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Anthropology and Clinical Importance of td Ridge-Count on Human Palms

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ABSTRACT The td ridge-count was introduced as an age-stable negative measure of the distal shift of the t-triradius on human palms. The aim of the paper is to see its variation in populations and pathological conditions. The sex difference and bilateral difference have also been examined. The genetic background of the td ridge-count and its relation to maximal atd angle has been estimated. The deviation from the negative correlation between td ridge-count and maximal atd angle in the patients of mood disorder and their relatives, which enhances the utility of studying td ridge-count, is noted.

INTRODUCTION

On human palms, there is a triradius normally located at the base, towards the wrist, which is called the t (terminal)-triradius. This triradius shifts distally towards the fingers in the patients with Down's syndrome (Cummins, 1939), Turner's syndrome, and Patau's syndrome and other chromosomal abnormalities (Penrose, 1963; Holt, 1968) in different degrees.. It is often claimed to be associated with several other genetic disorders. Therefore, it is necessary to quantify the amount of distal displacement of the t-triradius. .While several attempts with different methods (Cummins and Midlo, 1943; Sharma, 1963; and others) have been tried, Penrose (1954) has introduced the maximal atd angle as an elegant measure of the distal shift of the t-triradius. It has become a very popular measure among the clinicians through out the world,

But as Penrose has shown, the maximal atd angle is not an age-stable character. The angle depends on the shape of the hand, which changes with age (Weninger, 1973) The hand increases with age in length more than in breadth. As a result, the maximal atd angle is broader and larger in children than in adults. But clinicians generally have to diagnose and deal with young boys and girls as patients and compare their handprints with those of adult controls. The results, therefore, are often uncertain. To remove this difficulty, Mukherjee (1967) has introduced the ridge-count of the td distance between the distal-most t-triradius, and the ulnar-most d-triradius as a negative measure of the distal shift of the t-triradius (Holt, 1968). The td ridge-count, being age-stable, has the advantage that it can be compared between children and adults without any age-correction. It makes it possible to assess the distal shift of the t-triradius in the patients in comparison with unaffected controls (Mukherjee, 1974,1976; Loesch, 1983). But, although we have accepted it as an efficient dermatoglyphic method in the international agreement on dermatoglyphic nomenclature in 1967 (Penrose, 1968), it is yet only rarely utilised (Berg, 1968; Annapurna et al., 1978; Ahuja et al., 1980)

Some criticisms (Schaumann and Alter, 1976) do not properly apply to the td ridge-count. The hypothenar patterns do not interrupt the td line of the maximal atd angle. The distal transverse crease, which develops at the time of ridge differentiation, intercepts the td ridge-count. But it does not affect the td ridge count any more than 'white lines' and the width of the ridges affect the total ridge-count on the fingers (Holt, 1961), which has shown a high heritability. The td ridge-count may be laborious and time-consuming (Loesch, 1983). But its advantages outweigh this difficulty.

However, the usefulness of td ridge-count, as a criterion for genetic screening would require the knowledge of its anthropological and genetic variation. The bimanual, sexual and population variation of td ridge-count, its hereditary resemblance between relatives, the genetical basis of its relationship with maxinal atd angle.and evidence of its application in discriminating genetic diseases are discussed here.

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MATERIALS AND METHOD

The number of ridges touching the td arm of the maximal atd angle on the palm was recorded as the td ridge-count (Fig. 1). Palm prints (1) of 463 male and 372 female members of 145 Bengalee, mainly Brahman, families, (BB) acquired during 1964-65 from Kolkata and London, (2) of 35 pairs of English monozygotic twins, (Emz), collected on their third birth days by Peter Mitler of Berbeck College, London, and identified at Galton Laboratory, London, UCL in 1966 and (3) of 25 pairs of Sheik Sunni Muslim brothers, (BM), collected from the Khiri village of Bankura district by D.Mukhopadhyay in 1982 have been analysed after verification through pedigrees, and using OAB blood groups, in the sample from Kolkata. The published data on (4) rheumatic heart disease, RHD (Annapurna et al., 1978) in Andhra Pradesh,and on (5) Klinefelter's and (6)Turner's syndromes in England (Berg, 1968) with respective conrols have also been compared.

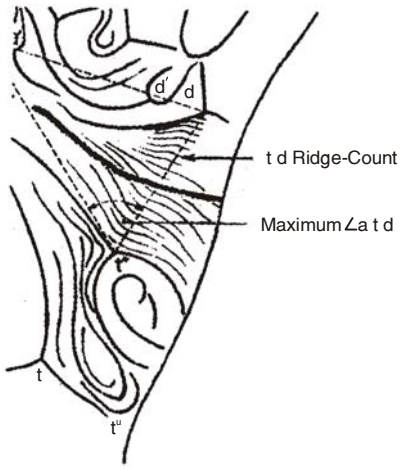

Fig. 1. td ridge-count and maximal atd angle

RESULTS AND DISCUSSION

Population and Pathological Variation: Mean with s,e, and S,D of the total td ridge-count on two palms is significantly larger ($p<0.05$) in the Bengalee, mainly Brahman, population, BB, than in English MZ twins, EMZ, and in the Bengalee Muslim, BM, male sample (Table 1). It is the largest in the control sample from Andhra Pradesh and the decline in the rheumatic heart disease, RHD, can still be traced from them.

Table 1: Population and pathological characteristics in td ridge-count

Sample	*Sex*	*palms*	*Mean td-count*	*S. E.*	*S.D.*	*Reference*
BB	M	926	194.5	1.7	36.9	Mukherjee, 1967
	F	744	185.5	1.8	34.0	
Emz	M	96	170.3	6.3	43.0	Data collected with Mitler, 1966
	F	44	175.9	8.0	37.5	
BM	M	50	168.6	5.2	36.7	Mukhopaghyay, 1982
CLP	M	14	159.9	12.7	47.5	Sengupta, 2002
	F	22	170.5	13.1	61.4	
Relatives	M	26	198.9	11.4	58.1	Sengupta, 2002
	F	24	188.9	16.3	79.9	
Caries	M	200	170.6	5.5	77.8	Sengupta, 2002
	F	200	140.8	6.2	87.7	mongols
	M	6	81.7	1.7	4..2	Sengupta, 2002
RHD	M	24	206.3	6.2	30,4	Annapurna et al., 1978
	F	38	182.4	7.4	45.6	
Andhra Control	M	50	207.6	3.6	25,5	Annapurna et al., 1978
	F	50	199.1	3.7	26.2	
Klinefelter's	M	31	186.2	6.7	37.3	Berg, 1968
Turner's	F	27	178.1	7.1	36.8	Berg, 1968
Br.controls	M	150	195.4	2.6	31.8	Berg, 1968
	F	150	190.3	2.7	33.5	
mongols	MF	160	112.9	3.2	40.1	Berg, 1968
Br.control	MF	300	192.9	1.9	32.7	Berg, 1968

Klinefelter's and Turner's syndromes also show a reduction from the control British..population. .The same is the case of Down's syndrome or mongolism. It appears that in oro- dental pathological conditions like 'cleft lip and palate', 'dental caries' and 'down's syndrome (mongolism)' patients have highly significant reduction of the mean td ridge-count (Table 1). Undoubtedly, the distal shift of the t-triradius is markedly greater even in three mongols (patients with down's syndrome) than in patients of orodental anomalies.

Sexual Difference: The sex difference in the

trait is not consistent over all populations, although it is significant in the BB sample and generally shows excess in males.

Bilateral Difference: The bilateral difference does not also show any significance in Emz and BM samples and do not display consistent excess in right or left hand (Table 2). The intraclass correlation between left (L) and right (R) palms works out to be around 0.7, indicating a small amount of asymmetry. The negative and negligible Intraclass correlation between (R-L) difference between pairs of twins or between brothers indicate absence of genetic influence on asymmetry of td ridge-count.

Table 2: Bilateral trends in td ridhge-count and correlation between left and right palms, r_{LR}

Sample	*Sex*	*Side*		*td ridge*	*S.E.*	r_{LR}
EMZ	Male	L	48	85.7	3.0	0.69
		R	48	84.6	3.0	(n 96)*
	Female	L	22	88.5	4.0	0.75
		R	22	87.4	4.0	(n 44)
BM	Male	L	50	83.3	3.0	0.73
		R	50	85.3	3.0	(n 100)

Genetical Analyses: The values of correlation for td ridge-count between different degrees of relationships**:** between mz twins, different pairs of parents and offspring, different pairs of siblings and between grandparents and grandchildren (Table 3) indicate a strong Influence of genes on the trait and correspond with similar findings for maximal atd angle (Penrose, 1954). It is noteworthy that the correlations for td ridge-count are about equal to that obtained for maximal atd angle in the present sample of Bengalee Brahman, families.

The heritability estimates based on BB family data (Table 4) closely agree with that based on mz twins The involvement of dominant / recessive genes, suggested for maximal atd angle (Penrose, 1954), is indicated by a smaller parent**:** offspring correlation than sibpair correlation. However, the dominant component constitutes only about a fourth of the total variation of each trait, the additive genetic component controlling over a double of it. None of the two traits**:** the td ridge-count and maximal atd angle, shows a significant birth order or maternal age effect (Mukherjee, 1990).

The low correlation between female relatives in general makes it tempting to consider the variable expression of two X-chromosomes in females, as postulated by Parsons (1964). But the pattern of different sibpair correlations does not support such a phenomenon for td ridge- count.

Table 3: Correlation between pairs of relatives for td ridge-count and max.atd angle

Sample	*Pairs of relatives*	*pairs*	*td ridge -count*	*Max-imal Atd angle*	*s.e.*
EMZ	mz twinpairs	70	0.78	0.76	0.05
BB	Parent: offspring	558	0.29	0.30	0.04
	sibpair	758	0.33	0.33	0.03
	Father: son	136	0.33	0.42	0.07
	Father:daughter	142	0.37	0.16	0.07
	Mother**:**son	138	0.21	0.18	0.08
	Mother**:**daughter	142	0.31	0.32	0.08
BM	Brother**:**brother	50	0.38	0.50	0.12
BB	Brother**:** brother	198	0.29	0.30	0.06
	Brother**:**sister	332	0.36	0.38	0.05
	Sister: sister	220	0.29	0.15	0.06
EMZ	Male mz twinpairs	48	0.83	0.84	0.04
	Female mz twins	22	0.65	0.70	0.06
BB	Grandparent: grandchild	64	0.24	0.06	0.06
	Uncle/aunt: Nephew/niece	262	0.06	0.03	0.05
	Father: mother	116	0.08	0.05	0.09

Table 4: Different genetic components in td ridge-count and maximal atd angle in the Bengalee sample (BB), using the formulae proposed by Fisher, 1918(A), Penrose, 1971 (B) and 1972 (C).

Genetic component	*Formula*	*td ridge -count*	*Maximal atd angle*
Total genetic h^2 component,	a and b	0.75	0.73
Additive genetic	A	0.55	0.63
component	B	0.53	0.55
Dominant genetic	A	0.20	0.10
Component	B	0,22	0.17
X-linked inheritance		-	
fromParent: offspring	B	0.14	0.48
correlation Sibpair	C	0.46	1.10
correlation			
Y-linked influence	B	0.14	0.48
from Parent:	C	0.23	0.55
offspring correlation			
Sibpair correlation			

The suggestion of an influence of Y-chromosome with occasional X-Y interchange for the position of t-triradius (Loesch, 1986) cannot be clearly seen in the parent: offspring correlations. A slight indication of Y-chromosome effects can be suggested in the positive value for Y-linked influence in the parent: offspring correlations, more so for maximal atd angle than in td ridge-

count. A high correlation between grandparents (mostly paternal grandfathers) and grandchildren (most of whom are son's sons) may however be indicative of Y-chromosome effect.

A large share of common genes between td ridge-count and maximal atd angle may be suggested from the high intercorrelation between the traits (from –0.68 to –0.78) in son's sons) may however be indicative of Y-chromosome effect (Table 5).

Table 5: Coefficient of correlation between td ridge-count and maximal atd angle

Different populations	*Sex*	*Individuals*	*r*	*S.E.*	*Reference*
BB	M	463	—0.70	0.02	Mukherjee,1967
	F	372	—0.68	0.03	Mukherjee, 1967
ENZ	M	48	—0.78	0.06	Present study
	F	22	—0.68	0.11	Present study
BM	M	50	—0.77	0.06	Present study

The cross-correlations for td ridge-count and maximal atd angle between parent: offspring pairs is - 0.24 and between sibpairs is –0.26 in the BB sample.

Critical Analysis: An advantage of using td ridge-count as a measure of distal displacement of t-triradius is to locate the problem of an associated trait. For example in table 6, it is shown that in a sub sample of 23 male Mood disorder, MDP, patients who were characterised as 'Bipolar', had both td ridge-count and maximal atd angle lower than in their 23 unaffected male close relatives. This indicates an ulnar shift of the d-triradius among the patients of bipolar disease. This is reflected by the adt angle which is over 160 degrees in the patients but only over 157 degrees in their relatives. This suggests the possibility of further usefulness of the use of td ridge-count in clinical diagnosis.

Table 6: Distribution of mean td ridge-count and mean maximal atd angle in 23 pairs of BP patients and their unaffected male parents

Trait	*BP patients*	*Unaffected male relatives*
td ridge-count	177.69 ± 7.6	185.32 ± 5.7
Maximal atd angle	175.30 ± 3.0	176.32 ± 2.4

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