THE ELECTROCARDIOGRAM IN PULMONARY VALVE STENOSIS WITH INTACT VENTRICULAR SEPTUM

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It has been stated that the electrocardiogram in pulmonary valve stenosis gives an accurate estimate of right ventricular systolic pressure. Nadas (1957) writes "we have not found any patient with a right ventricular systolic pressure of more than 100 mm. of Hg who has not demonstrated at least one of the following three important electrocardiographic criteria: (1) RV1 of more than 20 mms., (2) P pulmonale and (3) changes in the ST segment and T wave through V4. Furthermore, once any of these features are noted, the chances that the pressure in the right ventricle is high, are good." De Pasquale and Burch (1960) and Engle et al. (1960) report similar findings.

We have had reason to doubt the value of the cardiogram in the prediction of right ventricular systolic pressure. The present study was, therefore, undertaken.

SUBJECTS AND METHODS

Right heart catheterization data were available for 90 patients with pulmonary valve stenosis and intact ventricular septum of whom 45 were male and 45 female. The average age of the patients was 13·5 years (range 1·5 years to 48 years). They have been divided into four groups (Table I) according to the level of the right ventricular systolic pressure: Group I consisted of 7 patients with right ventricular systolic pressure less than 35 mm. Hg, Group II consisted of 35 patients with pressures between 36 and 60 mm. Hg, Group III of 31 patients with pressures between 61 and 110 mm. Hg, and Group IV of 17 patients with pressures in excess of 110 mm. Hg. A right-to-left shunt at atrial level (Table I) was found in 10, all of whom had a high right ventricular systolic pressure (range 68–240 mm. Hg).

RESULTS

Cardiograms recorded at the time of the cardiac catheterization have been studied and the results are summarized in Table I. It is evident that many of the cardiographic parameters are related to the right ventricular systolic pressure. P pulmonale and ST–T deformity in leads V1–V4 occurred only in Groups III and IV. The height of the R wave in lead V1 tends to increase and the depth of the S wave to decrease with rising right ventricular systolic pressure. The harmonic mean of the ratio R/S V1 rises from 0·4 in Group I to 5·9 in Group IV. The height of the R wave in lead V6 is not related to the right ventricular systolic pressure, but the depth of the S wave in lead V6 increases with increasing right ventricular systolic pressure. The electrical axis in the frontal plane tends to become deviated further to the right with increasing right ventricular systolic pressure, the mean value for Group I being +76° and for Group IV +137°. However, there is wide variation in the cardiographic parameters in each group, and cardiographic evidence of right ventricular hypertrophy may be entirely absent in patients with a high right ventricular systolic pressure (Fig. 1A, C, and D).

The present study shows that though the cardiographic signs of right ventricular hypertrophy indicate a high right ventricular systolic pressure, the converse is not true, and that a high right
ventricular systolic pressure can occur in their absence. Applying Nadas' (1957) three criteria in the present study, none of the 7 patients in whom the R wave in lead V1 was greater than 20 mm. had a right ventricular systolic pressure of less than 90 mm. Hg. P' pulmonale was present in the tracings of 8 patients among whom the lowest right ventricular systolic pressure was 93 mm. Hg. ST–T deformity in leads V1–V4 occurred in 10, and in only 2 of them was the right ventricular systolic
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Fig. 1.—Pulmonary valve stenosis. The electrocardiograms of 4 patients in Group III with right ventricular systolic pressures between 61–110 mm. Hg.
pressure less than 100 mm. Hg (60 and 80 mm. Hg). However, 12 (44\%) patients with right ventricular systolic pressure in excess of 100 mm. Hg showed none of the criteria cited by Nadas. The age range in the present study is wider than that of Nadas, but 5 of the 12 patients were less than 15 years and the youngest was 2\frac{1}{2} years.

Engle et al. (1960) found that a dominant S wave in V6 occurred only in patients with a right ventricular systolic pressure over 100 mm. Hg. In the present study, 6 patients had S/R ratio in V6 greater than 1.5; in 4 of these the right ventricular systolic pressure exceeded 100 mm. Hg and in all 6 it exceeded 90 mm. Hg. Engle et al. also found that an R wave in lead V1 greater than 10 mm. implied a right ventricular systolic pressure greater than 80 mm. Hg, and that patients whose right ventricular pressure exceeded 140 mm. Hg showed an R wave in lead V1 greater than 20 mm. Hg. This was not found to be invariably true in the present series. The R wave in lead V1 exceeded 10 mm. in 36 patients, and 7 (19\%) of these had right ventricular systolic pressures of less than 80 mm. Hg, while 5 (71\%) of the 7 patients whose right ventricular systolic pressure exceeded 140 mm. Hg had R waves in lead V1 of less than 20 mm.

De Pasquale and Burch (1960) found that the pattern rS lead I and Rs lead V1 occurred in patients with right ventricular systolic pressure over 100 mm. Hg. This was not a useful sign in the present study in which 16 (24\%) of the 63 patients with this pattern had right ventricular systolic pressures of less than 100 mm. Hg.

Bentivoglio, Maranhao, and Downing (1960) in a series of 100 patients in a similar age range to those of the present study considered that the right ventricular systolic pressure could not be predicted from analysis of the cardiogram. Keith, Rowe, and Vlad (1958) also found that it was not possible to predict the right ventricular systolic pressure from the height of the R wave of lead V1 in any individual.

**Summary**

The electrocardiograms of 90 patients with pulmonary valve stenosis and intact ventricular septum have been studied. It has been found that the cardiographic signs of right ventricular enlargement are associated with a high right ventricular systolic pressure and they are unlikely to occur unless this pressure is high. Individual variation is great and a normal electrocardiogram does not exclude the presence of a high right ventricular systolic pressure.

**REFERENCES**


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