

New considerations of the right ventricle

Cardiologists usually care for adult patients with valvular insufficiency on the left side of the heart, study long-term hemodynamic effects, measure the progressive dilation of the left ventricle and calculate the limits of the ejection fraction before the condition gets worse. Likewise, they estimate the prognosis and reversibility of the left ventricular dysfunction after valve replacement. The timing of surgical intervention is made up, therefore, at the fundamental moment of decision-making.

Less frequently, these professionals have to treat patients with pulmonary and/or tricuspid valve lesions that affect the size and function of the right ventricle (RV). But, again, the hemodynamic effects, ventricular dilation and limits of reversibility of the ejection fraction are repeated in the right ventricle, with the aggravating factor that lesions to be solved are multiple, of congenital nature in most of the cases, and that the cardiac chamber to be analyzed presents an irregular and complex geometry.

Undoubtedly, the right ventricle in tetralogy of Fallot, which has been surgically corrected, has been the best studied ventricular model, due to the frequency of well-operated patients and variability in sequelae and residual lesions that condition progressive dilation of this activity and the deterioration in contractile function.

Abnormalities in tetralogy of Fallot are subaortic interventricular communication with bad septal alignment, infundibular pulmonary stenosis (with valvular stenosis, atresia or agenesis), overriding aorta and ventricular hypertrophy. The corrective surgery includes the liberation of obstruction with a patch only in the RV, with transannular patch, patch in the pulmonary artery, with no patch or with a right ventricle to pulmonary artery conduit (RV-PA) and closure of the interventricular communication with transatrial or transventricular maneuver.

In adult life, corrected tetralogy of Fallot may present several sequelae and/or residual lesions that affect the size and function of the RV. These alterations include pulmonary valve insufficiency, residual pulmonary stenosis, interventricular communication and aneurysm of the right ventricular outflow tract. When these lesions are significant, patients should be re-operated.

Several reoperations were registered in a recent study in Toronto with a cohort study of 1069 patients with classical tetralogy of Fallot. These patients were born before 1984 and with surgical correction. Among them, we may mention: pulmonary valve replacement:

145 patients (14%), pulmonary artery extension: 93 (9%), repair of the RV outflow tract: 79 (8%), repair of the aneurysm of the RV outflow tract: 62 (6%) and replacement of the RV-PA conduit: 35 patients (3%). This indicates a high percentage of reoperation in a 20-year-old monitoring. (1)

However, the main problem of reoperation is to determine when it should be carried out; before dilation and deterioration of the right ventricle (RV) contractile function were irreversible, as it was shown in late pulmonary valve replacement surgeries in patients with corrected tetralogy of Fallot who presented severe pulmonary insufficiency. (2)

Therrien et al. observed that in this same kind of patients, pulmonary valve replacement may produce normalization of right ventricular volumes when it is performed before RV end-diastolic volume reaches 170 ml/m² or RV end-systolic volume reaches 85 ml/m², measured by cardiovascular magnetic resonance (MR) imaging. (3)

The advent of multiplanar MR imaging and the use of Simpson's method to analyze the tomographic cut series acquired at the end of the RV systole and diastole allow us to calculate volumes and ventricular function in a reliable way. (4, 5)

Several studies consider that cardiovascular MR should be included as a routine examination in the monitoring of these patients. Severe pulmonary insufficiency produces a progressive dilation of the RV which is estimated in 9 ml/m²/year. (6)

But, maybe, the most important study was the one carried out by Henkens et al. in 27 carrier patients with corrected tetralogy of Fallot and severe pulmonary insufficiency. A cardiovascular MR was performed in these patients before and after pulmonary valve replacement to analyze the predictive value of the size and function of the RV (before replacement) and the degree of improvement (after-replacement). The studied variables were: RV end-diastolic volume index for body surface (RVEDVI), RV end-systolic volume index for body surface (RVESVI), RV ejection fraction, left ventricular volumes and ejection fraction, pulmonary regurgitant fraction and corrected RV ejection fraction. In the results, the correlation between seriousness of pulmonary insufficiency with volumes and RV function (before replacement) and the reductions of such measures (after replacement) were ruled out. Likewise, a significant correlation between RVESVI (before replacement) and RVESVI together with RVESVI (after replacement) was observed. (7)

Even when, a universal criterion for pulmonary

valve replacement timing in corrected tetralogy of Fallot has not been established, its search over the base of the size and function of the RV with cardiovascular MR has allowed us to know the behavioural limits of this cavity before morphological changes were irreversible. This will help adult cardiologists to detect subtle modifications that are apparently asymptomatic in these patients.

From a wider perspective, the fact of knowing the spectrum of congenital heart diseases that affect the size and function of the RV is important. (8)

Congenital heart diseases that produce RV volume overload are: interatrial communication without correction, pulmonary insufficiency in corrected tetralogy of Fallot, pulmonary insufficiency in dilated pulmonary stenosis and tricuspid insufficiency in Ebstein's disease.

Congenital heart diseases that produce RV pressure overload are: RV and systemic RV outflow tract obstruction. The types of RV outflow tract obstruction include native pulmonary valve stenosis, infundibular and supra-valvar pulmonary stenosis and postoperative valvular, residual and prosthetic stenosis of the conduit and peripheral branches. The right ventricle in systemic position is placed in the corrected transposition of the great vessels and in the transposition of the great vessels with atrial *switch*.

The knowledge of the size and function of the RV in different congenital malformations will allow us to know the natural and modified evolution of these pathologies, to improve clinical monitoring and the appropriate medical and surgical treatment for the benefit of a number of patients with these conditions.

In this way, Dr. Warnes concept, "Born to be ill", may be changed into "Born to be treated well".

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