

INHERITANCE OF OCCIPITAL HAIR WHORLS IN MAN : A TWIN AND FAMILY STUDY

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Abstract

In order to investigate genetics of occipital hair whorls, data on 122 twin pairs, 76 siblings and 96 pairs of parents, were collected from Chandigarh. Twin data and segregation analysis of family data reveal that the clock wise hair whorl is inherited as a simple Mendelian dominant trait. Secondly, family data on double occipital hair whorls show that the trait is inherited as an autosomal recessive trait. But its very low concordance rate in MZ twins, speaks of the evidence pointing to the importance of environmental factors which influence the expression of the trait during prenatal development.

Key words : Occipital hair whorls, Twin and family study, Inheritance, Segregation analysis.

INTRODUCTION

Eschricht (1837) was probably the first author to make certain observations on occipital hair whorls in his study on the direction of human body hair. He observed that the hair at crown always come forth in a whorl. Volgt (1856) made a study similar to above. Kidd (1903), while investigating the direction of hair in man, observed that occipital hair whorl occurred over the posterior fontanelle and its position might be in right or left of the middle line and rarely in the middle line. In some of the persons it is double, one lying on each side of the middle line. Brewster (1925) reported that double occipital hair whorls generally turned in the same direction.

Significance of hair whorls as a racial character was dealt by a number of authors (Lauterbach and Knight, 1927 ; Biswas, 1938, 1950 ; Tripathi, 1966, Bhalla and Kaul, 1968).

Sano (1918) noted a case of reversal in direction of the crown in a pair of identical twins. Lauterbach (1925) studied 212 pairs of twins and found in 24.2 percent of all twin pairs (13.7 per cent of all cotwins) some variation from the clockwise whorl. It was further

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observed that this variation was not always in the form of counter-clockwise whorl, but frequently assumed the form of double whorls which might combine in number of ways. Sharma (1983) reported that the incidence of double occipital whorls was much higher in twins than in singletons. The high incidence of double whorls in twins was attributed to possible association between genes responsible for twinning and double occipital hair whorls.

Bernstein (1925) on the basis of study on family data consisting of 3500 persons noted that the direction of hair whorl was determined by a pair of Mendelian factors, counter-clockwise being dominant. Schwarzburg (1927) examined 4,259 boys and observed that the frequency of counter-clockwise were higher by four times than that of clockwise whorls and supported Bernstein's contention. On the contrary, Winchester (1958) and Montagu (1963) noted that the clockwise condition was inherited as a dominant trait. Scheinfeld (1965) pointed out that the direction of hair whorl may also be influenced by chance factors in pre-natal development. To conclude, the pattern of inheritance of hair whorl direction remains uncertain, and has to be solved by family studies.

With regard to the inheritance of double occipital hair whorls, Schwarzburg (1927), Winchester (1958) and Montagu (1963) showed the transmission of two whorls as recessive trait. Brewster (1925) recorded a family, in which a double whorl was inherited as a dominant trait with 7 cases (5 and 2) in three generations and concluded that the inheritance of double occipital hair whorls follows no simple Mendelian principle. Nehse (1936) studied the development of hair and hair streams, and found that double crowns and fore head hair whorls were commoner in idiots than in normal persons. Comparison between MZ and DZ twins with regard to the direction, position and line of the head hair showed that these were not inherited.

The above review reveals that the inheritance of double hair whorls and dominance of hair whorl direction remain unresolved and needs a through investigation. With this purpose in view, the present study was undertaken.

MATERIAL AND METHOD

The data on 122 twin pairs, their 76 siblings and 96 pairs of parents of Punjabi parentage were collected from Chandigarh, India. Zygosity of twins was determined by the similarity method using blood groups (A_1 , A_2 , BO, RH, MN), ABH secretion, PTC tasting ability, and other traits like somatoscopy, anthropometry and dermatoglyphics.

The subjects were observed for their occipital hair whorls from and above the occipital area. Determination of the number and direction of hair whorls was not difficult in individuals with short hair. But in subjects having long hair, it was often difficult to make reliable scoring and an aseptic comb was used for this purpose.

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The cases in which the hair were very long and curly or had entirely disappeared were left undetermined.

Lauterbach's (1925) method of designating the hair whorls was used in the present study. A plus sign (+) indicates a whorl to the right or clockwise, while a minus sign (-) shows that a whorl to the left or counter-clockwise. Two signs indicate a double crown, i. e., two occipital hair whorls, and position of the sign indicates the relative position on the head. According to this, four combinations of double whorls are possible:

- + - (clockwise-counter-clockwise),
- + (counter-clockwise-clockwise),
- ++ (clockwise-clockwise), and
- (counter-clockwise-counter-clockwise).

Only one case of tripple hair whorl was found in the sample; - + - (counter-clockwise-clockwise-counter-clockwise). Snyder's ratios (Snyder, 1932, Cavalli-Sforza and Bodmer, 1971) were used for segregation analysis.

RESULT AND DISCUSSION

Twin Studies

(a) Single Occipital Hair Whorl:

The concordance rates for the type of single occipital hair whorl are shown in Table 1. Among 99 pairs of twins having single hair whorls, the concordance rates are 96.3% for MZ twins and 65.28% for DZ twins, which is suggestive of the presence of hereditary component for the trait ($h^2=0.89$). Of 26 concordant MZ pairs 22 pairs have clockwise hair whorls, while only 4 pairs have counter-clockwise hair whorls. The incidence of clockwise hair whorls is thus five times more than that of counter-clockwise hair whorls. Similarly, DZ concordant twin pairs also show much higher incidences of clockwise hair whorls.

In MZ twins, there is only one case of mirror image, where there is a reversal in the direction of hair whorl in a cotwin.

(b) Double Occipital Hair Whorls:

Table 2 shows that only one (16.67 percent) of 6 MZ twin pairs is concordant for the type of double occipital hair whorl. The rather low concordance rate probably suggests the importance of prenatal environmental factors. In 17 DZ twin pairs, again only one pair is concordant for the presence of two occipital hair whorls. But that too is discordant for the type; one co-twin of the DZ pair has - + type while the other cotwin has + + type.

Among double occipital hair whorls, the plus (+ -) combination is most frequent. It is interesting to note that among 512 heads examined, no case of minus minus (- -)

combination of double occipital hair whorls was found. Only one case of tripple hair whorl having the combination minus-plus-minus ($- + -$) was observed.

Double hair whorls may lie very close to each other, so close that infact one merges with each other (See Table 3). In one cotwin, the distance between the two hair whorls was only 3 mm.

Family Studies

The familial data on occipital hair whorls is presented in Table 4. It is observed that 72.39% of the children have clockwise hair whorls and 16.79% counter-clockwise hair whorls, clock-wise hair whorls thus showing predominance over counter-clockwise ones. 10.45% children have double hair whorls, while polyhair whorls appear quite infrequently (0.37%). The frequency of double hair whorls in the offsprings is much higher when one of their parents have this trait. Out of 12 children from such matings, 4 (33.33%) have double hair whorls; while the frequency of double hair whorls in children from single x single hair whorl matings, is only 9.77%

In the first set of 55 matings in which both parents have clockwise whorls, 81.05% of the children have clockwise hair whorls, 9.80% have counter-clockwise and 9.15% have double occipital hair whorls. Segregation of counter-clockwise and double occipital hair whorls in children, in the light of absence of the trait in parents, suggest the possibility of their being inherited as autosomal recessive traits.

In the second set of 27 matings one of the parents have clockwise and the other possess counter-clockwise hair whorls. Of the total 72 children from these matings, 27.78% of the children have counter-clockwise hair whorls. Thus showing a much higher frequency of counter-clockwise whorls in children than the first set of matings.

Unfortunately there is only one family of counter-clockwise x counter-clockwise type of mating in the sample. And the two children from this mating have counter-clockwise hair whorls. It appears from the above that counter-clockwise hair whorls are recessively inherited. This hypothesis has been further confirmed by segregation analysis of single occipital hair whorls. But the data on double/multiple occipital hair whorls are not large enough for segregation analysis.

Segregation Analysis

Table 5 shows observed and expected numbers for each of the mating type under the assumption that the counter-clockwise hair whorls represent homozygosity for an autosomal recessive gene 'a' with a frequency of 0.42 in this population. This figure is the square root of the proportion of individuals having counter-clockwise hair whorls ($33/183=18\%$) found in the parental population. The expected frequencies were calculated using the above gene frequency and considering all possible genotypes present in each of the matings (see Table 5). Comparison was made between observed and

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TABLE 1: Single

Twin Types	
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TABLE 2: Double

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Segregation analysis shows that there are no significant differences between observed and expected phenotypes among the offsprings. Thus it supports the hypothesis that the counter-clockwise hair whorl phenotype is controlled by a pair of autosomal recessive gene.

To conclude, clockwise hair whorl is inherited as a simple Mendelian dominant trait. Family data on double occipital hair whorl reveal that the trait is inherited as an autosomal recessive trait. But its very low concordance rate in MZ twin indicates that the expression of trait may also be influenced by environmental factors during pre-natal development.

TABLE 1: Single Occipital Hair Whorls in Twins: Concordance and Discordance Rate.

Twin Types	Concordant		Discordant	Total	Concordance Rate
	++	--	+-		
MZ	22	4	1	27	96.30%
DZ	44	3	25	72	65.28%

++ = Both cotwins having clockwise hair whorls.

-- = Both cotwins having counter-clock hair whorls.

+- = One of the cotwins having clockwise while the other having counter-clockwise hair whorl.

TABLE 2: Double/Multiple Occipital Hair whorls in Twins ; Concordance Rate.

Zygosity of Twins ¹	Type of Hair Whorl	Incidence
MZ	+- +-	1
	+- +	3
	-+ +	2
Total		6
DZ	++ +	2
	++ -	1
	+- +	7
	+- -	3
	-+ +	1
	-+ -	1
	-+ ++	1
	-+ -+	1
Total		17

¹ Concordance rate for MZ is 16.67% and for DZ it is zero %.

TABLE 3: Occipital Hair Whorls in Families.

	Matings	Number of Matings	Children						Total
			+	-	++	+-	-+	-+-	
Single Hair Whorls	+Vs.+	55	124 (81.05)	15 (9.80)	3 (1.96)	9 (5.88)	2 (1.31)	—	153 (100.00)
	+Vs.—	27	46 (63.89)	20 (27.78)	—	4 (5.56)	2 (2.78)	—	72 (100.00)
	—Vs.—	1	—	2 (100.0)	—	—	—	—	2 (100.0)
	+Vs.?	8	16 (61.54)	5 (19.23)	—	3 (11.54)	1 (3.85)	1 (3.85)	26 (100.0)
	—Vs.?	1	3 (100.0)	—	—	—	—	—	3 (100.00)
Double Hair Whorls	+—Vs.+	1	3 (75.0)	—	—	1 (25.0)	—	—	4 (100.00)
	+—Vs.—	2	1 (20.0)	2 (40.0)	—	2 (40.0)	—	—	5 (100.00)
	—+Vs.+	—	—	—	—	—	—	—	—
	—+Vs.—	1	1 (33.33)	1 (33.33)	—	1 (33.33)	—	—	3 (100.0)
Total		96	194 (72.39)	45 (16.79)	3 (1.12)	20 (7.46)	5 (1.87)	1 (0.37)	268 (100.0)

Vs. Indicates versus.

? Indicates whorl of unknown type.

Figures in the parentheses are percentages.

TABLE 4: Segregation Analysis under the Assumption of Autosomal Recessive Gene.

Type of Matings	Number of families	Theoretical Mating Genotypes	OFFSPRING				X ²	P (1 df)
			Clockwise		Counter-clockwise			
			Obs.	Exp.	Obs.	Exp.		
+Vs.+	55	AA X AA AA X Aa Aa X Aa	124	126.49	15	12.51	0.545	>0.5
+Vs.—	27	AA X aa Aa X aa	46	46.20	20	19.80	0.003	>0.9
—Vs.—	1	aa X aa	0	0	2	2.00	—	—
Total	83	—	170	172.69	37	34.31	0.253	>0.9

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	0.003	>0.9
	—	—
	0.253	>0.9