Dermatoglyphics of mothers of Malawian children with spina bifida cystica: A comparative study with female controls

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Summary

Dermatoglyphic traits are formed under genetic control early in development and do not change thereafter, thus maintaining stability not affected by age.

Methodology: **We determined the dermatoglyphic traits of mothers of children with spina bifida cystica and compared then with controls matched for number, age and parity, by counting and classifying palmar, plantar and digital ridge pattern configurations of arches, loops, whorls and ridges based on standard techniques.**

Results: **Palmar pattern types, showed absence of arches, significantly higher frequency of whorls ($P > 0.05$), lower total finger ridge count (TFRC) and higher Pattern Intensity Index (PII) in these mothers than in the controls ($P > 0.001$).**

However, no significant differences were observed between both groups in atd angle and a-b ridge count ($P = 1.30$, 0.70 respectively). Plantar pattern types showed loops restricted to the first two digits and absence of arches in the first digit in these mothers compared to controls in whom there were loops in the first four digits and a 100% frequency of arches. Similarly, PII was higher and Dankmeijer's Index (DI) lower in these mothers than in controls.

Conclusion: **Our findings demonstrate dermatoglyphic differences between both groups that suggest that mothers presenting with these traits are more predisposed to giving birth to children with spina bifida cystica.**

Keywords: ***Dermatoglyphic traits, Mothers, Children, Spina bifida, Controls.***

Résumé

Des traits dermatoglyphiques sont formés sous le contrôle génétique très tôt au cours du dévéloppement et ne change pas après, ainsi, de cette manière, gardant la stabilité qui ne touche pas l'âge.

Méthodologie: Nous avons décidé les traits dermatoglyphiques des mères avec des enfants atteints de spina-bifida cystique et on les avait comparé avec des controles correspondant au nombre, âge, et parité tout en comptant et classification palmarn, tendance crête digitale et plantaire configurations des voutes, boucles, verticile et crêtes fondés sur techniques standards.

Résultats: La tendance des types palmar a montré l'absence des crêtes, la fréquence remarquablement élevée des verticilles ($P > 0,05$) le compte total de doigt de la crete inférieure (CTDC) et la Tendance d'index d'Intensite plus élevée (TII) chez ces mères plus que chez des contrôles ($P > 0,001$). Toutefois, on n'a pas noté aucun écart important entre les deux groupes dans l'angle atd et le compte de la crête a - b ($P = 1,30$, 0, 70 respectivment). Les types de la tendance Plantar avait indiqué des boucles limités à deux prémier chiffres chez ces mères par rapport aux contrôles chez lesquels il y avait des boucles dans les premiers quatre chiffres et un 100% fréquence des voutes. De même, PII était plus élevé et l'Index de dankmeijer (DI) inférieur chez ces mères plus que chez les contrôles.

Conclusion: On est arrive à la conclusion qu'il y a des écarts dermatoglyphiques entre les deux groupes ce qui semmblerait indiquer que des mères atteintes de ces traits sont plus prédisposées à donner naissance aux enfants atteints de spina-bifida cystique.

Introduction

Dermatoglyphic traits are formed at the end of the embryonic period under genetic control and do not change thereafter, thus remaining stable from an early stage of development.[1] This developmental programme can be destabilized by intercurrent physiological stress, resulting in developmental instability with some individuals having genotypes that are intrinsically more resistant to such destabilization than others.[2-4] For example, it has been shown that congenital vertebral anomalies may result from destabilization of early genetic developmental control. The spinal cord develops from neuroectoderm sequentially along the craniocaudal axis in a precise order that not only gives species-specific dating but permits comparison among embryos of widely differing species.[5] Consequently, anomalies of the vertebrae arise from the disturbance of either this initial somitogenesis or subsequent resegmentation in which final vertebral bodies are formed from the caudal half of one somite and the cranial half of the next.[6] The outcome of natural history in an individual case depends on the intrinsic stability of the genetic programme and the magnitude of the stresses to which the embryo is subjected. Severe stress will destabilize even the best genome; an unstable individual may be destabilized by perhaps normal stress.[1] Furthermore, many if not all, individuals require a further specific insult for developmental destabilization that is suggested by the high frequency of ridge dissociation in congenital vertebral anomaly.[1]

In a study of dermatoglyphics of healthy individuals (controls) and people with congenital vertebral anomalies, it was suggested that congenital vertebral anomalies arise from a non-specific insult during the embryonic period that destabilizes the developmental control systems and may result in congenital malformation of any organ undergoing concurrent epigenesis. Moreover, the study also showed that spinal deformity is a manifestation of major symmetry loss during development, caused by environmental stress that overwhelmed the stability of the specific genome.[1]

Literature search on the subject did not reveal any study

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on the dermatoglyphics of mothers of patients with spina bifida cystica. In the light of this, two questions of interest arise. Are mothers of patients with spina bifida cystica more prone to these non-specific insults? Does maternal dermatoglyphic pattern predict a high risk of having babies with spina bifida cystica? In an attempt to answer these questions, this study was carried out on the mothers of Malawian children with spinal bifida cystica at Queen Elizabeth Central Hospital in Blantyre, Malawi.

Materials and Methods

The study population was drawn from the surgical ward at the Queen Elizabeth Central Hospital in Blantyre, Malawi. Bilateral palmar, plantar and digital prints of the palms and soles of 20 mothers of children with spina bifida cystica were obtained by the inking method of Cummins and Midlo.[7] Pattern configuration were identified according to Cummins and Midlo[7] and only clear prints were classified into arches, loops and whorls. Ridge counts were done according to the method described by Holt.[8]

For the palm, total finger ridge count (TFRC), atd-angle, a-b ridge count and pattern intensity index (PII) were analysed. The total finger ridge count (TFRC) was calculated by counting all ridges in the fingers and their means determined. The atd angle is the angle subtended at the triradius (t) by lines drawn from this point to triradii (a) and (d) (Fig. 1). The a-b ridge count represents the number of ridges between triradii (a) and (b), while the pattern intensity index (PII) was the mean number of triradii formed on digits per individual subjects and it was calculated from the totals of the pattern type frequencies.

The sole was mapped topographically into 10 zones based on Cummins and Midlo's[7] nomenclature, where zones I - V represented the distal plantar sole and zones VI - X represented the proximal plantar sole (Table 3). The various plantar and digital patterns of arches, loops and whorls were counted and classified with the aid of a hand lens using Loesch and Skrinjaric's method.[9]

For the sole, the Dankmeijer (DI) and pattern intensity (PII) indices determined the digital variability of patterns. The DI is the total frequency of arches divided by the total frequency of whorls X 100 (Dankmeijer, [10]) while the PII is the mean number of triradii found on toes per individual.

Using all these parameters and the frequencies of the palmar and plantar digital ridge patterns, comparisons were made with normal healthy female controls matched for number, age and parity. Inter-observer variation in counting was eliminated as only one 'blinded' person who did not collect the prints examined all the prints. Chi-square tests were applied to the variables of arches, whorls and loops while t-tests were applied to the DI, PII, TFRC, atd angle and a-b ridge counts. These data were then compared with those of control mothers who gave birth to children without spina bifida cystica during the period of study.

Results

The digital palmar patterns

Table 1 compares the digital palmar pattern types of mothers of children with spina bifida cystica with control mothers expressed as percentage. Arches were absent in all the mothers of children with spina bifida cystica in contrast with control mothers with ten percent frequencies of arches and significantly higher frequency of whorls as compared to the control mothers in palmar pattern types.

The TFRC, PII, the atd angle and a-b ridge counts

The TFRC was significantly lower in mothers of children with the above condition than in the female controls ($P > 0.001$); similarly, PII was higher in these mothers than in control mothers. However, there were no significant differences in atd angle and a-b ridge count between both groups ($P > 0.1$; >0.05 respectively, table 2).

Table 1 Digital pattern types of mothers of children with spina bifida cystica in Malawi compared with controls expressed as percentage

Pattern Types	Mothers			Female Controls		
	Left	Right	Mean	Left	Right	Mean
Arch	0.00	0.00	0.00	10.00	10.00	10.00
Radial loop	3.54	3.80	3.67	5.00	5.42	5.21
Ulnar loop	61.04	70.20	65.63	80.55	79.02	79.79
Whorl	35.42	26.00	30.70	4.45	5.56	5.00

Table 2 The total finger ridge count (TFRC), pattern intensity indices (PII), atd angle and a-b ridge count in mothers of children with spina bifida cystica in Malawi compared with controls

Parameter	Mothers	Female Controls	P
TRFC			
Mean	135.40	140.15	<0.001
SD	17.76	39.82	
***PII**			
Mean	8.30	6.66	
atd angle			
Mean	77.00	80.66	>0.1
SD	8.60	8.50	
a-b ridge count			
Mean	62.60	64.66	>0.5
SD	12.36	13.22	

**PII was calculated from pattern type frequency totals; hence standard deviations were not obtained.*

Table 3 Classification of zones of sole of root using Penrose and Loesch (1969) Nomenclature

Topographical Zones	Nomenclature	Topographical Zones	Nomenclature
I	Hallucal	VI	Hypothenar distal
II	Second interdigital	VII	Hypothenar proximal
IV	Third interdigital	VIII	Calcar (heel)
IV	Fourth interdigital	XI	Thenar proximal
V	Hypothenar distal	X	Thenar distal

The plantar and digital patterns

Plantar pattern types, showed loops were restricted to the first two digits in mothers of children with spina bifida cystica as against the first

Table 4 The mean frequency of whorls on the distal part of the sole (Zones I - VI) expressed as a percentage in mothers of Malawian children with spina bifida cystica compared with controls

			Topographical Zones					
Groups	**Limb**	**N**	**I**	**II**	**III**	**IV**	**V**	**VI**
Female (Mothers)	Left	20	80.00	0.00	20.00	0.00	0.00	0.00
	Right	20	80.00	0.00	20.00	0.00	0.00	0.00
Female (Controls)	Left	20	50.00	4.20	4.20	4.20	0.00	0.00
	Right	20	50.00	0.00	8.50	8.50	0.00	0.00

Table 5 The frequency of whorls, loops and arches on toes expressed as a percentage in mothers of Malawian children with spina bifida cystica compared with controls.

Pattern type and women groups	**Limb**	**N**	**1**	**2**	**3**	**4**	**5**
(a) Whorls mothers	Left	20	0.00	0.00	0.00	0.00	0.00
	Right	20	0.00	0.00	0.00	0.00	0.00
Female controls	Left	20	0.00	0.00	0.00	0.00	0.00
	Right	20	0.00	0.00	0.00	0.00	0.00
(b) loops mothers	Left	20	90.00	70.00	0.00	0.00	0.00
	Right	20	90.00	70.00	0.00	0.00	0.00
Female controls	Left	20	71.10	25.60	21.10	4.20	10.00
	Right	20	88.90	33.10	33.10	0.00	0.00
(c) Arches mothers	Left	20	0.00	20.00	90.00	90.00	80.00
	Right	20	0.00	20.00	90.00	90.00	80.00
Female controls	Left	20	100.00	100.00	100.00	95.77	100.00
	Right	20	100.00	100.00	100.00	95.77	100.00

Table 6 Comparison of digital patterns variability between mothers of children with spina bifida cystica and controls in Malawi.

Variables	**Mothers**	**Female controls**
PII	8.22	6.66
DI	2.90	10.13

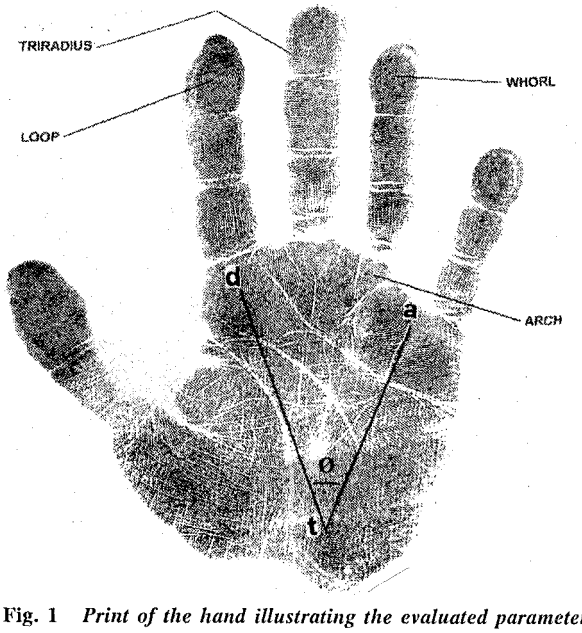

Fig. 1 *Print of the hand illustrating the evaluated parameters of arches, loops, whorls, triradii, a-b ridge count and atd angle.*

four digits in female controls (Table 4). Similarly, arches were absent in the first digit of these mothers compared to one hundred percent frequencies in the controls (Table 5). Again PII was higher in these mothers than in female controls (Table 6).

Discussion

The study has documented, probably for the first time, dermatoglyphic differences between mothers of children with spina bifida cystica and healthy female controls in both palmar and plantar pattern types and in TFRC, PII and DI parameters.

Palmar pattern types

We have shown that mothers who gave birth to children with spina bifida cystica lacked arches while the female controls had ten percent frequencies of arches. Indeed an earlier study on normal healthy Malawians of both sexes[11] had shown that Malawians shared with North Africans Barbers a high incidence of palmar arches, which was also confirmed by the control mothers in the present study. Other studies[2,3] have also shown that some individuals have genotypes that are intrinsically more resistant to destabilization than others and an unstable individual may be destabilized by perhaps normal stress.[1] Our study lends support to this assertion as mothers who gave birth to children with spina bifida cystica, have shown dermatoglyphic differences from controls. We found that the TFRC was significantly lower in these mothers than the female controls ($P > 0.001$) and the PII was higher than the controls. This accords the findings of Penrose[12] that TFRC was more influenced by early foetal environment. Our findings are further supported by the fact that dermatoglyphics have been documented to be familial and genetic in nature and are laid down in early ontogeny and remain unchanged thereafter.[1] It must be emphasised that PII is a function of triradii that has been shown by Penrose[12] to be useful in personal identification. In this connection, the rise in PII only identifies the group of mothers that is different from the healthy control mothers. It has been shown, for example, that mothers of Mongols if they had more than one affected child were more likely than control females to have centrally placed axial triradii.[12] Tsou et al.[13] suggested that the effect indicated above might be expressed as malformation or mismatching of metameric pairs. These workers also showed more subtle losses of left-right symmetry in palmar dermatoglyphics indicating that the insult was generalized, rather than applied topically to the affected vertebrae. This could explain the presence of other anomalies like cardiac, neurological or even renal that are often associated with vertebral anomalies.[1]

Plantar pattern types

Our findings have also indicated plantar differences exhibited by loops, which were restricted to the first two digits in these mothers as opposed to the first four digits in the controls. As in palms, arches were absent and in this case in the first digits of mothers of children with spina bifida cystica compared to one hundred percent frequencies in control women. Moreover, the PII was higher in these mothers than

the controls, with the mothers showing lower DI than in control women. These findings support observations previously reported where the frequencies of several plantar pattern elements in the XXY syndrome were different from those of normal male and female subjects.[14,15] Similarly, Turner's syndrome patients have been shown to show large whorls, large distal loops in the hallucal area and absence of triradii.[16] These studies compared patients with healthy controls but they indicate that dermatoglyphic differences do exist between patients with genetic disease conditions and healthy controls. However, the present study examined the dermatoglyphics of mothers of patients, rather than the patients themselves. But it is clear that dermatoglyphic differences do exist in both cases between mothers of children with spina bifida cystica and control mothers of children without this affection.

Conclusions

We have shown dermatoglyphic differences between mothers of children with spina bifida cystica and control mothers that suggest that mothers presenting with these dermatoglyphic traits are more predisposed to giving birth to children with vertebral anomalies. This theory, however, needs to be confirmed by genetic studies. Recent work in molecular biology on the homeobox genes have shown that this process involves hierarchies of master genes and cascades of "subroutines" likened by Kauffmann to a complex computer programme.[17-19] It would appear that the local and global timing of this growth-related enzyme-driven process is what causes morphogenesis.[1]

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