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PALM-PRINT PATTERN IN CONGENITAL HEART DISEASE

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In a previous paper (Sánchez Cascos, 1964) the results of an analysis of the finger-print pattern in a series of 150 patients with congenital heart disease were presented. Statistically significant differences were found between the patients as a whole and a normal control group and also between different diagnostic groups in the series. These differences seemed to be due to a relatively small number of patients who had abnormal patterns, and we suggested that these patients could represent the genetically determined fraction of congenital heart abnormalities.

In this paper the results of a palm-print analysis in 150 cases of congenital heart disease are presented. Most of these, but not all, are the same patients as those reported in the earlier paper.

The palm-print, like the finger-print, shows a complex pattern of ridges. In such a print the term "triradius" is used to describe a point from which three ridges radiate demarcating three regions, each of which contains a system of almost parallel ridges (Penrose, 1963). The palm-print usually contains five triradii (Fig. 1 and 2); four of them are found at the base of the second to fifth fingers and are called, respectively, the *a*, *b*, *c*, and *d* points; the fifth triradius is located near the base of the fourth metacarpal and is called the *axial* or *t* triradius. Sometimes the *t* triradius is displaced distally towards the centre of the palm and the symbols *t'* and *t"* are used to indicate progressive distal displacement. Occasionally a *t'* triradius is found in addition to the normally placed *t* (Fig. 2), in which case only the abnormal *t'* triradius is used for the angle measurements described below.

The *atd* angle is under strong genetic control (Penrose, 1954) and its variation has been studied extensively in mongolism and other chromosomal abnormalities.

This paper reports a study of this angle and of the triangle based on the *a*, *d*, and *t* points in this series of patients with congenital heart disease.

Material and Methods

Palm-prints were made from both hands of the 150 patients with congenital heart disease (CHD), all of whom had been investigated in the Department of Cardiology of the Fundación Jiménez Díaz of Madrid. Only patients in whom the diagnosis was soundly established were included in this study.

There were 17 patients with atrial septal defect (ASD), 21 with isolated ventricular defect (VSD), 23 with isolated pulmonary valve stenosis (PS), 34 with Fallot's tetralogy (FT), 18 with aortic stenosis (AS), including valvar and subvalvar varieties, and one with supravalvar stenosis, 7 with aortic coarctation (AC), 12 with persistent ductus arteriosus (PDA), and 18 with various other anomalies (Var). Fifty normal subjects (Nor) were used as controls.

From the palm-prints the three angles, *atd*, *tda*, and *tad* were measured and the *atd palm triangle* was constructed. The *t* point was described as being in the *t°* position when the *atd* angle was 45° or less, in the t' position if it was between 46° and 70°, and in the *t"* position if the angle was 71° or more. The amplitude of the *tda* angle determines whether the *t* point is in the ulnar or radial side or in the middle of the palm. We have described the *t* points as t_U when the *tda* angle was 86° or more, t_M if it was between 76° and 85°, and t_R if it was 75° or less. These geometric relations and the positions of the triradii are illustrated in Fig. 1. Fig. 2 is an example of an actual palm-print in a case of Fallot's tetralogy in which both *t°* and *t'* points coexist.

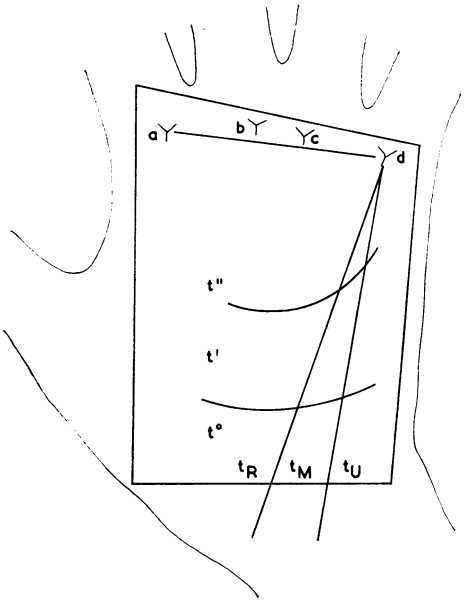

FIG. 1.—Schematic drawing of the palm triradii and the possible positions of *t*.

In 13 of the patients and two of the control subjects there were two *t* triradii coexistent on one or both hands; in these 15, as mentioned above, the more distal of the two triradii was used for the angle measurements.

RESULTS

The *t* point was absent in both hands of one patient with transposition of the great vessels (group Var) and on one hand of a patient with PDA. The *d* point was absent on both hands of one case of PS. In these cases it was, of course, not possible to construct the *atd* triangle.

The Table shows the mean values of each of the three angles in the right hand, in the left hand, and in both hands; and also the number of palms with each of the 9 possible *t* positions found in the different groups of patients and in the control subjects. In Fig. 3 the percentage of patients in each group having t°, t', or t'' and t_U, t_M, or t_R positions is shown graphically.

TABLE

PALM-PRINT MEASUREMENTS IN PATIENTS AND CONTROLS

Group	No. of cases	Hand	Mean values of angles			No. of palms showing								
			atd	*tda*	*tad*	t_U°	t_M°	t_R°	t'_U	t'_M	t'_R	t''_U	t''_M	t''_R
ASD ..	17	Right	56°	44°	80°	1	10	4	—	—	2	—	—	—
		Left	55°	44°	81°	1	9	2	—	3	2	—	—	—
		Both	56°	44°	80°	2	19	6	—	3	4	—	—	—
VSD ..	21	Right	56°	45°	79°	4	6	5	—	1	4	—	—	1
		Left	58°	45°	77°	2	10	5	—	1	2	—	—	1
		Both	57°	45°	78°	6	16	10	—	2	6	—	—	2
PS ..	23	Right	54°	44°	82°	3	10	4	2	1	2	—	—	—
		Left	55°	44°	81°	2	14	3	—	1	2	—	—	—
		Both	54°	44°	82°	5	24	7	2	2	4	—	—	—
FT ..	34	Right	51°	51°	78°	1	8	6	—	10	8	—	1	—
		Left	54°	51°	75°	—	8	7	1	7	10	—	—	1
		Both	52°	51°	77°	1	16	13	1	17	18	—	1	1
AS ..	18	Right	57°	42°	81°	3	9	4	—	1	1	—	—	—
		Left	54°	42°	84°	3	11	1	2	1	—	—	—	—
		Both	56°	42°	82°	6	20	5	2	2	1	—	—	—
AC ..	7	Right	61°	39°	80°	—	4	3	—	—	—	—	—	—
		Left	65°	38°	77°	—	4	3	—	—	—	—	—	—
		Both	63°	38°	79°	—	8	6	—	—	—	—	—	—
PDA ..	12	Right	56°	42°	82°	2	7	1	—	1	—	—	—	—
		Left	55°	41°	84°	1	8	1	1	—	1	—	—	—
		Both	55°	42°	83°	3	15	2	1	1	1	—	—	—
Var. ..	18	Right	56°	45°	79°	—	8	5	—	2	1	—	—	1
		Left	55°	45°	80°	2	6	4	—	4	—	—	—	1
		Both	56°	45°	79°	2	14	9	—	6	1	—	—	2
Nor. ..	50	Right	55°	42°	83°	12	30	4	—	2	—	—	—	2
		Left	53°	41°	86°	19	26	1	—	2	1	—	—	1
		Both	54°	41°	85°	31	56	5	—	4	1	—	—	3

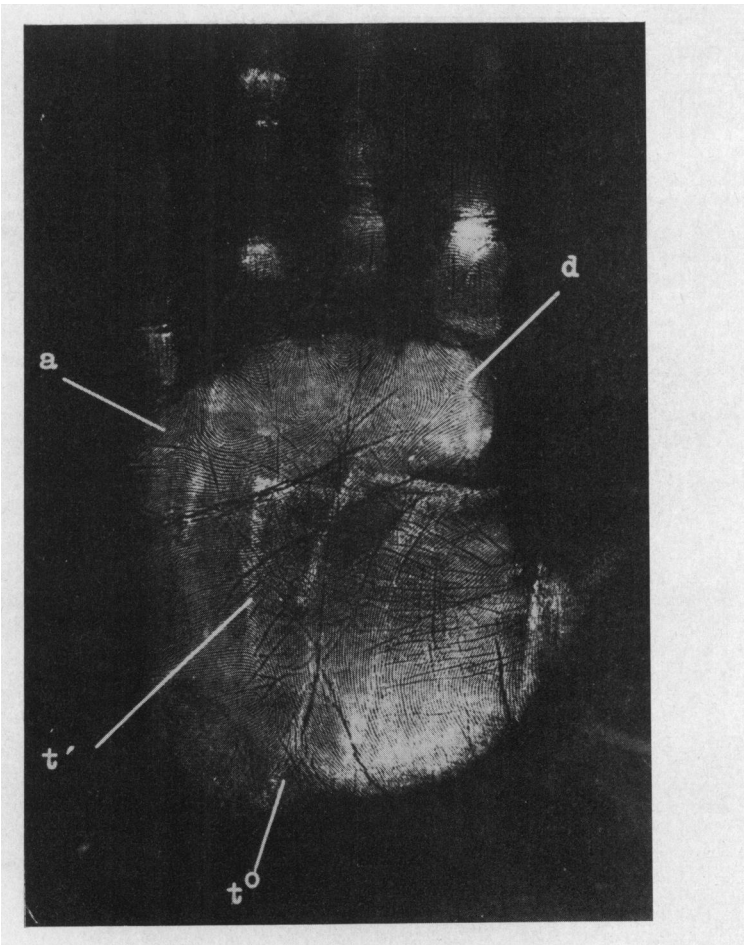

FIG. 2.—Actual palm-print in a case of Fallot's tetralogy. Two *t* points (*t*° and *t'*) coexist.

In general there is a tendency in the patients for the *t* triradius to occupy a more distal position (*t'* or *t''*) and this of course is associated with a wider *atd* angle. This is most marked in the Fallot's tetralogy group where the mean *atd* angle was 51°, compared with 41° in the controls ($p < 0{\cdot}001$). For the whole series of patients the difference in the *t* position as compared with the controls is statistically significant ($\chi^2 = 143{\cdot}15$; $p < 0{\cdot}001$). The groups with aortic stenosis, coarctation, and persistent ductus differed least from the normal subjects.

The *t* triradius was found most commonly in the t_U or t_M position in the controls and here again the patients with aortic stenosis and persistent ductus closely resembled the normals. The series as a whole, however, showed a greater proportion of cases with a t_R location; the difference between the whole series and the normal subjects is again statistically significant with $\chi^2 = 59{\cdot}77$ and $p < 0{\cdot}001$. As before, the Fallot's tetralogy group shows the greatest difference from the controls with nearly half the patients having a t_R position which was present in only 9 per cent of the controls ($\chi^2 = 14$; and $p < 0{\cdot}001$).

DISCUSSION

Genetic control of the position of the *t*, or axial, triradius of the palm is well established from twin and parent-child correlations. It appears that the magnitude of the *atd* angle is determined by

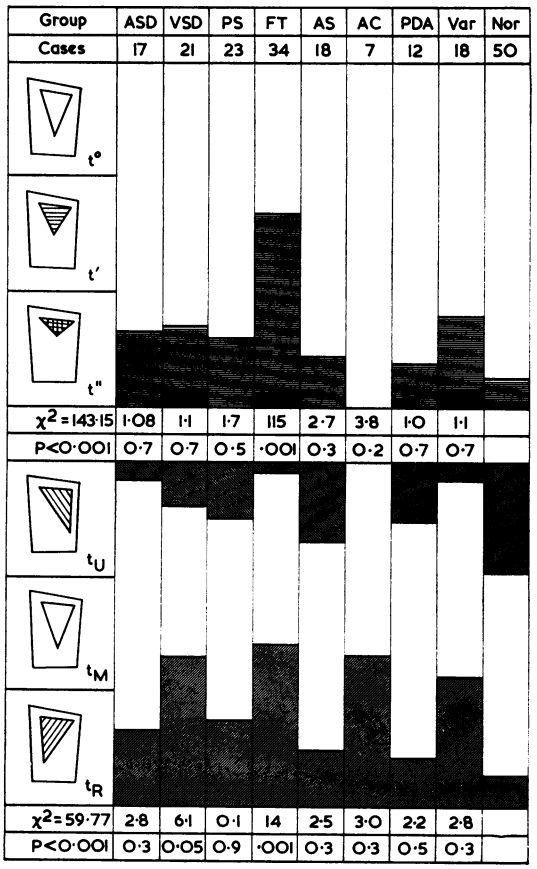

FIG. 3.—This shows the incidence of the different palm-print patterns found in the various groups of patients and in normal subjects. Abbreviations are as indicated in the text. The different *atd* palm triangles, according to position of *t*, are illustrated on the left and their respective incidence in each group is graphically expressed.

more than one gene pair, though environmental factors during an early fœtal stage of development can also influence it (Penrose, 1954).

Increase of the *atd* angle is due to a distal shift of the *t* point, bringing it closer to the *a* and *d* triradii which are relatively fixed. Penrose (1954) arbitrarily defined the *t*, *t'*, and *t"* positions as those with *atd* angles less than 45°, 45° to 56°, and more than 56°, respectively. More recently he has defined a *t"'* position where the *atd* angle exceeds 100° (Penrose, 1963). Using his definition, the *t* position occurs in 80 per cent of normal subjects (Penrose 1954), while *t'* is common in Turner's syndrome, *t"* in mongolism, and *t"'* in 13–15 trisomy (Penrose, 1963).

Hale, Phillips, and Burch (1961) defined the *t* position as that located in the proximal mid-palmar area between thenar and hypothenar areas, and the *t'* position as lying on a line transecting the base of the thumb.

These definitions, as the one we have used (described above), are arbitrary and rather artificial as distribution of the size of the *atd* angle is continuous: they do, however, reflect a real phenomenon of a shift of the axial triradius to a more distal position in the palm. The same phenomenon is present when the axial triradius is duplicated: a distal one is found in the *t'* or *t"* position and a secondary one in the normal *t*° position.

Hale and his colleagues (1961) studied the *t* location in 157 patients with congenital heart disease and in 143 patients with acquired heart disease. They found a statistically significant difference between the two groups with a greater tendency for the axial triradius to occupy a more distal position in the congenital group. They did not, however, analyse their data according to the different diagnostic categories in this group.

Rowe and Uchida (1961) also found in mongoloid patients that the axial triradius was more frequently in the normal *t*° position in those without cardiac abnormality than it was in those with associated congenital heart disease.

The total number studied in the present series is rather small, but the analysis of the results according to diagnosis has yielded some interesting results. In keeping with Hale's observations there is a tendency to a more distal position for the axial triradius in the series of congenital heart disease patients as a whole. While 92 per cent of the normal controls have a *t*° position, the patients with congenital heart disease, other than those with aortic stenosis, aortic coarctation, and PDA have a less frequent *t*° position, ranging from 82 per cent in those with isolated pulmonary stenosis to only 49 per cent in those with Fallot's tetralogy.

The shift of the axial triradius is not only distally but also radially. Only 9 per cent of the controls had a t_R position, but most of the congenital heart disease groups had 25 per cent or more with *t* in this position. This was again most marked in the patients with Fallot's tetralogy where t_R

occurred in 47 per cent. In all groups the increase in the incidence of the t_R position was at the expense of the t_U position, there being no significant difference in the incidence of t_M. In this respect also the patients with aortic stenosis and PDA showed the least variation from the normal U.M.R. pattern.

If these results are considered together with those of the analysis of the finger-print patterns in congenital heart disease already reported (Sánchez Cascos, 1964) three main conclusions emerge:

(1) There is a fraction of the patients with congenital heart disease whose dermatoglyphs differ substantially from the normal pattern. Knowing that finger- and palm-print patterns have a genetic basis it seems logical to suspect that this fraction represents the genetically determined fraction of the patients. Further study of this fraction and of their families is indicated and is now in progress in our laboratory.

(2) If the first conclusion is accepted it seems, as judged from dermatoglyphs, that some types of congenital heart disease, notably Fallot's tetralogy, fairly commonly have a genetic basis, while others, especially PDA, but also VSD, aortic stenosis, and coarction of the aorta, more rarely do so.

(3) Dermatoglyphic analysis can be useful diagnostically. In the earlier paper we noted that a patient with congenital heart disease having more than two arches in their finger-prints was very likely to have pulmonary stenosis, whereas one with more than four whorls probably had either aortic stenosis, coarctation of the aorta, or Fallot's tetralogy. The present results suggest that a patient with t'_M or t'_R pattern is likely to have Fallot's tetralogy; the presence of the t'_R pattern indeed makes the probability of this diagnosis more than 50 per cent.

SUMMARY

Palm-prints from 150 cases of congenital heart disease have been analysed and compared with those of 50 normal control subjects. Differences between the patients and the controls were statistically significant.

Patients with congenital heart disease tend to have their axial triradius in a more distal and more radial position than do normal subjects. This shift was particularly conspicuous in the group with Fallot's tetralogy. On the other hand patients with aortic stenosis, coarctation of the aorta, and persistent ductus arteriosus differed least from the normal.

The dermatoglyph patterns may provide a means of identifying the genetically determined fraction of patients with congenital heart disease and may also be of some diagnostic use.

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