Parental Dermatoglyphs in Age-independent Mongolism

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Penrose and Smith (1966) have estimated that about three-fifths of all clinical mongolism is caused by some process closely related to ageing of the ovum (the age-dependent group), while the other two-fifths (age-independent) includes the so-called hereditary causes and some strongly suggestive instances of environmental origin. The relative proportion of cases in the two classes differs from one country to another and from one study to another. It has also been reconfirmed recently (Sigler *et al.*, 1965) that there exists no statistically significant association between paternal age and mongolism. Inherited translocation mongolism accounts for a small proportion of the age-independent group (Mikkelsen, 1967; Wright *et al.*, 1967). What are other hereditary factors in this group? Why should young mothers deliver mongol children with standard trisomy?

Penrose (1954) noted that mothers showed significant resemblance to the mongol child when the palmar axial triradius was measured in dermal patterns. Furthermore, Penrose and Smith (1966) have presented the view, with supporting evidence, that a percentage of the mothers of mongols are themselves mosaic mongols. In this study we were interested in further measurement of dermatoglyphic data. It was important to determine if parents show additional dermatoglyphic microsymptoms of mongolism, and if they do, is this finding more pronounced in the age-independent group, since this group would not include processes related to ageing of the ovum.

Subjects and Methods

The study group consisted of 68 mongols, 40 confirmed to have G group trisomy by analysis of peripheral blood cultures, and 28 diagnosed by clinical signs alone. There were also 51 parent pairs each with one mongol offspring conceived at maternal age under 35, and 27 parent pairs each with one mongol offspring conceived

at maternal age 35 or over. The parent control group consisted of 33 parent pairs, each with at least two non-mongol offspring. Maternal age of 35 years at time of conception was made the dividing line between age-dependent and age-independent mongolism, since the risk of affected offspring increases markedly at this maternal age, according to Benda (1960).

The total dermal index of Walker (1958) was used without any modifications for the dermatoglyphic analyses on individuals with mongolism, their parents, and the parents in the control group. The dermal areas studied in this total dermal index are 10 digital patterns, the position of two palmar axial triradii, two interdigital patterns, and two plantar hallucal patterns. A single total dermal index was obtained from hand and foot prints obtained from each individual; standard ink or inkless methods were used (Cummins and Midlo, 1961). The total index was originally based on the frequencies of mongol to control dermal patterns, expressed as logarithms (Walker, 1958). Mongol patterns are more positive. In this investigation the dermal indexes in the various study subgroups were compared, using the Student's *t* test to evaluate the significance of differences. A *p* value of 0.05 or less was considered significant.

Results

Reliability of Total Dermal Index. To ascertain that the total dermal index was a reliable measure of clinical mongolism in the population studied in this report, histograms were prepared of the total dermal indexes of the 68 mongols in the study, and the 66 parents in the control group (Fig. 1). It can be seen that there are no normal (non-mongol) individuals who score +3 or more, and there are no individuals with clinical mongolism who score -3 or less. The range of overlap between +3 and -3 included approximately 30% of both groups, while about 70% of mongols and 70% of non-mongols fell, respectively, above or below this range. The resemblance of the histograms for this study to those originally prepared by Walker (1958) is striking. It was felt that the index was a reliable measure of clinical mongolism in the present study group.

FIG. 1. Histograms of the dermal indexes of mongols and parents of non-mongol offspring in the present study. Dermal index is indicated on the abscissa; number of cases is indicated on the ordinate. The dotted areas represent all the mongol cases who score +3 or more and all the normal individuals who score -3 or less.

Confirmed G Trisomy Compared to Clinically Diagnosed Mongolism. Indexes of father, mother, and index case were compared between confirmed G trisomy and clinical mongolism in index case to determine if chromosome confirmation affected the index (Table I). It can be seen that there were no significant differences between these groups. Thus, if any of the clinically diag-

nosed mongols carried translocation or normal chromosomes, the effect on the dermal indexes in the total group was insignificant.

Selection of Control Parent Group. It was necessary to compare, within the control parent group, those parents with two or more clinically normal children and those with two or more non-mongol children who were not necessarily normal clinically (Table II). Because there were no significant differences among these comparisons, the control parent group included mothers and fathers of both normal and abnormal offspring, as long as the children were not mongols clinically.

Effect of Sex and Maternal Age on Mongol Dermal Index. The dermal index did not differ significantly between male and female mongols (Table III). The dermal index of mongols born at old maternal age was higher than the dermal index of mongols born at young maternal age, though the difference was not statistically significant (Table IV).

Effect of Maternal Age on Parental Dermal Index. In the group of parents with maternal age under 35 at conception of mongol offspring, the mean paternal age at conception was 28 years and the mean maternal age was 25 years. In the group of parents with maternal age 35 and over, the mean paternal age was 40 and the mean maternal age was 39.

In the young maternal age-group but not in the old maternal age-group, mothers had significantly higher dermal indexes when compared to fathers in the same maternal age-groups (Table V; Fig. 2).

TABLE I

MEANS AND TESTS OF SIGNIFICANCE FOR DERMAL INDEX OF FATHER, MOTHER, AND INDEX CASE IN CONFIRMED G TRISOMY VERSUS CLINICAL MONGOLISM IN INDEX CASE

	Father		Mother		Mongol Index Case	
	Confirmed G Trisomy	Clinical Mongolism	Confirmed G Trisomy	Clinical Mongolism	Confirmed G Trisomy	Clinical Mongolism
No.	47	31	47	31	40	28
Means	-3.65 ± 1.59	-3.53 ± 1.36	-3.18 ± 1.86	-3.01 ± 1.73	+4.28 ± 2.91	+4.56 ± 2.55

CONFIRMED G TRISOMY
vs CLINICAL MONGOLISM

	n	t	p
Father	78	0.34	0.80 - 0.70
Mother	78	0.41	0.70 - 0.60
Index case	68	0.41	0.70 - 0.60

TABLE II

MEANS AND TESTS OF SIGNIFICANCE FOR DERMAL INDEX OF CONTROL PARENTS WITH NORMAL CHILDREN VERSUS CONTROL PARENTS WITH NON-MONGOL CHILDREN

	Control Fathers		Control Mothers		Control Fathers and Mothers	
	Normal Children	Non-mongol Children	Normal Children	Non-mongol Children	Normal Children	Non-mongol Children
No.	13	20	13	20	26	40
Means	- 4.23 ± 2.14	- 4.33 ± 1.57	- 3.48 ± 1.94	- 3.67 ± 1.66	- 3.85 ± 1.63	- 4.00 ± 2.09

NORMAL CHILDREN vs NON-MONGOL CHILDREN

	n	t	p
Control fathers	33	0.17	0.90 - 0.80
Control mothers	33	0.25	0.80
Control fathers and mothers	66	0.31	0.80 - 0.70

TABLE III

MEANS AND TESTS OF SIGNIFICANCE FOR DERMAL INDEX OF MALE MONGOLS VERSUS FEMALE MONGOLS ACCORDING TO MATERNAL AGE

	Maternal Age < 35		Maternal Age > 35		All Maternal Ages	
	Male	Female	Male	Female	Male	Female
No.	31	12	11	13	42	25
Means	+ 4.69 ± 2.68	+ 4.62 ± 2.70	+ 3.81 ± 2.90	+ 3.88 ± 3.12	+ 4.46 ± 2.73	+ 4.24 ± 2.89

MALE vs FEMALE MONGOLS

	n	t	p
Maternal age < 35	43	0.08	> 0.90
Maternal age > 35	24	0.06	> 0.90
All maternal ages	67	0.31	0.80 - 0.70

TABLE IV

MEANS AND TESTS OF SIGNIFICANCE FOR DERMAL INDEX OF MONGOLS ACCORDING TO MATERNAL AGE

	Maternal Age < 35	vs	Maternal Age > 35
No.	44		24
Means	+ 4.74 ± 2.66		+ 3.85 ± 2.95

n	t	p
68	1.27	0.25 - 0.20

FIG. 2. A comparison of fathers and mothers in young and old maternal age-groups. The difference is statistically significant between father and mother in the maternal age-group under age 35.

TABLE V

MEANS AND TESTS OF SIGNIFICANCE FOR DERMAL INDEX OF FATHERS
VERSUS MOTHERS ACCORDING TO DIFFERENT MATERNAL AGES AND
IN CONTROL GROUP

	Control Parents		Maternal Age < 35		Maternal Age > 35	
	Father	Mother	Father	Mother	Father	Mother
No.	33	33	51	51	27	27
Means	-4.29 ± 1.63	-3.60 ± 2.13	-3.90 ± 1.47	-2.98 ± 1.85	-3.27 ± 1.75	-3.36 ± 1.72

FATHERS vs MOTHERS

	n	t	p
Control parents	66	1.48	0.20 - 0.10
Maternal age < 35	102	2.78	0.01 - 0.005
Maternal age > 35	54	0.19	0.90 - 0.80

FATHERS

	n	t	p
Control vs < 35	84	1.14	0.30 - 0.25
Control vs > 35	60	2.34	0.025 - 0.02
< 35 vs > 35	78	1.68	0.10 - 0.05

MOTHERS

	n	t	p
Control vs < 35	84	1.41	0.20 - 0.10
Control vs > 35	60	0.47	0.70 - 0.60
< 35 vs > 35	78	0.88	0.40 - 0.30

Mothers had higher indexes than fathers in the control group but the difference did not reach a p value of 0.05, and was therefore not statistically significant. (Note the high standard deviation for control mothers, Table V.) Mothers under age 35 at conception of their mongol offspring were also more positive than control mothers, but the difference was not significant (Table V; Fig. 3).

Fathers in the old maternal age-group had significantly higher dermal indexes than fathers in the control group. The difference between fathers in young and old maternal age-groups approached but did not reach significance, fathers in the old maternal age-group being higher (Table V).

FIG. 3. A comparison of parents who have and have not shown ability to produce mongol offspring.

TABLE VI

MEANS AND TESTS OF SIGNIFICANCE FOR
DERMAL INDEX OF PARENTS WITH MONGOL
OFFSPRING VERSUS PARENTS WITHOUT MONGOL
OFFSPRING

	Control Parents		All Parents of Mongols	
	Father	Mother	Father	Mother
No.	33	33	78	78
Means	-4.29 ± 1.63	-3.60 ± 2.13	-3.62 ± 1.59	-3.12 ± 1.80

	n	t	p
Father vs mother			
Control parents	66	1.48	0.20 - 0.10
Parents of mongols	156	1.85	0.10 - 0.05
Fathers			
Control vs mongols	111	2.03	0.05 - 0.025
Mothers			
Control vs mongols	111	1.22	0.20

FIG. 4. A comparison of fathers who have and have not shown ability to produce mongol offspring. The difference is statistically significant.

Dermal Index of Parents with Mongol Offspring Compared to Parents without Mongol Offspring. When all parents of mongols, regardless of maternal age, were compared to control parents, fathers of mongols had significantly higher dermal indexes than fathers of non-mongol offspring (Table VI; Fig. 4). All mothers of mongols also had higher dermal indexes than mothers of non-mongol offspring, but the difference was not significant. Control mothers had higher indexes than control fathers, but the difference was not significant.

Discussion

When dermal indexes are studied, mothers under age 35 at conception of a mongol resemble their affected offspring significantly more than fathers resemble their affected offspring in the same maternal age-group. This observation does not apply to mothers age 35 or over at time of conception of the mongol offspring (Fig. 2). Furthermore, when parents with and without mongol offspring are compared, the fathers of mongols have significantly higher dermal indexes than the fathers of non-mongols (Fig. 4). What conclusions can one draw from these data? What bearing do they have on the four major hypotheses considered to account for age-independent mongolism? (Penrose and Smith, 1966).

(1) Environmental influences during pregnancy with the mongol child cannot account for parental dermal microsymptoms of mongolism. (2) Translocation carriers cannot account for the findings, because the mongols in this study were either proved to have standard trisomy or were proved not to differ significantly, as regards dermal index, from

the confirmed G trisomy group. (3) Parental tendency to non-disjunction could be associated with parental dermal microsymptoms. However, it would be necessary to postulate that single gene or polygenic influences causing non-disjunction also cause certain types of dermal ridge patterns. The mechanism for such a relation is at present not clear, and is certainly difficult to test. In addition, recent studies conclude that recessive genes are unlikely to be involved in the aetiology of G group non-disjunction in younger mothers (Matsunaga, 1966). (4) Inevitable non-disjunction, with mother or father partially mosaic for G trisomy, is the remaining explanation for the findings in this study.

If the last explanation is correct, these data suggest that the incidence of mosaicism is higher in the mother than in the father, since mothers of age-independent mongols show a tendency to higher dermal indexes than fathers of all mongol offspring (18% difference between bars E and C, Fig. 3). Sex is shown not to affect the dermal index in mongols (Table III). However, the difference between control fathers and fathers of mongols is approximately the same as the difference between control mothers and age-independent mothers (16% difference between bars A and C, and 17% difference between bars B and E, Fig. 3). This comparison between parents who have and have not shown ability to produce mongol offspring suggests that the incidence of G trisomy mosaicism actually, resulting in mongol offspring is similar between mother and father. For an equal number of ($n+1$) male and female gametes to participate in fertilization is entirely conceivable, in spite of different proportions in the stem lines. To test these hypotheses concerning gonadal mosaicism is at present difficult.

An unexpected finding in this study was the difference between control fathers and fathers in the old maternal age-group, the latter having significantly higher dermal indexes (Table V). A comparison of fathers in the two maternal age-groups also shows that the indexes of fathers in the old maternal age-group are higher than those in the young maternal age-group, though the difference does not quite reach significance. The mean paternal age is higher in older as compared to younger maternal age-groups (40 and 28 years, respectively). However, in the absence of a known relation between paternal age and mongolism, how can the high paternal dermal index in the old maternal age-group be explained? One explanation is the selective inclusion, in the old maternal age-group, of paternal mosaics resulting in mongol offspring. If this explanation is correct, some so-

called maternal age-dependent mongolism is the result of paternal mosaicism.

The social implications of these conclusions seem important in terms of preventive measures. If there is a stable pool of G trisomy mosaicism in humans, it will remain difficult to prevent the occurrence of a regular incidence of age-independent mongolism. Furthermore, these cases will be often sporadic, in the sense that they can appear unexpectedly in a family. The task of screening a general population for chromosomal mosaicism before child-bearing age is certainly formidable.

Summary

When total dermal indexes are studied, mothers of age-independent mongols resemble their affected offspring significantly more than fathers resemble their affected offspring in the same maternal age-group. This observation does not apply to mothers age 35 or over at conception of a mongol. These data can be explained by the hypothesis of inevitable non-disjunction, with age-independent mothers partially mosaic for G trisomy. Furthermore, when parents with and without mongol offspring are compared, the fathers of mongols have significantly higher dermal indexes than the fathers of non-mongols. The explanation could be G trisomy mosaicism in fathers of mongols. If there is a stable pool of mosaicism in humans, it will remain difficult to prevent the occurrence of a regular incidence of age-independent mongolism.

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