

Pediatric Melody mitral valve replacement — an alternative to non-reparable left atrio-ventricular valve in children

Implantacja zastawki Melody w pozycję mitralną — u dziecka z nienaprawialnym uszkodzeniem zastawki w przebiegu infekcyjnego zapalenia wsierdza

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Abstract

We present a case of emergency mitral valve replacement with the first — to the best of our knowledge — use of Melody balloon expandable stented bioprosthesis in a 2-years-old patient with acute endocarditis, subsequent mitral (bicuspid) valve incompetence after aggressive infective destruction, with the symptoms of critical multiorgan failure.

The patient with a history of rapid deterioration after 2-weeks-long septicemia in the course of acute endocarditis was operated for life-saving indications. Melody valve was expanded over 16 mm TyShak balloon and implanted into a mitral position (Melody-MVR) with good result.

Based on actual knowledge concerning heart valves reconstructions and institutional experience we conclude that infected mitral valve in children should be primarily repaired, nevertheless Melody valve could be reasonably considered as a mitral prosthesis in patients with non-reparable conditions.

Key words: Melody valve, pediatric mitral valve replacement, acute endocarditis, pediatric cardiac surgery

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Introduction

Despite a great progress in medical technologies there is no 'ideal' heart valve prosthesis that could be superior to patient's own natural valve. The issue is twice as important in pediatric population because of small dimensions of the heart itself, and expected life-long growth of the patient. 'Graft overgrowth' phenomenon is observed after almost

every reconstructive procedure performed in small children, thus the risk of necessary reoperation is clearly defined in patients who underwent surgical correction of congenital heart defects at the age of first 6–12 months.

Current knowledge concerning heart valves reconstructions as well as personal experience naturally indicates a primary repair of every defected, damaged or insufficient valve in affected children [1]. The real hindrances

for modern pediatric cardiac surgery are 'non-reparable' heart valves with critical hemodynamics. Limited amount of prostheses designed for valve replacement in children, particularly for very small annular sizes less than 15–16 mm, and the need for individually-designed surgery makes the procedures twice as complicated.

Our interest of expandable valves comes from institutional experience with pulmonary implantations as well as literature data regarding a bovine jugular vein graft (Medtronic Melody valve) used for mitral replacement (MVR) in children. In spite of the fact that mitral Melody replacement procedures (Melody-MVR) are still reported casually, the authors consecutively show reliable techniques and promising short-term results [2]. The main arguments to reach for Melody-MVR in selected patients were previously well defined advantages of Melody valve implanted in pulmonary position: perfect hemodynamics, favorable effective orifice area (EOA) index, low transannular gradient and an unique potential for percutaneous transcatheter balloon dilation of expandable stented valve following the growth of the child [3, 4].

We present our initial considerations after emergency MVR with the first — to the best of our knowledge — use of Melody balloon expandable stented bioprosthesis (Melody-MVR) in pediatric patient suffering from aggressive acute endocarditis (AE), subsequent mitral valve incompetence and infective destruction of the both leaflets, with the symptoms of critical multiorgan failure.

Case report

Clinical report

The 2-years-old girl 12 kg body weight was referred for urgent-emergency surgical mitral repair, or mitral valve replacement procedure for life-saving indications after two weeks of antibiotic therapy in the course of septicemia due to acute endocarditis. The child demonstrated the progression of congestive heart failure because of massive mitral valve insufficiency (MVI), left ventricular (LV) failure and acute pulmonary edema, with artificial ventilation, inotropic support and intense stimulation of diuresis. The symptoms of renal and liver dysfunction with ascites, central and peripheral edema were evident, while her circulatory de-compensation led to general deterioration despite advanced conventional intensive therapy. The diagnostics was based on transthoracic echocardiography (TTE) that showed massive MVI with fixed vegetations over posterior and anterior leaflets, with disrupted chordae. Additionally an infiltration over the left atrial posterior wall was seen (Figure 1).

Surgical technique

Medtronic Melody TPV 22 valve needed to be prepared before the beginning of the operation. To enable surgical

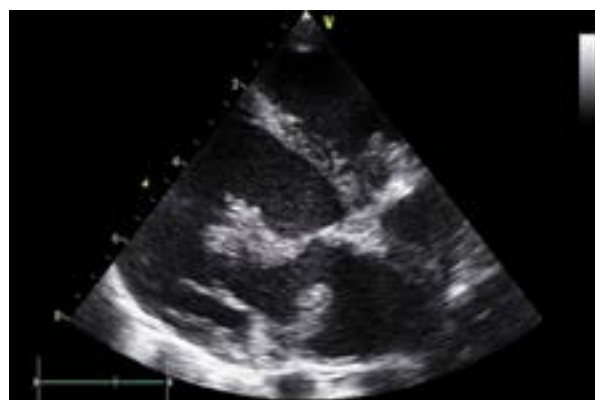


Figure 1. Diagnostic transthoracic echocardiography (TTE) showed massive mitral valve insufficiency (MVI) with fixed vegetations over posterior and anterior leaflets and disrupted chordae

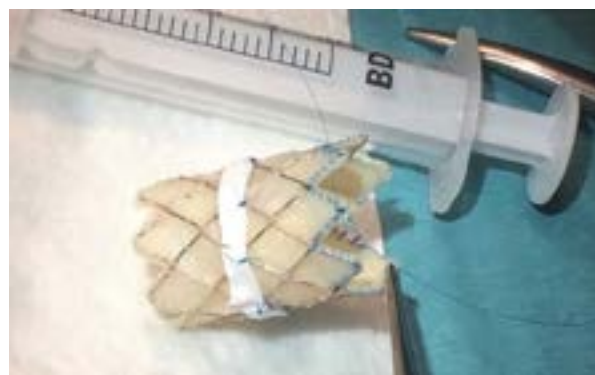


Figure 2. With the fully expanded valve a 3-mm stripe of incised ePTFE (polytetrafluoroethylene) was secured to the stent using interrupted superficial sutures. The ventricular part of the stent was excised to prevent left ventricular outflow tract obstruction (LVOTO)

implantation of the expandable valve the sewing cuff was added externally to the stent, in the middle of its longitudinal diameter. We performed a cuff on the fully expanded valve washed consecutively for 9 minutes. Afterwards a 3-mm stripe of incised ePTFE (polytetrafluoroethylene) was cut, and secured to the stent using interrupted, superficial sutures. It's very important to perform a shallow bites limited to anchor metal elements only, with a great care to avoid any disruption of the valve inserted in the stent. The collar was regularly incised every 6–8 mm on its entire length to facilitate further balloon expansion, following the growth of the patient. After meticulous analysis of LV echocardiography diameters (the distance between the posterior wall and left ventricle outflow tract [LVOT] area) the excision of apical part of the valve adjacent to LVOT was necessary (Figure 2). The excised conduit material was secured to the remaining intact stent with meticulous single monofilament sutures, to save the valve structure and its function after implantation. The margin opposite

to excised segments was marked with a single marking suture to facilitate proper orientation of the valve, and fixation to the posterior wall, or posterior papillary muscle, as recommended.

The procedure was performed with extracorporeal circulation (ECC), mild hypothermia, cardiac arrest and MV transseptal approach. After identification of AE vegetations on the both MV leaflets, despite gentle dissection, the leaflets appeared completely damaged, with disrupted chordae. Finally only a small rim of leaflets was left intact close to the annulus to facilitate implantation and prevent injury to conduction system and circumflex coronary artery. The head of posterior papillary muscle was indicated as a target for posterior fixation of the valvular stent. The annulus after leaflets resection was additionally sized with Hegar dilators (14–16–18 mm) to match the size of the balloon for final valve expansion.

The Melody valve was gently compressed and crimped by the surgeon over 5-ml syringe to enable the insertion through the mitral annulus. To provide a stable position and prevent tilting of the Melody valve into the LVOT during systole causing left ventricular outflow tract obstruction (LVOTO)-similar to systolic anterior motion phenomenon (SAM), the ventricular aspect of Melody stent was fixed to the incised head of posterior papillary muscle with a single pledgeted monofilament suture. The suture tying was hampered because of registered approach and the stent in place, thus the knots were every time secured with delicate instruments. Additionally posterior-fixing suture was passed through ePTFE valvular ring, and tied after valve fixation. Afterwards the sewing ePTFE ring of the valve was sutured to prepared mitral annulus with the use of 3 semi-continuous 5.0 monofilament circumferential sutures. The sutures were tightened and tied just after the balloon dilation of the stented valve.

Final dilation was performed with 16 mm/4 cm long TyShak balloon. The size of the balloon was planned following preoperative measurements of the annulus with echocardiography. The size was matched to intraoperative sizing with Hegars after excision of the valve on flaccid heart. The balloon catheter over soft "J" guidewire was carefully inserted through the central lumen of the valve after removing of the syringe. Three consecutive inflations to 4 atm were done and the Melody was carefully inspected to ensure that the stent was regularly dilated. During the last dilation, the balloon was maintained at 4 atm pressure to tighten, and tie 3 circumferential semi-continuous sutures. The valve was meticulously inspected to ensure free mobility of all 3 leaflets. LA vent was passed through the valve to ensure de-airing of LV with saline filling, and minimized ventricular compression to avoid any risk of deformation of the stent.

The atrial side of the stent was flared on its entire circumference to limit the protrusion of the valve into LA body (Figure 3). The atrial septum was closed with a calibrated



Figure 3. Postoperative chest X-ray with Melody stented valve: note the excision of ventricular part and flaring of the atrial segment

foramen ovale-like ePTFE patch. The hole of the patch was faced with the inflow part of the Melody stent to enable future re-dilation of the valve. After subsequent deairing of the heart, and removing of the cross-clamp, sinus rhythm recovery with no signs of ischemia or local contractility problems was noticed. The ECC was terminated with an average inotropic support. Intraoperative epicardial echocardiography (EE) confirmed good Melody function without any signs of LVOTO.

Postoperative care

The anticoagulation was started with intravenous heparin until oral aspirin was initiated, and chronically continued [5]. Antibiotic administration was continued due to therapeutic European Society of Cardiology (ESC) guidelines for bacterial endocarditis surgical treatment [6]. Further TTE controls confirmed good Melody valve function in mitral position (Figure 4). The girl was discharged home with negative blood cultures and inflammatory parameters; her intensive postoperative rehabilitation was continued.

Discussion

Valvular dysfunctions, stenosis as well as insufficiency, remain a challenge for professionals engaged in pediatric structural heart diseases, congenital and acquired. There is no doubt that heart valve repair is superior to replacement with any prosthesis, especially in subgroup of patients with expected long-life survival, growth potential and contraindications to chronic anticoagulation [7].

There is growing list of promising reports of successful Melody-MVR procedures in children with congenital mitral valve defects. Despite still hardly mid-term follow up there are some significant arguments for utility of stented ex-

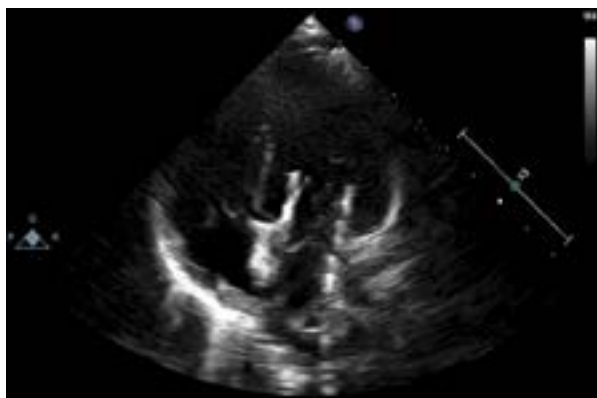


Figure 4. Control transthoracic echocardiography (TTE) examination performed before the discharge showed good Melody function in mitral position

pandable bioprostheses for mitral replacement in small children. Although the design of the device made it adjusted for implantation into the right ventricular outflow tract, its characteristics makes possible 'hand-made' modification of the prosthesis for alternative implantation into the mitral position.

The length of the Melody valve (usually 23–25 mm when expanded) predisposes the protrusion into the LV cavity, with the risk of LVOTO in smaller patients. There was a lack of a professionally-designed sewing cuff to implant the Melody device to the atrioventricular valve annulus. The modification of the valve stent with additionally sewed cuff, resection of its apical segments and flaring of the inflow part were necessary. These maneuvers facilitated atypical implantation, provided proper position in mitral annulus, and prevented from LVOTO [4]. The preparation of Melody valve was performed before the initiation of the procedure to limit the duration of cross-clamp and CPB, as recommended. In a case of unexpected difficulties or intraoperative change of the strategy, when the implantation appears impossible — the Melody prosthesis is naturally lost.

Surgery in pediatric patients with AE is rare; thus, there is still limited number of available articles concerning mitral valve repairs, or replacement in small children suffering from AE. The decision to use Melody valve in acute endocarditis was made without any previous comparable data, or available recommendations. We strongly believed that biological stented expandable bioprosthesis could definitely

appear superior over any other total artificial valve in septic surrounding. The vegetations and all infected tissues were carefully excised before the implantation; nevertheless there is still a hazard of Melody prosthesis local infection despite a vast spectrum of antibiotics. Expandable prosthesis implanted in presented technique enable better adjustment of valvular stent to native annulus without the need of extraordinary tricks, like described for supraannular implantation of mechanical valve. The semi-continuous sutures implantation technique comes from personal experience with classic mitral replacements and was preferred by the operator.

The reports of Melody-MVR confirm good function at short-term follow-up, although there is not up to the launch of the manuscript, known report of Melody valve implanted in mitral position in AE in a child. The risk of endocarditis on implanted Melody was reported and analyzed over prostheses implanted in RVOT, and several in-vitro studies [8, 9]. The risk of infection and damage of the Melody valve exposed for bacterial infection is similar to other biological valves, and implanted homografts [10].

All reported Melody-MVRs in children were carefully controlled because of perivalvular leaks, dysfunction of the device, or LVOTO. These unfavorable complications might require percutaneous intervention, reoperation, or replacement of implanted prosthesis. Other complications including LVOTO were reported in 10% of patients [4, 10]. Balloon expansion of the valve at up to 4 years following implantation has been reported for preserving valvular competence, and reduce gradient. There was no need for reoperation caused by Melody dysfunction or its local infection in mitral position. Perivalvular leaks or Melody-related LVOTO were casually reported, with a potential for transcatheter interventions [3].

Conclusions

The implantation of Melody valve in mitral position (Melody-MVR) appeared safe and effective treatment for a child with non-reparable rapid acute endocarditis. The progress in the development of diminished devices designed for implantations into atrioventricular positions in children remains reasonable.

Conflict of interest(s)

The authors declare no conflict of interest.

Streszczenie

Przedstawiono opis pierwszej implantacji zastawki Melody w pozycję mitralną u 2-letniej dziewczynki z nienaprawialnym uszkodzeniem zastawki mitralnej w przebiegu infekcyjnego zapalenia wsierdza.

Dziewczynkę przyjęto w stanie krytycznym z niewydolnością wielonarządową; u dziecka doszło do nagłego pogorszenia stanu ogólnego po 2 tygodniach od rozpoznania bakteriemii w przebiegu infekcyjnego zapalenia wsierdza. Z powodu gwałtownie narastających objawów niewydolności serca wszczepiono zastawkę Melody w miejsce całkowicie uszkodzonej przez wegetacje bakteryjne zastawki mitralnej. Uzyskano dobrą funkcję zastawki Melody w pozycji mitralnej oraz stabilizację stanu dziecka.

W przebiegu zakażeń zastawki mitralnej postępowaniem z wyboru jest plastyka zastawki, jednak w przypadku nienaprawialnego uszkodzenia zastawki można rozważyć wszczepienie zastawki Melody w pozycję mitralną.

Słowa kluczowe: Melody, zastawka mitralna, infekcyjne zapalenie wsierdza, kardiochirurgia dziecięca

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