist Hospital, Ibadan, Nigeria. Data were analysed with Automated Fingerprint Identification System and STATA software ($P \leq 0.05$). In AC and their mothers and NAC and their mothers, arch was statistically significant in the right fingers (RF). In AC and their fathers and NAC and their fathers, the ulnar loop was statistically significant in RF. Absolute finger ridge count was significant in RF of AC and their fathers and NAC and their fathers. In minutiae, the bifurcation and double bifurcation were statistically significant in the left fingers (LF) of AC and NAC. In AC and their mothers and NAC and their mothers, opposed bifurcation was statistically significant in LF. In AC and their fathers and NAC and their fathers, double bifurcation, bridge, dot, and break were statistically significant in LF, lake was significant in both RF and LF. There were weak positive and negative correlations in the patterns and minutiae distributions between AC and their parents. This study may be used as a marker alongside other genetic markers to identify predisposition to inguino-genital swellings of non-inflammatory, hereditary origin.

Keywords: *Fingerprints, Patterns, Minutiae, Inguino-genital swellings, Inheritance.*

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INTRODUCTION

Inguino-genital swelling of hernia/hydrocele is prevalent in children and are incredibly common surgical problem (Javaid *et al*., 2018; Prasanna *et al*., 2023). Connective tissue diseases play significant role in the development of hernias. Presence of same type of hernia in family member indicates collagen synthesis disease (Prasanna *et al*., 2023; Somuncu & Somuncu, 2021; Castori et aI., 2015). Family history of hernia have greater risk of hernia development (Öberg *et al*., 2023; Burcharth *et al*., 2017) compared to the normal population. Dermatoglyphic studies as a non-invasive screening tool for hernia/hydrocele inheritance may increase its suspicion, early detection, and prompt intervention of the condition.

This study aimed to investigate relationship between dermatoglyphic characteristics and clinically diagnosed children with hernia/hydrocele compared with their biological parents.

MATERIALS AND METHODS

This study used a convenience sampling method. Informed consent and assent forms were signed by the participants before their fingerprints were obtained. The fingerprints of 129 individuals comprising 27 affected children (25 males and 2 females), 34 parents of affected children (8 fathers and 28 mothers), 32 non-affected children (22 males and 10 females), and 36 parents of non-affected children (6 fathers and 30 mothers) were obtained from tertiary hospitals. Fingerprints were taken with a Dermalog LF10 fingerprint scanner, Hamburg, Germany. Before taking prints, participants' fingers were carefully cleaned using a sterilized tissue. A small amount of pressure was applied to the fingers on the scanner to ensure appropriate contact between the fingers and the scanner.

The whorl, loops, arch, Absolute Finger Ridge Count (AFRC), and Total Finger Ridge Count (TFRC) were analyzed. Bifurcation, short ridge, spur, ridge ending, bridge, lake, double bifurcation, brake, dot, ridge crossing, and opposed bifurcation were level 2 details (minutiae) analyzed. The right and left thumbprints were taken separately from the remaining fingerprints to ensure proper capturing and each print was labeled appropriately for accurate analysis. With the aid of Automated Fingerprint Identification System (AFIS) software (FBI, 1991), level 2 details were identified and analyzed.

The data was analyzed with Statistical Analysis (STATA) software. T-test was used to compare the means of the variables, $P<0.05$ was considered significant. The classification of the fingerprint patterns was according to (Nature and 1963, n.d.) (Penrose 1968) and Cummins and Midlo (Cummins and Midlo 1961).

The required data were collected based on ethical guidelines relating to the use of human subjects under the reference number UI/EC/22/0265. The ethical approval was obtained from the University/hospital Ethical Review Committee.

RESULTS

The level 1 (Fig. 1) and level 2 (Fig. 2) of 129 individuals (27 affected children, 34 parents of affected children, 32 non-affected children, and 36 parents of non-affected children) were analysed in this study. These constitute the 1290 digital fingerprints used for this study.

The most and least predominant pattern types in both affected and non-affected children were the ulnar and radial loops respectively. In the affected children, the mean values of ulnar loop, whorl, arch, and radial loop were 2.28, 1.31, 0.93, and 0.19 respectively. However, in the non-affected children, the mean values of ulnar loop, whorl, arch, and radial loop were 2.61, 1.31, 0.61, and 0.11 respectively (Table 1).

Tables 2, 3, and 4 showed the mean distribution of the pattern types in each finger (digits I-V). In the affected children, the radial loop was found in digits I and II while it was present only in the digit II of non-affected children (Table 2).

Figure 1:
The three basic fingerprint patterns (A) Whorl (B) Loop (C) Arch

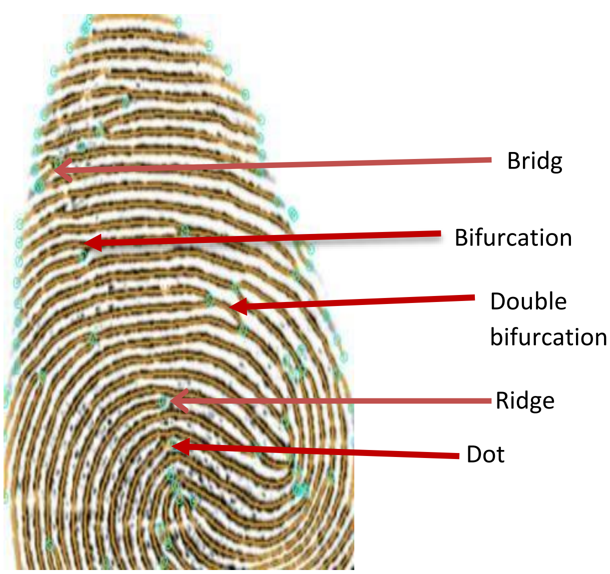

Fig. 2:
Level 2 details (minutiae characteristics)

Table 1:
The frequency of the pattern types in affected and non-affected children

	Affected children	Non-Affected children
Pattern type	Mean±SD	Mean±SD
A	0.93±0.19	0.61±0.14
RL	0.19±0.08	0.11±0.04
UL	2.28±0.22	2.61±0.22
W	1.31±0.21	1.31±0.17

*A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl
+P<0.05

Table 2:
The mean distribution of fingerprint patterns in fingers I-V of affected and non-affected children

	AFFECTED					NON-AFFECTED				
	Children					Children				
Pattern type	I	11	111	1V	V	I	11	111	1V	V
A	11.11	14.81	18.52	11.11	18.52	18.75	9.38	12.5	3.13	0
RL	3.7	7.41	0	0	0	0	9.38	0	0	0
UL	40.74	37.04	62.96	40.74	55.56	28.13	40.63	68.75	46.88	78.13
W	37.04	37.04	14.81	40.74	18.52	40.63	31.25	12.5	43.75	9.38

*A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl

Table 3:
The mean distribution of fingerprint patterns in fingers 1-V of the mothers of affected and non-affected children

	Affected Mothers					Non-Affected Mothers				
Pattern type (%)	I	11	111	1V	V	I	11	111	1V	V
A	3.7	3.7	3.7	3.7	0	3.13	3.13	6.25	3.13	0
RL	0	3.7	0	0	0	0	0	0	0	0
UL	3.7	11.11	14.81	14.81	25.93	0	3.13	12.5	6.25	12.5
W	22.22	11.11	11.11	11.11	3.7	15.63	12.5	0	9.38	6.25

**A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl*

Table 4:
The mean distribution of fingerprint patterns in fingers 1-V of the fathers of affected and non-affected children

	Affected Fathers					Non-Affected Fathers				
Pattern type (%)	I	11	111	1V	V	I	11	111	1V	V
A	14.81	7.41	0	0	3.7	6.25	6.25	6.25	3.13	0
RL	3.7	7.41	0	3.7	3.7	6.25	12.5	0	3.13	0
UL	40.74	66.67	81.48	59.26	77.78	40.63	46.88	68.75	53.13	81.25
W	37.04	14.81	14.81	33.33	11.11	37.5	28.13	18.75	34.38	12.5

*A- Arch, RL-Radial loop, UL- Ulnar loop, W- Whorl

Table 5:
Comparison of pattern types between affected children and their mothers with non-affected children and their mothers

		AFFECTED			NON-AFFECTED		
		CHILDREN	MOTHER		CHILDREN	MOTHER	
Pattern type		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
A	R	0.74±0.23	0.15±0.3	**0.035	0.44±0.15	0.16±0.11	0.134
	L	1.11±0.15	-	**<0.001	0.78±0.24	0.16±0.11	**0.023
RL	R	0.11±0.06	0.04±0.04	0.308	0.09±0.05	-	0.078
	L	0.26±0.16	0.04±0.04	0.173	0.13	0.06	0.399
UL	R	2.37±0.3	0.7±0.27	**<0.001	2.63±0.29	0.34±0.14	**<0.001
	L	2.19±0.31	0.81±0.3	**0.003	2.59±0.32	0.31±0.13	**<0.001
W	R	1.48±0.32	0.59±0.25	**0.031	1.38±0.23	0.44±0.2	**0.003
	L	1.15±0.29	0.59±0.26	0.155	1.25±0.25	0.41±0.2	**0.011

*A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl +P<0.05

In the mothers of affected children, the radial loop was absent in all fingers except the second digit while there was no record of this pattern in the mothers of non-affected children. Ulnar loop and whorl were also absent in the thumb and digit III of the mothers of non-affected children respectively (Table 3). The arch pattern was absent in digits III and IV of the fathers of affected children while the radial loop was absent in the digit III of the fathers of both affected and non-affected children (Table 4).

When the fingerprints of affected children and their mothers were compared, the arch and ulnar loop on the right and left fingers were statistically significant. However, the whorl was only significant on the right fingers (Table 5). Meanwhile, when the fingerprints of non-affected children and their mothers were compared, the arch showed significant difference on the left fingers while the ulnar loop and whorl were significant on both the right and left fingers (Table 5).

The arch showed significant difference on the left fingers while the ulnar loop showed significant difference on the right fingers when the fingerprints of the affected children and their fathers were compared. The arch was only significant on the left fingers when the fingerprints of the non-affected children and their fathers were compared (Table 6).

Table 6:
Comparison between affected children and their fathers with non-affected children and their fathers

		AFFECTED			NON-AFFECTED		
		Children	**Father**		**Children**	**Father**	
Pattern type		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
A	R	0.74±0.23	0.26±0.13	0.072	0.44±0.15	0.22±.0.11	0.237
	L	1.11±0.3	0.37±0.11	**0.026	0.78±0.24	0.19±0.08	**0.025
RL	R	0.11±0.06	0.19±0.12	0.585	0.09±0.05	0.22±0.09	0.222
	L	0.26±0.16	0.11±0.08	0.045	0.13±0.06	0.25±0.09	0.25
UL	R	2.37±0.3	3.26±0.26	**0.032	2.63±0.29	2.91±0.3	0.505
	L	2.19±0.31	2.44±0.32	0.562	2.59±0.32	2.91±0.31	0.483
W	R	1.48±0.32	1.11±0.24	0.357	1.38±0.23	1.31±0.29	0.867
	L	1.15±0.29	1.33±0.27	0.638	1.25±0.25	1.34±0.3	0.812

*A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl +P<0.05

Table 7:
Comparison of the AFRC and TFRC in affected children and their mothers with non-affected children and their mothers

		AFFECTED			NON-AFFECTED		
		Children	**Mothers**		**Children**	**Mothers**	
		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
		44.9±4.8			43.7±3.8		
AFRC	R		16.7±5.9	**0.001		9.9±4.1	**<0.001
	L	46.3±5.2	23.2±7	**0.011	47.2±4	10.9±4.4	**<0.001
TFRC		88.4±10.1	39.9±12.8	**0.005	92.1±7.8	20.8±8.5	**<0.001

*AFRC- Absolute Finger Ridge Count, TFRC- Total Finger Ridge Count +P<0.05

Table 8:
Comparison of the AFRC and TFRC in affected children and their fathers with non-affected children and their fathers

		AFFECTED			NON-AFFECTED		
		Children	**Fathers**		**Children**	**Fathers**	
		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
		44.9±4.8			43.7±3.8		
AFRC	R		60.1±4.6	**0.025		52.3±3.8	0.116
	L	46.3±5.2	52.9±5.1	0.372	47.2±4	57.2±3.7	0.072
TFRC		88.4±10.1	111.2±8.9	0.096	92.1±7.8	109.2±7.8	0.126

**AFRC- Absolute Finger Ridge Count, TFRC- Total Finger Ridge Count*
+P<0.05

Table 9:
Correlation of the pattern types between affected children and their mothers

	Children			
Mothers	**A**	**RL**	**UL**	**W**
A	-0.075	-0.062	0.215	-0.134
RL	-0.006	-0.057	-0.08	-0.138
UL	0.037	0.205	-0.047	-0.131
W	-0.003	0.067	-0.158	0.149

*A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl +P<0.05

Table 10:
Correlation of the pattern types between affected children and their fathers

Pattern	A_child	RL_child	UL_child	W_child
A_father	0.110	0.021	0.047	-0.251
RL_father	-0.005	0.024	-0.066	0.113
UL_father	0.031	0.044	0.017	-0.096
W_father	0.023	0.015	-0.086	0.112

**A- Arch, RL- Radial loop, UL- Ulnar loop, W- Whorl*
+P<0.05

When the AFRC and TFRC were compared in affected children and their mothers and between non-affected children and their mothers, they were significant on the right and left fingers (p<0.05). Both parameters did not distinguish the affected and non-affected groups (Table 7).

The AFRC was significant only on the right fingers when the fingerprints of the affected children and their fathers were compared (Table 8).

The fingerprint pattern correlation between the affected children and their parents did not reveal strong positive and negative correlations (Tables 9 and 10). In the comparison of the minutiae between the affected and non-affected children, the bifurcation and double bifurcation were significant on the left fingers (p<0.05) while the opposed bifurcation was significant on both right and left fingers (Table 11).

In the comparison between the affected children and their mothers, all minutiae except the opposed bifurcation and dot on the right fingers were statistically significant while the lake was not statistically significant on both right and left fingers (Table 12). All the minutiae except the opposed bifurcation on the left fingers were significant in the comparison between the non-affected children and their mothers (Table 12).

Table 11:
Comparison of minutiae distribution in affected and non-affected children

		AFFECTED CHILDREN	NON-AFFECTED CHILDREN	
Minutiae		Mean±SD	Mean±SD	p-value
R End	R	10±0.9	11.3±0.9	0.337
	L	11.7±1.1	14±1.2	0.168
Bif	R	22.1±1.9	19±1.2	0.153
	L	23.6±1.7	19±1.2	**0.023
D Bif	R	4.96±0.7	5.63±0.5	0.448
	L	6.33±0.7	4.28±0.3	**0.003
Bridge	R	8.74±1.2	7.97±1	0.616
	L	11.1±1.2	8.47±1	0.102
OppBif	R	1.19±0.2	2.88±0.4	**0.002
	L	1±0.2	1.84±0.2	**0.026
RCross	R	2.63±0.6	4.19±0.7	0.09
	L	2.7±0.6	2.75±0.4	0.994
Shrt R	R	6.26±0.9	5.38±0.7	0.419
	L	7.56±0.8	8.59±1.1	0.466
Spur	R	7.11±0.8	5.44±0.9	0.166
	L	8.22±0.9	6.31±0.69	0.087
Dot	R	3.07±0.7	3.63±0.6	0.526
	L	4.44±0.6	4±0.6	0.631
Lake	R	7.41±0.9	6.84±1	0.672
	L	9.63±1	7.94±1	0.229
Break	R	5.44±0.8	3.94±0.5	0.12
	L	5.81±0.8	5.25±0.6	0.562

*R End: ridge ending, Bif: bifurcation, D Bif: double bifurcation, Opp Bif: opposed bifurcation, +R Cross: ridge crossing, Shrt R: short ridge, P<0.05

When the minutiae of the affected children and their fathers were compared, only the bridge, ridge crossing, lake, and break were statistically significant on both the right and left fingers while the opposed bifurcation was only significant on the right fingers (Table 13). In the comparison between the non-affected children and their fathers, only the ridge crossing was significant on both right and left fingers while the double bifurcation, bridge, opposed bifurcation, short ridge, spur, and break were significant on the right fingers only (Table 13).

There were weak positive and negative correlations between the affected children and their parents in the minutiae (Table 14).

DISCUSSION

In this study, the most prevalent pattern type in both hands of affected and non-affected children including their parents was the ulnar loop. The predominance of ulnar loop has been reported in previous studies by other researchers (Ofori *et al*., 2021; Jaiyeoba-Ojigho *et al*., 2019; Shrestha & Malla, 2019). There was increase in the arch pattern found on the right fingers of the affected children compared to their mothers, also low incidence of ulnar loop in the affected children compared to their fathers, and the higher AFRCs on the right fingers of the fathers compared to the affected children. These findings may be indication that the offspring of the affected parents may have proclivity to inguino-genital swelling of hernia/hydrocele.

The weak positive and negative correlations observed in the pattern distribution between the affected children and their parents may not be of heritability importance.

Table 12:
Comparison of minutiae distribution in affected children and their mothers including non-affected children and their mothers

		AFFECTED			NON-AFFECTED		
		CHILDREN	MOTHERS		CHILDREN	MOTHERS	
Minutiae		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
R End	R	9.96±0.9	4±1.8	**0.006	11.25±0.9	2.16±0.8	**<0.001
	L	11.67±1.1	4.7±1.7	**0.001	14±1.2	3.81±1.5	**<0.001
Bif	R	22.07±1.9	7.22±2.3	**<0.001	19±12	5.13±1.9	**<0.001
	L	23.63±1.7	7.63±2.4	**<0.001	19±1.2	4.63±1.7	**<0.001
D Bif	R	4.96±0.7	1.15±0.4	**<0.001	5.63±0.5	1.69±0.7	**<0.001
	L	6.33±0.7	1.81±0.6	**<0.001	4.28±0.3	2.03±0.8	**0.008
Bridge	R	8.74±1.2	1.41±0.5	**<0.001	7.97±1	1.38±0.6	**<0.001
	L	11.11±1.2	2±0.7	**<0.001	8.47±1	0.44±0.3	**<0.001
Opp Bif	R	1.19±0.2	0.52±0.5	0.202	2.88±0.4	0.25±0.1	**<0.001
	L	1±0.2	0.15±0.1	**0.004	1.84±0.3	1.09±0.5	0.168
R Cross	R	2.63±0.6	0.37±0.4	**0.001	4.19±0.7	0.09±0.1	**<0.001
	L	2.7±0.6	0.3±0.2	**<0.001	2.75±0.4	0.47±0.2	**<0.001
Shrt R	R	6.26±0.9	1.85±0.7	**<0.001	5.38±0.7	1.81±0.7	**0.001
	L	7.56±0.8	1.59±0.6	**<0.001	8.59±1.1	1.06±0.4	**<0.001
Spur	R	7.11±0.8	2.81±1.2	**0.005	5.44±0.9	1.72±0.7	**0.001
	L	8.22±0.9	2.33±0.8	**<0.001	6.31±0.7	1.91±0.7	**<0.001
Dot	R	3.07±0.7	1.7±0.8	0.177	3.63±0.6	0.22±0.1	**<0.001
	L	4.44±0.6	1±0.6	**<0.001	4±0.6	1.47±0.6	**0.006
Lake	R	7.41±0.9	5.04±2.4	0.359	6.84±1	2.06±0.8	**<0.001
	L	9.63±1	5.74±2.9	0.204	7.94±1	2.72±1.1	**0.001
Break	R	5.44±0.8	0.63±0.4	**<0.001	3.94±0.5	1.16±0.5	**<0.001
	L	5.81±0.8	0.74±0.5	**<0.001	5.25±0.6	1.28±0.5	**<0.001

*R End: ridge ending, Bif: bifurcation, D Bif: double bifurcation, Opp Bif: opposed bifurcation, +R Cross: ridge crossing, Shrt R: short ridge, P<0.05

Table 14:
The correlation of the minutiae distribution between affected children and their parents

R End		**Shrt R**	
Mother	-0.087	Mother	0.016
Father	0.099	Father	0.101
Bif		**Spur**	
Mother	0.136	Mother	-0.001
Father	0.158	Father	0.002
D Bif		**Dot**	
Mother	-0.075	Mother	-0.032
Father	0.076	Father	0.07
Bridge		**Lake**	
Mother	-0.155	Mother	-0.002
Father	0.119	Father	0.053
Opp Bif		**Break**	
Mother	-0.017	Mother	0.048
Father	0.039	Father	0.06
R Cross			
Mother	-0.067		
Father	-0.003		

**R End: ridge ending, Bif: bifurcation, D Bif: double bifurcation, Opp Bif: opposed bifurcation,*
+R Cross: ridge crossing, Shrt R: short ridge

Table 13:
Comparison of minutiae distribution in affected children and their fathers including non-affected children and their fathers

		AFFECTED			NON-AFFECTED		
		CHILDREN	FATHERS		CHILDREN	FATHERS	
Minutiale		Mean±SD	Mean±SD	P-value	Mean±SD	Mean±SD	P-value
R End	R	9.96±0.9	13.19±1.7	0.103	11.25±0.9	13.34±1.3	0.189
	L	11.67±1.1	12.33±1.7	0.744	14±1.2	15.44±1.7	0.494
Bif	R	22.07±1.9	21±1.5	0.656	19±1.16	20.94±1.7	0.341
	L	23.63±1.7	22.63±2.2	0.718	19±1.2	19.09±1.1	0.954
D Bif	R	4.96±0.7	4.85±0.6	0.451	5.63±0.5	3.19±0.4	**0.001
	L	6.33±0.7	4.41±0.6	**0.03	4.28±0.3	4.34±0.4	0.898
Bridge	R	8.74±1.2	3.93±0.6	**0.001	7.97±1	3.66±0.8	**0.001
	L	11.11±1.2	6.33±1	**0.005	8.47±1	7.44±0.7	0.401
Opp Bif	R	1.19±0.2	0.33±0.1	**<0.001	2.88±0.4	1.69±0.2	**0.022
	L	1±0.2	0.81±0.3	0.603	1.84±0.3	2.47±0.5	0.279
R Cross	R	2.63±0.6	0.56±0.2	**0.001	4.19±0.7	0.38±0.1	**<0.001
	L	2.7±0.6	0.7±0.3	**0.03	2.75±0.4	0.31±0.1	**<0.001
Shrt R	R	6.26±0.9	7.07±1.3	0.598	5.38±0.7	11.78±1.5	**<0.001
	L	7.56±0.8	5.11±0.9	0.052	8.59±1.1	9.66±0.9	0.454
Spur	R	7.11±0.8	8.67±1.5	0.358	5.44±0.9	7.97±0.7	**0.027
	L	8.22±0.9	10.15±1.4	0.248	6.31±0.7	5.63±0.8	0.516
Dot	R	3.07±0.7	2.7±0.6	0.683	3.63±0.6	3.72±0.6	0.911
	L	4.44±0.6	1.81±0.4	**0.001	4±0.6	3.13±0.7	0.362
Lake	R	7.41±0.9	18.78±4.01	**0.008	6.84±1	10±2	0.158
	L	9.63±1	18.59±2.9	**0.005	7.94±1	10.59±1.9	0.217
Break	R	5.44±0.8	2.41±0.6	**0.004	3.94±0.5	2.5±0.4	**0.026
	L	5.81±0.8	2.56±0.5	**0.001	5.25±0.6	4.19±0.5	0.168

*R End: ridge ending, Bif: bifurcation, D Bif: double bifurcation, Opp Bif: opposed bifurcation,
+R Cross: ridge crossing, Shrt R: short ridge, P<0.05

Bifurcation and double bifurcation were distinguishing minutiae between affected children and non-affected children. The opposed bifurcation on the left fingers was significantly higher in the affected children population compared to their mothers. The high incidence of the minutiae may be a marker for predisposition to inguino-genital swelling. In the population of the children and their fathers, this study showed that the double bifurcation, bridge, dot, and break on the left fingers of the children were pointers to the risk of developing inguino-genital swelling in the offspring. Furthermore, the lakes on both hands of the affected fathers were higher than the children.

The weak positive and negative correlations observed in the minutiae distribution between the affected children and their parents may not be of inguino-genital swelling inheritance importance.

In conclusion, this study may be used as a marker alongside other genetic markers to identify predisposition to inguino-genital swelling of hernia/hydrocele.

Limitation of the study

There was low sample size because most of the fathers recruited for this study were not cooperative in making themselves available for the capturing of their fingerprints, also low turnout of patients in the hospital.

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