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Transcatheter aortic valve replacement and His bundle pacing in the presence of severe left ventricular dysfunction and left bundle branch block

Implante transcater de valva aórtica e marca-passo em feixe de His na vigência de disfunção ventricular esquerda grave e bloqueio de ramo esquerdo

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ABSTRACT – Aortic stenosis is the most prevalent valve disease in developed countries and has high morbidity and mortality after the onset of symptoms. The prevalence of severe aortic stenosis in elderly patients (>75 years) is approximately 3.4%. The transcatheter aortic valve replacement has been employed for approximately 20 years and had robust outcomes published. However, it is a challenging procedure when performed on a patient in cardiogenic shock, caused by severe deterioration of left ventricular function, a condition aggravated in cases of electromechanical dyssynchrony due to left bundle branch block. There is evidence that reestablishing the electrical conduction with a pacemaker implanted directly in the conduction system, in patients with left ventricular dysfunction and dyssynchrony, can significantly improve the systolic function. In this context, the objective of the present study was to present and discuss the particularities and evidence available for treating this complex subgroup of patients.

Keywords: Aortic valve stenosis; Bundle-branch block; Heart failure; Transcatheter aortic valve replacement; Pacemaker, artificial; Bundle of His

RESUMO – A estenose aórtica é a doença valvar mais prevalente em países desenvolvidos e apresenta alta morbidade e mortalidade após o início dos sintomas. A prevalência de estenose aórtica grave em pacientes idosos (>75 anos) é de aproximadamente 3,4%. O implante transcater de valva aórtica tem quase 20 anos de aplicabilidade e resultados robustos publicados. No entanto, é um procedimento desafiador quando realizado em paciente em choque cardiogênico causado por severa deterioração da função do ventrículo esquerdo, situação agravada em casos de dissincronia eletromecânica por bloqueio de ramo esquerdo. Há evidências de que o reestabelecimento da condução elétrica por meio de implante de marca-passo diretamente no sistema de condução em pacientes com disfunção ventricular esquerda e dissincronia pode trazer melhora significativa à função sistólica. Nesse contexto, o objetivo do presente trabalho foi apresentar e discutir as particularidades e as evidências disponíveis para tratamento desse subgrupo complexo de pacientes.

Descritores: Estenose da valva aórtica; Bloqueio de ramo; Insuficiência cardíaca; Substituição da valva aórtica transcater; Marca-passo artificial; Fascículo atrioventricular

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BACKGROUND

Aortic stenosis is the most prevalent valve disease in developed countries and has high morbidity and mortality after the onset of symptoms.¹ The prevalence of severe aortic stenosis in elderly patients (>75 years) is approximately 3.4%.²

The transcatheter aortic valve replacement (TAVR) has been employed for almost 20 years and had robust outcomes published.³⁻⁵ However, it is a challenging procedure when performed on a patient in cardiogenic shock, caused by severe deterioration of

left ventricle (LV) function, a condition aggravated in cases of electromechanical dyssynchrony caused by left bundle branch block (LBBB). There is evidence that reestablishing the electrical conduction with a pacemaker implanted directly in the conduction system, in patients with left ventricular dysfunction and dyssynchrony, can significantly improve the systolic function.⁶

In this context, the objective of the present study was to present and discuss the particularities and evidence available for treating this complex subgroup of patients.

The Research Ethics Committee of the *Instituto de Cardiologia de Santa Catarina* analyzed and approved this study (protocol 4.479.010), CAAE 39745020.7.0000.0113.

CASE REPORT

An 83-year old female patient with severe aortic valve stenosis, and history of hypertension and stroke with no sequelae, with preserved cognitive ability. History of dyspnea upon exertion with progressive worsening, and drop in ejection fraction on serial echocardiograms.

Electrocardiogram with sinus rhythm, LBBB and first-degree atrioventricular block (AVB). The transthoracic echocardiogram (TTE) showed a left ventricular ejection fraction (LVEF) of 32%, dyssynergy of septal contraction, diffuse hypokinesia of the other segments, and mean gradient between LV and aorta (LV-Ao) of 50mmHg; systolic pressure in the pulmonary artery of 50mmHg. She was under outpatient follow-up with treatment planning for aortic stenosis.

After 30 days, she was admitted to the hospital emergency room with pre-syncope and hypotension. A new TTE showed LVEF equal to 11%, mean VE-Ao gradient of 36mmHg, and aortic valve area (by continuity equation) of 0.32cm².

We opted for urgent TAVR, due to the high surgical risk, with postoperative mortality in 30 days estimated at 12.74%, by the risk score of the Society of Thoracic Surgeons (STS). There was a need for hemodynamic support with inotropes until the procedure was performed.

The computed tomography angiography revealed an aortic annulus area of 461mm², mean annular diameter of 24mm, annular calcification and, in the leaflets, no subvalvular calcium deposit. Coronary arteries originating more than 12mm from the valve plane and coronary sinus with an average width >30mm. The right femoral and iliac artery access had good anatomy.

She underwent general anesthesia with inotropic and vasopressor support. A temporary pacemaker implantation was performed. Pre-dilation was performed with an 18mm-diameter balloon catheter, with the implantation of a SAPIEN 3 prosthesis, number 23 (Figure 1). The procedure was concluded uneventfully. The trans-procedure echocardiogram revealed a final mean gradient of 4mmHg, with minimal anterior paraprosthetic regurgitation at the mitral-aortic annulus. On the fourth postoperative day, a new TTE showed LVEF of 21%. She was discharged on

Figure 1. Post-replacement aortography of SAPIEN 3 prosthesis number 23 with no signs of aortic paravalvular regurgitation.

the 11^o postoperative day as New York Heart Association (NYHA) functional class II.

The patient was readmitted to the emergency room 15 days after discharge, and 26 days after TAVR with symptoms of decompensated heart failure (HF) and urinary tract infection (UTI). The UTI was treated with ceftriaxone, with good clinical response.

The TTE showed an aortic valve prosthesis with good opening of its leaflets, mean VE-Ao gradient of 10mmHg, minimal paraprosthetic regurgitation, and LVEF of 17%. Considering the good result of the valve replacement and no consistent improvement in left ventricular function associated with the difficulty in clinical improvement, we opted for implantation of a pacemaker in the conduction system, aiming to minimize dyssynchrony caused by LBBB.

The procedure was performed under sedation and local anesthesia 7 days after hospital readmission and 33 days after TAVR. An electrophysiological study recorded the basic conduction intervals, observing conduction slowness at the infra-Hisian level in the presence of complete left bundle branch block: AH of 65 milliseconds, HV of 70 milliseconds (normal up to 55 milliseconds), and QRS of 230 milliseconds. For the safe implantation of the electrode next to the conduction system, an electrode was provisionally positioned in the right ventricle (RV) and, with a C304 deflectable sheath, a SelectSecure 3830 electrode (Medtronic) was taken up to the bundle of His with easy identification of a large Hisian electrogram.

At this point, there was capture of the conduction system with LBBB correction (QRS 120 milliseconds) with 1.5Vx1.0 millisecond (Figure 2). The implantation was

Figure 2. On the left, a pacemaker electrode positioned on the interventricular septum. On the right, electrocardiogram conducted before Hisian stimulus (QRS 230 milliseconds) and during stimulation with Hisian pacemaker (QRS 120 milliseconds).

completed with the placement of an electrode in the coronary sinus and an atrial electrode. Of all possible forms of stimulation, the greatest narrowing of the QRS complex was achieved with selective and corrective stimulation of the bundle of His, without further improvement with the use of the coronary sinus electrode. Thirteen days after the implantation of the pacemaker, the patient was discharged with significant clinical improvement.

After a 2-month follow-up, a new TTE showed LVEF of 43%, minimal paravalvular regurgitation, and a maximum VE-Ao gradient of 20mmHg. After a 9-month follow-up, the patient was in NYHA functional class I, with a LVEF of 48%.

DISCUSSION

For over a decade, TAVR has become a routine procedure in patients with severe aortic stenosis and high surgical risk, with an expected success rate of more than 90% in experienced centers.⁷ However, cardiogenic shock caused by severe aortic stenosis in a patient with LVEF <20% is an extremely challenging situation, due to the risk of the patient not enduring the procedure and to doubt about a chance of significant recovery of LV function.

In the reported case, the patient tolerated the TAVR procedure very well, despite the need for inotropic and vasopressor support. This confirms that TAVR is feasible and should be an option in patients in cardiogenic shock with markedly depressed LVEF (<20%), especially if such LVEF is a result of recent deterioration of LV function. Although the patient recovered from the acute phase and was discharged from the hospital, the LVEF remained below 30%

and she returned to the hospital presenting HF. The possibility that ventricular dyssynchrony caused by LBBB was preventing further improvement in LVEF was considered, therefore we opted for a Hisian pacemaker implantation, resulting in a significant recovery of contractile function.

Recently, Vijayaraman et al. showed a significant improvement in left ventricular function in eight of 11 patients with LVEF ≤50% after implantation of a pacemaker in a conduction bundle. In them, the baseline LVEF of $35\pm10\%$ rose to $42\pm9\%$ during follow-up. Three of these patients underwent implantation because of LBBB and reduced ventricular function.⁶ This finding is in line with the important improvement in our patient's LVEF. The result obtained in the present case warns to the routine need of considering the deleterious role of electromechanical dyssynchrony caused by LBBB in the left ventricular contractility in patients who maintain severe ventricular dysfunction, despite the good result of TAVR. It also indicates that, in case of the requiring a pacemaker after TAVR, especially in patients with LV dysfunction, preference should be given to the implantation of an electrode in the conduction system.^{6,8}

TAVR is feasible in patients with cardiogenic shock and severely depressed LVEF (<20%), especially if recent progressive deterioration of LV function is observed. Hemodynamic support with inotropes has a fundamental pre- and trans-procedure role. In patients with severe left ventricular dysfunction (LVEF <20%) undergoing TAVR and who have LBBB, the implantation of a pacemaker in the conduction system, abolishing the deleterious effect of electromechanical dyssynchrony, has a decisive role in obtaining additional improvement in ventricular function.

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None.

DECLARATION OF CONFLICTS OF INTEREST

The authors declare having no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: LEKST, LSCL and ARJDF; data collection: LEKST, LSCL and ARJDF; data interpretation: LEKST, LSCL and ARJDF; text writing: LEKST, LSCL, AT, ASG, AAS and ARJDF; approval of the final version to be published: LEKST, LSCL, AT, ASG, AAS and ARJDF.

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