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Afterload – Mismatch: It's Importance in Surgical Decision Making

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Abstract

In valvular heart disease, heart failure due to intrinsic myocardial damage causes surgical high mortality. When patient survives surgical time; the functional class not always is below II, and long-term mortality is high. On the other hand, when heart failure is due to excessive afterload and normal myocardial structure, the reduction of excessive afterload normalizes ventricular function, reduce surgical mortality and improve long term survival.

Keywords: Afterload Mismatch; Aortic Valve Disease; Heart Failure

Introduction

The afterload is a fundamental determinant of left ventricular function in conjunction with the contractility, and preload [1]; with non invasive image methods as echocardiography [2] and magnetic resonance [3] has been possible obtain the calculation of systolic wall stress (afterload), based on of Laplace law. In clinical practice common to carry out surgical indications of cardiac valvular disease taken as fundamental parameter ejection fraction (EF) [4], excluding the value of hemodynamic loads to which the left ventricle is subjected. In 1980 Carabello et al. [5], demonstrates that in aortic stenosis with severe heart failure when afterload is excessively high the surgical treatment has low mortality, is followed by disappearance of heart failure [5] and improve long term survival. Since 1985 John Ross Jr. described the importance of relationship of afterload and ventricular function in mitral and aortic valve heart disease and describes the concept of afterload-mismatch [1]. In recent years, we have studied by echocardiography [2] and nuclear magnetic resonance [3] the importance of hemodynamic loads in the surgical valvular indication [2,3]. In this report we aim to demonstrate the value of the afterload to build a surgical indication in valvular surgery.

Ventricular function is usually assumed to be reflected only by ejection fraction (EF), and does not take into account all its determinants. This is specially apparent in the surgical indications of valvular heart disease, current guidelines use the EF, and ventricular end systolic diameter as the parameters used to assess the severity, prognosis, and surgical indication [4].

The importance of the concept of afterload-mismatch is exemplified with a 34 years old patient with an aortic root aneurysm, severe aortic regurgitation and mitral insufficiency. Two years previously he had closed a hypertensive ductus arteriosus with an Amplatzer. He presented to the Institute of Cardiology 11 months later with rapidly progressive dyspnea, orthopnea, at same time began, to have edema of lower limbs upward quickly progressed to anasarca and total disability; also appear progressive muscular atrophy to the point of needing a wheelchair to transfer (cardiac cachexia) (NY functional class III-IV). X-Ray thorax revealed significant cardiomegaly with a cardiothoracic ratio of 0.73, severe pulmonary venous congestion and pulmonary arterial hypertension (Figure 1A and Figure 2) and echocardiogram showed a huge ventricular dilatation with an end diastolic diameter of 86 mm, end systolic diameter of 74 mm and an EF of 28% (Figure 3A), and dP/dT of 646 mmHg/s. We calculated systolic wall stress which was found to be extremely high 191 g/cm^2 (normal values 41 g/cm^2) (Figure 3B) [2]. the case was submitted for clinical-surgical session and the patient was rejected by considering the high risk unacceptable form with little chance of survival during the surgical time; however, showed that the systolic wall stress (afterload) it was extremely high:191 gm/cm^2 (normal 41 gm/cm^2 + 0.05) [2,3], (Figure 3B) suggesting that severe heart

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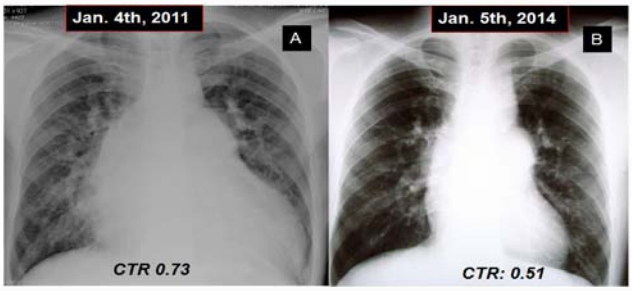

Figure 1: Thorax X Ray.
A) Cardiothoracic ratio (CTR 0.73) with significant left ventricular enlargement dilatation, also, ascending aortic and pulmonary trunk dilatation, it can be noted considerable pulmonary congestion.
B) Significat reduction in heart size CTR 0.51 and disappearance of radiological signs of pulmonary congestion.

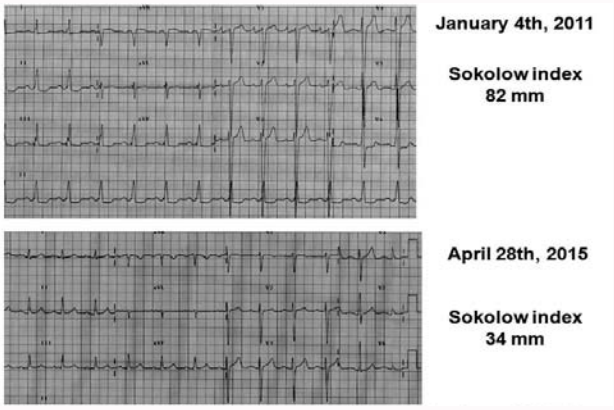

Figure 2: The electrocardiogram shows a significant reduction of Sokolow index from 80 to 34 mm.

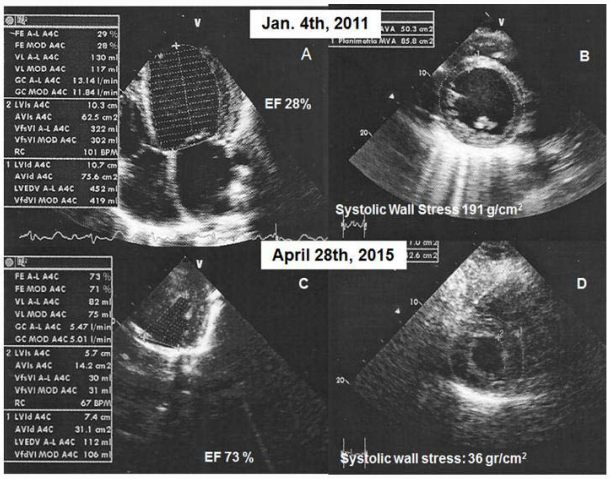

Figure 3: A) Baseline Echocardiogram EF 28%. **B)** Baseline systolic wall stress 191 g/cm^2. **C)** Echocardiogram 3 years after surgery with and EF 73%. **D)** Systolic wall stress of 36 g/cm^2 after surgery.

failure was due to excessive afterload (afterload-mismatch) (Figure 3B and 4) [1,2], so again the case was filed and decided to take him to surgery. Bentall and Bono with replacement of the aortic root and aortic prosthesis and St Jude mitral valve was successfully performed in January 2011. He was discharged and began cardiac rehabilitation and three months later he was found to be in NYHA class I. Three

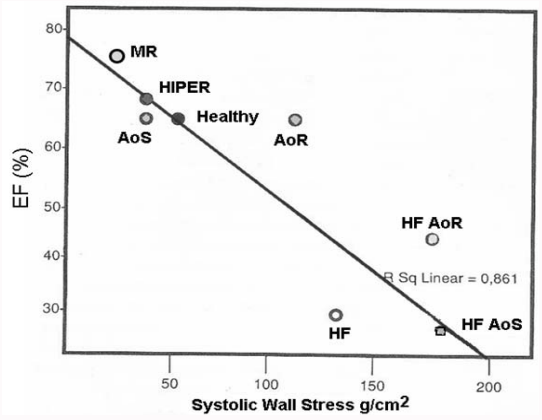

Figure 4: EF-Afterload Relationship [3].
When afterload is low the EF is high (mitral regurgitation: MR); in systolic overload (aortic stenosis: (AoS) and systemic hypertension: (Hyper)) the hypertrophy normalizes the afterload and it can be lower than normal (Healthy). Excessive afterload can reduce significantly the EF may result in severe heart failure without myocardial damage (afterload mismatch), aortic stenosis (HF AoS) or Hear failure in aortic regurgitation (HF AoR).

years later we performed a thorax X Ray shows a cardiothoracic ratio of 0.51 without pulmonary congestion (Figure 1B). Echocardiogram showed and EF of 73% (Figure 3C) and afterload (systolic wall stress) was normal 36 g/cm^2 (Figure 3D).

In patients with aortic valve disease and heart failure, with very high systolic wall stress which reflects left ventricular afterload-mismatch (Figure 4), surgery can be life saving even if EF is very low [2,3,5]. On the other hand, when afterload is near normal, it indicates the presence of myocardial damage, which increased surgical mortality [3,5]. In these subset of guidelines [1] support surgery for patients with symptomatic severe aortic regurgitation, EF is not the only parameter to assess ventricular function. By incorporating afterload on the evaluation of these patients [2,3] mortality may be reduced and long term survival significantly improved, just as this case demonstrates. Prospective studies are needed to evaluate optimal cut offs for afterload to predict surgical mortality and long term survival.

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