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Original Articles

Survival in Atrioventricular Discordance

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SUMMARY. **Limited information is available concerning the long-term survival of patients with atrioventricular discordance, ventriculoarterial discordance, and two ventricles (corrected transposition). The long-term follow-up of 107 patients examined at the Mayo Clinic over a 30-year period between 1951 and 1981 was reviewed. Overall survival from the date of Mayo Clinic diagnosis was 70% at five years and 64% at ten years. Associated variables were analyzed for their effect on survival including sex, age at diagnosis, presence of ventricular septal defect, pulmonary stenosis, dextrocardia, left atrioventricular valve insufficiency, and complete heart block.**

There was no significant difference between those with and without a ventricular septal defect (VSD). Pulmonary stenosis was protective when a VSD was present but was not a significant predictor of long-term survival. The only variable that consistently correlated with decreased survival was left atrioventricular valve insufficiency ($p < 0.04$ for univariate and stepwise Cox, and $p = 0.08$ for multivariate analysis). A logistic model for survival after open-heart surgery failed to identify any significant variable.

We conclude that the presence of left atrioventricular valve insufficiency in association with atrioventricular discordance significantly alters the long-term outcome. Atrioventricular valve replacement should be considered in such patients when insufficiency becomes hemodynamically significant.

KEY WORDS: **Heart block — Corrected transposition — Congenital heart disease — Ventricular septal defect — Tricuspid valve insufficiency**

It is known that atrioventricular discordance (also called corrected transposition) may be compatible with a normal life span when there is no other significant abnormality [1, 7]. However, congenital cardiac defects associated with atrioventricular discordance affect the clinical presentation and outcome [2, 4]. Because of the rarity of this condition, there is little quantitative information available concerning the expected long-term outcome of patients with atrioventricular discordance following their diagnosis. Therefore, an analysis of the clinical course of 107 patients was performed in order to answer two questions:

1) What is the expected survival of patients presenting with atrioventricular discordance?
2) What associated anatomic defects and/or naturally occurring complications affect the long-term survival?

Materials and Methods

The clinical histories of 107 patients with atrioventricular discordance were reviewed. Patients with double-inlet ventricle or isolated atrioventricular discordance (with ventriculoarterial concordance) were excluded. Data were tabulated by transferring information to computer punch cards concerning the age and date of Mayo Clinic diagnosis, date of birth, date of definitive diagnosis by cardiac catheterization, associated anatomic abnormalities if any, previous surgery (dates and procedures), most recent cardiac rhythm documentation, complete heart block date and cause (naturally occurring or associated with surgery), and last date known to be alive or date of death and cause. Patients with double-inlet ventricle were excluded. After extraction of the

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Table 1. Cardiac defects and their frequencies

Age at diagnosis	Mean = 12.7 years (birth–56 years)
Sex	Male, 64; female, 43
Ventricular septal defect	Present, 82; intact septum, 25
Pulmonary stenosis	Present, 57; absent, 50
Dextrocardia	Present, 24; levocardia, 83
Left atrioventricular valve insufficiency	Present, 35; none, 72
Complete heart block[a]	Present, 35 (23 natural onset)
Surgery: 69 at least one operation; 49 including patch closure of VSD and 55 at least one open-heart operation	

[a] Natural or surgical onset at any time prior to birth or during the follow-up period.

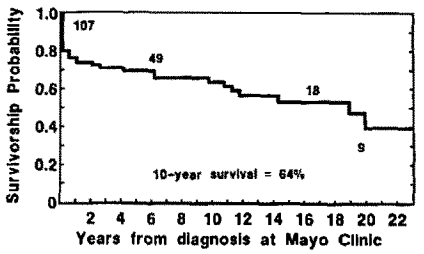

Fig. 1. Survivorship from Mayo Clinic diagnosis of 107 patients with atrioventricular discordance. Numbers indicate the patients alive and still being followed at several follow-up intervals.

above data from the clinical records, a letter follow-up was performed to establish the clinical condition of those patients without a Mayo Clinic examination in the previous year. Patients lost to follow-up were withdrawn from the analysis at the date of their last follow-up. Survival was analyzed to the date of death. Because surgical intervention of any kind was performed on 69 of the 107 patients (65%), an attempt was made to compare this group with those without surgery.

Complete heart block occurred in 35 patients between conception and 53 years of age and was a time-dependent variable. Therefore analysis was attempted, for this variable only, using the time-dependent covariate approach comparing those with and without this complication using the $BMDP_2L$ Statistical Software, Inc., package. Univariate survival analysis was performed with the logrank and Gehan-Wilcoxon tests. The analysis of survival was performed for continuous and discrete variables by the Cox method using a stepwise multivariate approach [3] removing variables with a p greater than 0.10. Survival was estimated using Kaplan-Meier curves [6].

All patients had cardiac catheterization and angiography. Left atrioventricular valve (tricuspid) insufficiency was graded angiographically as trivial, mild, moderate, or severe, and was judged to be present if at least mild (left atrium opacified without filling the pulmonary veins and rapid clearing of the atrium). Pulmonary stenosis was present if left ventricle to main pulmonary trunk peak systolic pressure gradient was 25 mmHg or greater. Patients with pulmonary atresia were included in the pulmonary stenosis group for purposes of survival analysis. The associated cardiac defects and their frequencies are summarized in Table 1. With the exception of one patient with situs inversus, the left-sided atrioventricular valve was the tricuspid valve.

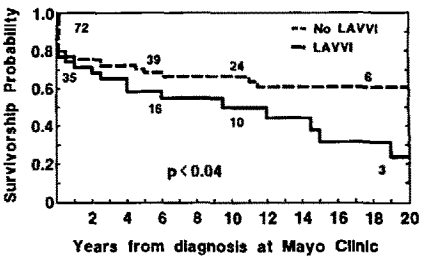

Fig. 2. Comparison of survivorship probability in patients with and without left atrioventricular valve insufficiency (*LAVVI*). The number of patients alive and still being followed in each group is indicated.

Results

Survival

The long-term survival from Mayo Clinic diagnosis of the 107 patients with atrioventricular discordance is shown in Fig. 1. After the initial mortality related to congestive heart failure in infancy, the survival curve was nearly constant at a rate of approximately 1%–2% per year of follow-up. Survival was 70% at five years and 64% at ten years. The median follow-up interval for the 62 patients alive at follow-up was 8.7 years and the median age at Mayo Clinic diagnosis was 8.7 years. The mean age at last follow-up was 23.1 years (range 5–75 years).

Risk Factors

The only variable that correlated with decreased long-term survival was left atrioventricular (tricuspid) valve insufficiency (stepwise proportional hazards, $p = 0.04$) and was present in 35 patients (33%) (Fig. 2). This was also true using univariate analysis (logrank test, $p < 0.03$) and Cox (see Table 2). Left atrioventricular valve insufficiency was significant when adjusted for other variables in the Cox model, and did not appear to be associated with other anatomic variables, age at diagnosis, or with sex. With all the variables in the model together, atrioventricular valve insufficiency was the only variable that approached significance at the 0.1 level ($p = 0.08$).

Left atrioventricular valve insufficiency appeared to be frequent in the group with intact ventricular septum. Although this group had an overall survival comparable to those with ventricular septal defect, the incidence of left atrioventricular valve insufficiency was higher, 13 (52%) of 25 versus 22 (27%) of 82, in the latter group.

The patients with ventricular septal defect had a slightly worse survival compared with those with

Table 2. Cox's life table regression model of survival in atrioventricular discordance

Variables	Beta[a]	SE[b]	*p*
Age at diagnosis	−0.004	0.013	0.75 (NS)[d]
Sex	−0.098	0.31	0.75 (NS)
Dextrocardia	0.23	0.34	0.49 (NS)
Ventricular septal defect	0.43	0.37	0.24 (NS)
Pulmonary stenosis	−0.40	0.30	0.18 (NS)
Left AV[c] valve insufficiency	0.62	0.30	<0.04[e]

[a] Positive beta indicates a variable correlated with decreased survival.
[b] SE, standard error of beta.
[c] AV, atrioventricular.
[d] NS, not significant.
[e] Significant at 5% level.

intact septum; however, this difference appeared to be due to surgical mortality and the other methods of analysis did not show ventricular septal defect (VSD) to be an independent risk factor for long-term outcome. A total of 42 patients with ventricular septal defect, no left atrioventricular valve insufficiency, and pulmonary stenosis had improved survival when compared with 18 patients with VSD, no left atrioventricular valve insufficiency, and no pulmonary stenosis ($p < 0.02$), even after adjusting for age and sex. Comparing the 57 patients with pulmonary stenosis with the 50 without, however, there was increased survival using univariate analysis only with the Gehan-Wilcoxon test ($p < 0.04$), but not with the logrank test. This was due to the difference only early after Mayo Clinic diagnosis (Fig. 3). Comparing those with intact septum and pulmonary stenosis and those with VSD and pulmonary stenosis showed no significant difference, but there were too few patients with intact septum and pulmonary stenosis to analyze properly the effect of pulmonary stenosis with and without VSD.

Natural onset complete heart block occurred in 35 patients (33%) and did not affect survival ($p = 0.37$). Other nonsignificant variables were sex, age at diagnosis, and dextrocardia. Other factors not separately analyzed because of frequency less than 3% in the group included patent ductus arteriosus, atrial septal defect, pulmonary vascular disease, right atrioventricular valve insufficiency, and pulmonary valve atresia.

Survival from the time of open-heart surgery was analyzed and multivariate analysis was performed in an attempt to identify factors that may increase the risk of such surgery (Fig. 4). No variable was predictive of outcome. A total of 55 patients had open-heart surgery and there were 40 late survivors. Survival at ten years postoperatively was 54%. Survival in those 38 patients who had neither a palliative nor open-heart surgery revealed a ten-year survivorship of 68%.

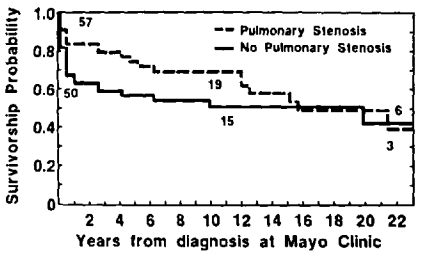

Fig. 3. Comparison of survivorship probability in patients with and without pulmonary stenosis. Note the early difference which is insignificant later.

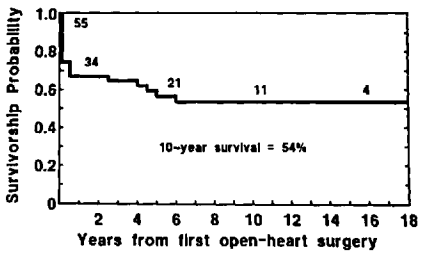

Fig. 4. Survivorship probability of patients having open-heart surgery. Closure of a ventricular septal defect was part of the operation in 49 (89%) of 55. The number of patients included (55) and the number alive and still being followed at several intervals are indicated.

Discussion

The survival of patients presenting with atrioventricular discordance depends on the associated abnormalities. Abnormality of the left atrioventricular valve that results in insufficiency of the valve leads to decreased survival whether occurring alone or in association with other defects. Those patients without any significant associated abnormality (corrected transposition with no VSD, left ventricular outflow tract obstruction, or atrioventricular valve insufficiency) are rare and numbered only seven (7%) in this study. Such patients are an important group with regard to the capability of the morphologic right ventricle to function normally for a normal life span. However, the high incidence of left atrioventricular valve insufficiency and its negative effect on survival raises the question of whether it is the right ventricular function or actually the morphologic tricuspid valve functioning in the systemic circulation which affects survival. If it is the latter, then atrioventricular valve replacement may be indicated in an attempt to interrupt this natural his-

tory. Because of the association of Ebstein's malformation of the tricuspid valve, valvuloplasty is often difficult and valve replacement is usually the only option.

Long-term postoperative follow-up of patients with a large VSD and pulmonary stenosis is not yet available, but it is suggested from this early data that late deaths are few and that their outlook will be comparable to the natural history without associated defects. Unfortunately, the increased mortality associated with left atrioventricular valve insufficiency and the hazards of natural onset complete heart block may still affect these patients. The incidence of the latter appears to be similar before and after complete surgical repair [5].

We conclude that left atrioventricular valve insufficiency is a negative prognostic factor in patients with atrioventricular discordance and should be of concern in their follow-up. When signs of significant left atrioventricular valve insufficiency—such as right ventricular and left atrial enlargement, pulmonary ventricular hypertension, and atrial dysrhythmias—are present, then left atrioventricular valve replacement should be considered.

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