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Case Report / Приказ болесника

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Left ventricular assist device implantation and concomitant aortic valve replacement

Имплантација уређаја за механичку циркулторну потпору леве коморе и придружена замена аортне валвуле

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SUMMARY

Introduction The implantable device for mechanical support of the left ventricular circulation (LVAD) is widely applied as therapeutic option for survival and improvement of the quality of life in patients with the end stage heart failure.

The objective of our paper was to present the implantation of the aforementioned device together with the aortic valve replacement in the same procedure.

Case outline The patient was admitted to the hospital during his terminal stage of a health failure with ejection fraction of 18%. In the last two years, the patient has been taken in to the hospital because of the acute worsening of a heart failure. The ergospirometry test showed that the maximum VO2 was 10.1 ml/kg/min. Because the medicament therapy didn't give sufficient results, the LVAD device was implanted as a bridge until a transplantation. Due to severe aortic insufficiency, the aortic valve was concomitantly replaced with bioprosthesis in order to prevent the negative effect of this valvular disease on pump work and clinical outcome.

Conclusion This case report confirms that LVAD implantation with the correction of a significant aortic insufficiency is a procedure with satisfactory short-term and long-term results.

Keywords: cardiac failure; LVAD; aortic valve

САЖЕТАК

Увод Имплантабилни уређаји за механичку потпору циркулације леве коморе (*LVAD*), широко се користе као терапијска опција за преживљавање и побољшање квалитета живота пацијената са терминлном срчаном слабошћу.

Циљ рада је презентација имплантације уређаја за трајну механичку циркулторну потпору леве коморе уз замену аортне валвуле у истој процедури.

Приказ болесника Пацијент је хиспитализован у терминалном стадијуму срчане инсуфицијенције са ејекционом фракцијом од 18%. У последње две године болесник је цетри пута хоспитализован због акутизације срчане инсуфицијенције. Ергоспирометријски тест показао је BO_2 максимум од 10,1 *ml/kg/min*. С обзиром на то да медикментозна терапија није дала задовољавајуће резултате уграђен је *LVAD* као мост до трансплантације срца. Због значајне аортне инуфицијенције валвула је змењена биопротезом да би се превенирао неповољни утицај на рад пумпе и клинички исход.

Закључак Имплантација *LVAD*-а уз корекцију значајне аортне инсуфициенције је процедура са задовољавајућим краткорочним и дугорочним резултатима .

Кључне речи: срчана слабост; *LVAD*; аортна валвула

INTRODUCTION

The implantation of the left ventricular assist device is a therapeutic option for treatment of the end-stage heart failure patients. However, this group of patients often suffer from different associated pathological changes of the heart, most commonly cardiac valves. Some of these defected valves require surgical correction at the same time when LVAD is being implanted. If not, they could interfere with the function of device and have unfavorable effect on the clinical outcome.[1].

In addition, uncorrected aortic insufficiency at the time of LVAD implantation may progress and affect the effectiveness of the pump by limiting forward flow [2].

We present the first case report in Serbia of the implantation of the left ventricular assist device and concomitant aortic valve replacement in patients with the end-stage heart failure.

CASE REPORT

A 64-year old male patient presented in the end-stage heart failure due to ischemic cardiomyopathy. The patient mentioned fatigue and continuous squeezing chest pains as symptoms. He has also been treated for bronchial asthma and frequent respiratory infections. In the last 2 years, the patient was hospitalized 4 times because of the heart failure symptoms. Selective coronarography has shown that left anterior descending artery (LAD) artery has a proximal stenosis around 90-95%, while the circumflex artery is occluded in its medial segment. The proximal part of the right coronary artery was also occluded.

Ergospirometry (cardiopulmonary exercise testing) showed reduced exercise capacity with peak oxygen consumption (VO_2 peak) 10.1 ml/kg/min.

A single-photon emission computerized tomography (SPECT) showed the absence of viable myocardium of theapex, lateral and inferior walls.

Echocardiography recorded severely impaired ejection fraction of the left ventricle with combined aortic defect. The complete aortic defect manifesting with aortic stenosis and low flow gradient due to extremely impaired systolic function of the left ventricle was evident (aortic valve area was 1.1 cm^2, peek gradient was 27, V max 2,6). Aortic insufficiency (AI) 2-3+ was recorded. The left ventricle dimensions were enlarged, end-diastolic diameter (EDD) was 7.2 cm, end-systolic diameter (ESD) was 6.6cm with ejection fraction (EF) 20% by Biplane and 18% by Teicholz. Echocardiography also recorded akinetic septum and basal segment of the anterior wall, akinetic posterior wall, as well as fibrously modified and dyskinetic basal inferior wall. Mitral valve morphology was preserved. The left moderate to severe atrial MR 2-3+ with its normal dimensions, i.e. 3.9 cm, was noted. The right

ventricular dimension was normal (1.8 cm), with good systolic and longitudinal functions, FAC 50% and TAPSE 24 mm.

The patient was categorized as NYHA class IV, INTERMACS class 4.

Upon the complete preoperative preparation, the patient was operated on in the conditions of extracorporeal circulation. After median sternotomy, the patient was heparinized and cannulated. Aortic valve replacements preceded pump implantation. Myocardial protection was achieved using antegrade cardioplegia solution. The aortic valve was replaced with na St. Jude Medical Biocor Bioprosthesis (Number 23).

The aortotomy was closed. After releasing the clamp, HeartWare LVAD (Medtronic, Minneapolis, MN, USA)was implanted on beating heart. The inflow cannula device was installed over the top of the left ventricle, the output graft was connected with the ascending aorta, while the power cable was drawn through the skin (Figure 1).

The patient became fully activated in the postoperative period. The patient and his family members were educated on hygiene maintenance of the spot where the power cable exits out the skin as well as interpretation of basic findings and LVAD controller alarm.

Echocardiography finding on discharge showed biological artificial aortic valve closing with each cardiac cycle. The left ventricle had mildly enlarged dimensions, EDD 5.8 cm and ESD 5.0 cm and EF in basal segment was estimated to 29%. The right ventricle had normal dimension – 2.6 cm, good systolic and poorer longitudinal function, TAPSE 12 mm (underestimated due to opening the pericardium).

The pump speed was set at 2,600 rpm, pump flow at 6.7 l/min, pump power at 4.1 Watts, and spare controller at 2,600 rpm.

The therapy prescribed on discharge included: Wafarin (according to therapeutic protocol so that INR would be 2–3); Acetilsalicid acid 100 mg, Ramipril tab. 2 × 5 mg, Bisoprolol Fumarate1 × 5 mg, Amiodarone 200 mg, Furosemide tab. 1 × 20 mg, Spironolactone 1 × 25 mg, Trimetazidine 2 × 35 mg, Pantoprazole 2 × 20 mg and Atrovastatin 1 × 10 mg.

On 30 day, 2-month, six month and one-year control visits, the patient did not manifest the signs of heart failure and LVAD parameters on controller were stable.

The pump speed was set at 2,700 rpm, in order to achieve better unloading of the LV, with pump flow 5 l/min and pump power 4.4 Watts. Echocardiography examination at 15 months showed biological artificial aortic valve closing with each cardiac cycle, with normal flow gradients, improvement in EDD and ESD from baseline values of 7.2 cm and 6.6 cm to 6.4 cm and 4.9cm respectively and mild mitral regurgitation. For EF and BNP (pg/ml), the baseline values of 20% and 960, improved to 46% and 176, respectively. The dimension of the right ventricle was sustained in normal range (2.6 cm) with good systolic function. There was normal flow through both inflow and outflow cannula.

DISCUSSION

The prevalence of a heart failure is roughly around 1 to 2 percent in adults and goes all the way up to 10 percent in patients older than 70 years.[3].

The therapy of choice for treating end-stage heart failure is the heart transplantation. However, the insufficient number of donors has accelerated the development of mechanical circulatory support devices. In the last couple of decades, the biggest improvement (leap) in treatment of heart failure was made in usage of short-term mechanical circulatory support for cardiogenic shock, and a long-term mechanical circulatory support for destination or bridge-to-transplant therapy [4].

Current indications for LVAD implantation are bridge-to-transplant patients, implantation as a permanent or destination therapy and a bridge to recovery of heart's function in cases when there is a significant improvement of heart's structure and function that is enough to achieve long-term disappearance of symptoms (in these cases, the explanation of the device is considered)[5].

The number of LVADs that are implanted worldwide is continuously rising. The growing experience of LVAD implantation has led to a substantial improvement of the outcome, with 1-year survival rates approaching to those in patients with heart transplantation. These refinements have caused growing interest for expanding the clinical indications for LVAD therapy, especially in patients with less advanced heart failure [6, 7].

The criteria for LVAD implantation are NYHA class 4 heart failure refractory to optimal medical therapy, LVEF less than 25%, systolic blood pressure < 80 mmHg, pulmonary capillary wedge pressure > 20 mmHg, cardiac index < 2.0 L/min/m^2 despite continuous intravenous inotropic therapy and intra-aortic counterpulsation. In addition to these criteria, malignant cardiac arrhythmias, as well as patients who are on the transplantation waiting list can also be considered for the LVAD therapy. Patients who suffer from an advanced congestive heart failure are a bigger challenge and therefore, physicians must monitor the symptoms closely in order to identify the right timing for the implantation of LVAD. If the LVAD is implanted too early, benefits and the potential of this medical treatment to recover heart function won't be fully utilized. If the LVAD is implanted too late, the outcome may worsen due to a secondary organ damage caused by a prolonged heart failure.

It is important to note that valvular heart disease is often present. The decision to surgically manage valvular disease at the same time as LVAD implantation depends on several factors such as the influence of valvular disease on post-implantation period and indications for surgical management of a valvular disease [8].

It is known that aortic insufficiency is a complication in approximately 25% of the patients with non-pulsatile mechanical circulatory support device (MCS). Although the increase in LVAD speed improves hemodynamics, it also deteriorates aortic regurgitation. Aortic insufficiency in patients with LVAD support contributes to higher baseline central venous pressure, peek capillary wedge pressure (PCWP), and lower pulmonary artery pulsatility index. [9].

Mitral stenosis must be managed during LVAD implantation, since the presence of the mitral valve prosthesis (biological or mechanical) is not a contraindication for LVAD implantation [10].

Secondary tricuspid regurgitation (TR) is frequent in patients with the associated failure of the right cardiac ventricle who are undergoing a LVAD implantation. The decision to perform a tricuspid valve repair during LVAD implantation is in correlation with moderate-to-severe degree of TR. If TR was corrected, it might have benefit on venous flow and renal perfusion and also improve postoperative morbidity [11].

Truby and assoc. have reported that out ot 10,603 eligible patients, 1,399 patients on CF-LVAD support developed moderate to severe AI. The prevalence of a significant AI progressively increased over time. The predictors of AI worsening included older age, female sex, smaller body mass index, mild pre-implantation AI, and destination therapy strategy. Moderate to severe AI was associated with significantly higher left ventricular end-diastolic diameter, reduced cardiac output, and higher levels of brain natriuretic peptide. Significant AI was associated with higher rates of rehospitalization (32.1% vs. 26.6%, respectively, at 2 years; p = 0.015) and mortality (77.2% *vs.* 71.4%, respectively, at 2 years; p = 0.005), conditional upon survival to 1 year. [12, 9].

The surgical strategy and timing of a significant aortic regurgitation (AR) surgical management have not been fully defined. There have been several articles describing a few treatments of the AR at the time of LVAD implantation. The understanding of the aortic insufficiency after MCS is evolving; however, continuous closure of the aortic valve is thought to be a main cause. Careful attention to outflow cannula orientation in order to prevent direct flow toward the aortic valve can minimize the stress on the valve. [9].

Today, the most common procedure is a simultaneous aortic valve replacement with bioprosthesis. However, you may also find reports of patch closure of the outflow tract, primary aortic cusp closure with felt strips, and a coaptation stitching of the valve cusps that are more rare procedure s [13].

The bioprosthetic valve replacement has the advantage of eliminating valve pathology altogether and not rendering the patient LVAD-dependent. It is very important to know that the controlled work pump and heart beat ratio provide occasional opening of the aortic valve (or bioprosthesis) that could potentially prevent development of clot formations and fusion of the aortic root washout [14].

Timing of the aortic valve replacement is a unique clinical challenge as well, and the decision is made based on the degree of AR, as well as indications for LVAD implantation. Patients with mild to moderate AR who belong to „bridge-to transplant“ group where a shorter time of organ donation is expected, the replacement of aortic valve is not necessary. On the other hand, in “destination therapy” group and patients with a significant AR, AV replacement during LVAD implantation is a reasonable option [15].

The case presented in our report underwent implantation of LVAD for maintaining vital parameters and eliminating symptoms of the heart failure. The significant aortic failure was repaired at the same time as LVAD implantation by replacing the impaired valve with bioprosthesis. This case report shows that LVAD implantation, along with correction of a significant aortic insufficiency by replacing the aortic valve with bioprosthesis, is a procedure that has satisfying results.

Conflict of Interest: None declared.

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Figure 1. A) Preparation of the Heart Ware device – connecting outflow graft to the pump and rinsing the pump; B) after the circular opening of the left ventricle and fastening the ring pump was fixed and hemostasis checked; C) outlet graft fastened to the ascendant aorta

