

Electro Cardiographic Features of Patients With Tetralogy of Fallot

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Abstract

Background: For many decades, the ECG was the workhorse of non-invasive cardiac test and today although other techniques provide more details about the structural anomalies in congenital heart diseases, ECG is likely to be part of clinical evaluation of patients with such diseases because it is inexpensive, easy to perform and in certain situations may be both sensitive and specific.

Objective: this study carried out to identify the pattern of ECG study in patients with TOF.

Methods: this is a retrospective study of 200 patients with TOF, referred to Ibn Al-Bitar cardiac center from April 1993 to May 1999. The diagnosis of TOF established by echocardiographic, catheterization and angiographic

study. For each patient, the ECG tracing had been analyzed for rhythm, p-wave, P-R interval, QRS axis, duration and T-wave in V1 and any chamber enlargement.

Results: The ECG analysis revealed that all patients had sinus rhythm, normal P-R interval and normal p-wave duration and amplitude, and normal QRS duration. All studied patients had one criteria of RVH and 95% of them had two or more of such criteria.

Conclusion: we found that in the absence of RVH criteria, the diagnosis of TOF is unlikely and the present of northwest axis should indicate canal type VSD.

Key words: ECG, TOF, congenital heart disease

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Introduction

Willem Eintoven considered the father of electrocardiography (ECG) and he credited with bringing the ECG to the bedside, in 1901 he published a description of advice ideally suited for recording the rapidly changing and weak current of cardiac electrical activity present on his body surface and he identified the major waveform of the ECG. At 1932 chest leads ECG had been described⁽¹⁾.

For many decades, the ECG was the workhorse of non-invasive cardiac test and today although other techniques provide more details about the structural anomalies in congenital heart diseases; ECG is likely to be part of clinical evaluation of patients with such diseases because it is inexpensive, easy to perform and in certain situations may be both sensitive and specific. Tetralogy of Fallot (TOF) is the most common form of cyanotic congenital heart disease and it represents about 8-10% of all congenital heart diseases. TOF characterized by four features⁽²⁾:

Large Ventricular Septal Defect (VSD), Pulmonary Stenosis (PS), Overriding of Aorta. Right Ventricular Hypertrophy (RVH).

The atrioventricular conduction is normal both in the surface electrocardiograph, and by electrocardiophysiological study. So the rhythm as a rule is sinus and PR interval is normal. The RVH, which is one of the morphological criteria of TOF, is common finding on ECG of TOF patients without the diagnosis is unlikely.^(2,3,4)

Methods

This is a retrospective study of 200 patients with TOF, referred to Ibn Al-Bitar cardiac center from April 1993 to May 1999. The diagnosis of TOF established by echocardiography, catheterization and angiographic study. For each patient, the ECG tracing had been analyzed for rhythm, p-wave, PR-interval, QRS axis, duration and T-wave in V1.

The standard electrocardiograms were recorded on direct writing units with the patient in supine position and included the classical six standard and augmented limb leads and the six precordial leads (VI to V6). The conventional recording speed is 25 mm/sec and at full standardization an amplitude of 10mm is equaled to 1 mv. The ECG tracing were analyzed for rhythm, axis, p-wave and QR.S-T contour. The simplest way to measure the frontal plane QRS axis direction is to represent lead I as 0 (left) to 180 (right) and lead AVF as 90 (inferior) to 90 (superior). Normal QRS direction is age dependant and range from 10-120° in spit. That there is no single recognized authority for electrocardiography and various experts have suggest slight different limits of normal. Right axis deviation present when the QRS axis is more positive than normal (up to +180) and left axis deviation is present when QRS- axis is less then normal (up to -90). The axis is referred to as "superior" or "indeterminate" or "northwest" (neither left nor right) when it is between - 90° to ± 180. Right axis deviation is a criterion for RVH but in pediatric patients left axis deviation is not criterion for LVH.

The upper limit of the normal P-R interval considered in this study was 0.2 seconds, and for the height of p-wave (lead 2) was 2mv and for p wave duration (lead 2) was 0.12 second.

The QRS duration is age dependent; it is less than 90 milliseconds throughout childhood and early adolescence and less than 80 milliseconds through age 8 years.

Criterion for RVH tends to be more specific than those for LVH and include right axis deviation, tall R wave in right precordial lead (V1, V2), positive T wave in lead VI after 48 hours, RSR pattern in lead VI positive avR, and deep S wave in left precordial lead (V2, V6), also evaluation of R:S ration in V1 and V6 are useful for detecting RVH.

Criteria for LVH is less specific and include ST segment depression and T wave inversion "LV strain pattern" in left precordial leads (V5, V6) and deep Q wave in these leads in addition to increase in voltage amplitude (S in V1 and R in V6) but there has not been general agreement on the amplitude of Q, R and S waves in defining what might be considered abnormal .It is important to emphasize that evaluation of ventricular hypertrophy should not based on voltage criteria alone. Biventricular hypertrophy may be inferred when criteria for both left and right ventricular hypertrophy are met. An alternative criterion uses prominent wide precordial voltage to diagnose biventricular hypertrophy (Katz-Wachtel criteria) .

Results

The analysis of the ECG records of studied group reveals that all patients were in sinus rhythm and the P-R interval was normal in all, but one patient had P-R interval prolongation. All cases had normal p-

wave duration and amplitude except in one patient with tall and peaked and in 24 patients (12%) the p wave were deeply inverted in right pericardial leads. The QRS duration (measured in lead II) was normal in almost all instances and Most cases showed a sharp transition of QRS in V1 to V2 from predominant positive to predominant negative deflection. The QRS AXIS was determined in all cases. It was right axis deviation in 178 patients (89%) and within normal range in 6 patients (3%) while the northwest or undetermined in 16 patients (8%). The majority of cases had axis from +120 to +170. There was no left axis deviation in any patients. The mean QRS axis was 150°. The distribution of axis deviation showed in Fig. 1. The analysis of QRS in V1 showed that in 185 patients (92.5 %) of cases the R/S ratio was greater than 1 and was considered as evidence of RVH. The mean height of R were in V1 was 11.5 mm while in the mean of S wave was 1.8 mm. Q wave was detected in V1 in 15 cases (8.5%) while in the other 185 patients (92.5 %) there were no such Q wave in that lead. In most of the cases there is persistent of S wave in the left pericardial leads (V5, V5) and the R/S ratio were less than 1 in 178 patients (26 %) the R/S ratio were more than 1. The R/S ratio in lead AVR was greater than (+ve deflection) in 189 patients (89%) and this considered as other sign of RVH. There were 126 cases (63 %) with inverted deflection of T wave in V1 and in the remaining (37 %) it was upright in same lead.

Degree of axis	Frequency	Percentage%
80	1	0.5
85	2	1.5
90	3	3
100	3	4.5
110	1	5
120	14	12
130	30	27
140	28	41
150	40	61
160	38	80
170	20	90
180	4	92
200	6	95
210	2	96
220	8	100
	200 patients	100%

Discussion

The ECG tracing showed that all patients had sinus rhythm and all (except one) had normal atrioventricular conduction and this finding compatible with other studies⁽⁵⁾.

The ECG showed that the p wave in most patients were peaked or tent shape, but it was not abnormally tall or wide and this due to absence of right atrial enlargement. We noticed that 24 patient (12%) had negative deflection of the P wave in lead VI, and although this finding is common in sever isolated pulmonary valvular stenosis, due to right atrial enlargement and dilation, in TOF this finding is not mentioned previously and a data regarding this finding are not available in reports of other series reviewed. We found a relation between this ECG finding and history of hyper cyanotic spells, which is statistically significant with P value =0.01. The possible explanation that the P wave is not influenced by RA enlargement alone but also, to a less important way, by the degree of peripheral oxygen desaturation, the effect of which could possibly be related to the increased tonus of the sympathetic systems by increased the degree of desaturation⁽⁶⁾.

All our patients had normal QRS duration and this compatible with other series⁽⁷⁾. The majority of patients in this study (90%) had right axis deviation and this compatible to the finding of most other studies^(5,6,7).

The mean of axis of our patients was +150°, and this is relatively higher than Pileggi study⁽⁵⁾ where the average was +135 and this due to older patients included in our study with more severe degree RVH and pressure on which the axis depend to some extent. There was 18 patients with undetermined or northwest axis, 6 patients of them had the non classical VSD (3 with AV canal and 3 with inlet type VSD), while all other patients had classical VSD with moderate severity. Normal axis deviation is exceptional in TOF. Six patients had such axis, 2 of them only had mild "acyanotic" TOF, while all other had moderate or sever form of TOF. All other patient with pink TOF had axis deviation In usual range, from these finding we conclude that there is very

minimal correlation between the frontal plane QRS axis and different homodynamic groups of TOF and this compatible with Edward *et al*⁽⁸⁾ study, while DEPASQUALE *et al*⁽⁷⁾ reported that the degree of pulmonary stenosis is sufficient to alter the orientation of QRS axis.

All our patient (100%) had one criteria of RVH according to Ganzalo *et al* criteria (right axis deviation, R/S V1 >1, R/S V6 <1, +ve AVR and T inversion in VI) while 2 criteria presented in 95% of patients. So in the absence of RVH criteria on ECG, the diagnosis of TOF should considered cautiously, and this compatible with Edward *et al*⁽⁸⁾ study and in the presence of any degree of cyanosis with any combination of such ECG finding, the diagnosis of TOF is likely, but it wise to remember that there is no diagnostic combination of ECG signs for TOF.

Among the 200 patients included in this study, 15 patients only (7.5%). had QR pattern in lead VI; in 3 patients only there was suprasystemic RV pressure; 2 patients with LV pressure more higher than RV pressure while in all other patients the pressure in two ventricles was equal and in all the 15 patients the RA pressure was normal. This result does not agree with those of many other authors who related this finding to suprasystemic RV pressure or to RA enlargement⁽⁹⁾.

Conclusions

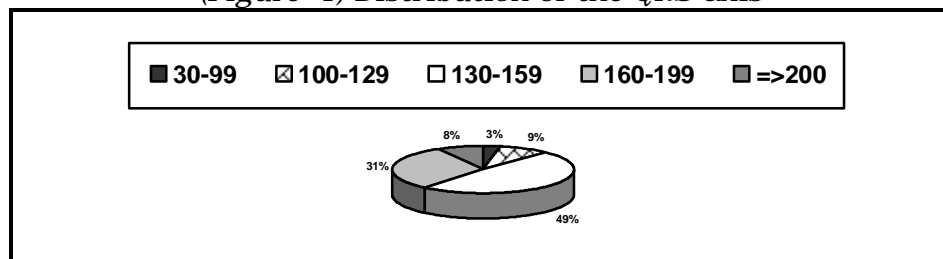
Although there is no pathognomonic ECG finding in patients with TOF, the combination of ECG criteria can strongly suggest the diagnosis.

The presence of sinus rhythm, normal atrioventricular conduction, one or more criteria of RVH and right axis deviation suggest the diagnosis of TOF and the absent of any one of these features.

There is a poor correlation between the frontal plane axis and the hemodynamic severity of the patients.

The presence of northwest axis indicates the presence of canal type VSD.

(Figure- 1) Distribution of the QRS axis



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