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Paediatric Melody® mitral valve replacement in acute endocarditis — alternative surgical-hybrid technique

Ireneusz Haponiuk[1, 2], Maciej Chojnicki[1], Radosław Jaworski[1], Mariusz Steffens[1], Konrad Paczkowski[1], Aneta Szofer-Sendrowska[1], Marta Paśko-Majewska[1], Katarzyna Gierat-Haponiuk[2, 3], Anna Romanowicz[1], Wiktor Szymanowicz[1]

[1]Department of Paediatric Cardiac Surgery, St. Adalbertus Hospital, Gdansk-Zaspa, Poland
[2]Chair of Physiotherapy, Faculty of Rehabilitation and Kinesiology, Gdansk Academy of Physical Education and Sport, Gdansk, Poland
[3]Department of Rehabilitation, Medical University of Gdansk, Gdansk, Poland

Abstract

Background and aim: Acute endocarditis (AE) is still rare disease in the paediatric population; nevertheless, the children suffering from AE usually need heart valve repair or replacement in emergency settings.

Methods: We present a case of emergency mitral valve replacement with the use of Melody balloon expandable stented bioprosthesis in a two-year-old patient with AE and subsequent mitral (bicuspid) valve incompetence after aggressive infective destruction with the symptoms of critical multi-organ failure.

Results: The patient, with a history of rapid deterioration after two-week-long septicaemia in the course of AE, was operated urgently after initial antibiotic treatment because of huge vegetations into the mitral valve orifice. A Melody TVP 22 valve was expanded over a 16-mm TyShak balloon and implanted into a mitral position (Melody-MVR) with good result.

Conclusions: Based on current knowledge concerning heart valve reconstructions and institutional experience, we conclude that infected mitral valve in children should be primarily repaired; nevertheless, the Melody valve could be reasonably considered as a mitral prosthesis in such conditions.

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

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INTRODUCTION

Acute endocarditis (AE) is still a rare disease in the paediatric population; nevertheless, the children suffering from AE usually need heart valve repair or replacement in emergency settings. Surgery augmented with antibiotic treatment is applied also in the acute phase of AE in children because of the aggressive infective destruction of endocardial structures, and subsequent acute heart failure [1]. Current knowledge concerning heart valve reconstruction as well as institutional experience naturally lead to maximal efforts to enable a primary repair of every infected valve in children [2]. An irreparable valve is a hindrance for the surgeon because of limited amount of prostheses designed for valve replacement in children, particularly for annular sizes less than 15–16 mm. Infective surroundings in AE, despite advanced antibiotic treatment, is suboptimal for prosthetic valves, while the majority of commercially designed valvular biological prostheses are too large for paediatric patients.

The reports regarding a bovine jugular vein graft (Medtronic Melody valve) used for mitral replacement demonstrated acceptable short-term results [3]. The advantages of the Melody valve are perfect haemodynamics with favourable effective orifice area (EOA) index, low transannular gradient, and the main issue — presenting a unique potential for percutaneous transcatheter balloon dilation following the growth of the child [4, 5].

Address for correspondence:
Ireneusz Haponiuk, MD, PhD, Department of Paediatric Cardiac Surgery, St. Adalbertus Hospital, ul. Jana Pawła II 50, 80–462 Gdańsk, Poland, tel: +48 58 76 84 881, e-mail: ireneusz_haponiuk@poczta.onet.pl

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METHODS

We present a case of emergency mitral valve replacement with the use of Melody balloon expandable stented bioprosthesis (Melody-MVR) in a two-year-old patient with AE and subsequent bicuspid valve incompetence after aggressive infective destruction with the symptoms of critical multi-organ failure.

Patient N.J., a two-year-old girl, 12 kg body weight was admitted to the Department of Paediatric Cardiac Surgery because of heart insufficiency, presented with hectic temperature up to 40°C and clinical signs of sepsis with concomitant mitral valve (MV) incompetence and cardiogenic shock. The patient, with a history of rapid deterioration after two-week-long septicaemia in the course of AE, was urgently referred for surgery after an incident of cardiopulmonary resuscitation, after confirmation of huge, antibiotic-resistant vegetations protruding into MV orifice. Microbiological specimens were negative, the antibiotic treatment was started and continued upon the clinical presentation of the disease.

Prior to the surgery the baby demonstrated progression of congestive heart failure because of massive mitral valve insufficiency (MVI), left ventricular (LV) dysfunction, and acute pulmonary oedema, with the need of artificial ventilation, inotropic support, and stimulation of diuresis. The symptoms of progressive renal and liver dysfunction with ascites and peripheral oedema were evident, while her circulatory compensation was borderline, with general deterioration despite advanced intensive therapy. Diagnostic transthoracic echocardiography (TTE) showed massive MVI with the presence of fixed vegetations over posterior and anterior leaflets and disrupted anterior chordae (Fig. 1). Additionally, an infiltration over the left atrial (LA) posterior wall was seen. The body temperature permanently ranged 38°C despite pharmacological treatment and core cooling, while blood cultures obtained after the initiation of antibiotic therapy were all negative.

The child was referred for urgent emergency surgical mitral repair or MV replacement procedure for life-saving indications after two weeks of antibiotic therapy.

RESULTS

A Medtronic Melody TPV 22 valve was prepared on a back table before the operation during the time usually spent in preparation of the operation field, after initial anaesthesia. To enable surgical implantation the sewing cuff was added externally to the stent in its midsection. With the fully expanded valve washed consecutively for 9 min, a 3-mm strip of incised ePTFE (polytetrafluoroethylene) was cut and secured to the stent using interrupted superficial sutures with delicate bites limited to anchor metal elements only (Fig. 2). With great care to avoid any disruption of the stent supporting the valve apparatus, the excision of the apical part of the valve adjacent to LV outflow tract (LVOT) was necessary, while securing the excised conduit material to the remaining intact stent. The opposite margin was marked with a single suture to facilitate the orientation of the valve and fixation to the posterior papillary muscle as recommended.

After initiation of extracorporeal circulation (ECC) and aortic cross-clamp the MV was exposed via transseptal approach. The vegetations of the both MV leaflets were found, and resected, with good exposure of completely damaged leaflets and chordae (Fig. 3). During gentle resection of the leaflet material and resection of the vegetations, a small rim of leaflets was left intact on the annulus to avoid injury to conduction and coronary artery during implantation. Hegar dilators 14–16–18 mm were used to size the annulus following leaflet resection and to choose the size of the balloon prepared for valve expansion.

The Melody valve prosthesis was compressed and crimped over a 5-mL syringe to allow passage through the mitral annulus. To prevent tilting of the Melody valve into the LVOT during systole, the distal aspect of the Melody stent was fixed to the remnants of the posterior papillary muscle with a single patched monofilament suture. The suture tying was hampered due to limited space, thus a knot secured with delicate instruments was necessary. Afterwards the sewing of the ePTFE ring of the valve was secured to the mitral annulus. The three semi-continuous circumferential sutures were tied after the valve was dilated to the desired size.

Finally, dilation with TyShak balloon (16 mm in diameter and 4 cm long) in the valve was performed, with balloon size based on preoperative measurement of the annulus size by echocardiogram and intraoperative sizing after excision of the valve. The balloon catheter over a soft "J" guidewire was carefully inserted through the central lumen of the valve after removing of the syringe and inflated to 4 atm, while the Melody was inspected to ensure that the stent was regularly dilated. During the dilation, the balloon was maintained at 4 atm pressure while all three circumferential semi-continuous sutures were tightened, and tied (Fig. 4). After removing of the balloon, the valve was inspected to ensure free mobility of all three leaflets. The LA vent was passed through the valve to ensure de-airing of the LV with saline filling and minimised compression to avoid any deformation of the stent. The atrial side of the stent was flared to limit the protrusion of the valve into the LA body. The atrial septal closure with a calibrated foramen ovale ePTFE patch was performed. After subsequent de-airing of the heart the cross-clamp was removed, with sinus rhythm recovery. The ECC was terminated with an average inotropic support. The epicardial echocardiography confirmed good Melody function without any signs of LVOT obstruction (LVOTO).

In postoperative echocardiographic examination three days after operation, a small paravalvular leak (PVL) from the ventricular side with communication to the LA was detected. Four weeks after operation echocardiography, confirmed spontaneous closure of PVL (Fig. 5). The postoperative course of the child was uneventful. An extensive individually-

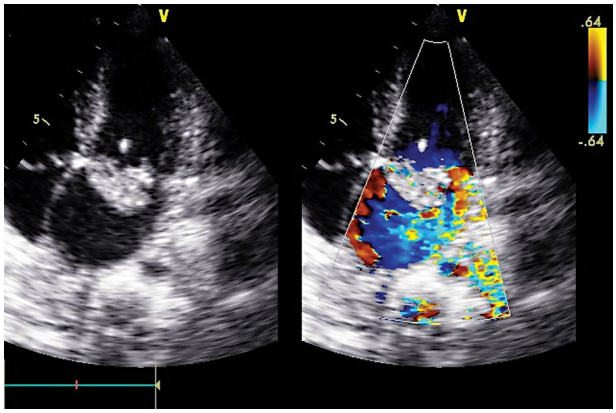

Figure 1. Diagnostic transthoracic echocardiography showing massive mitral valve insufficiency with the presence of fixed vegetations over posterior and anterior leaflets, disrupted anterior chordae

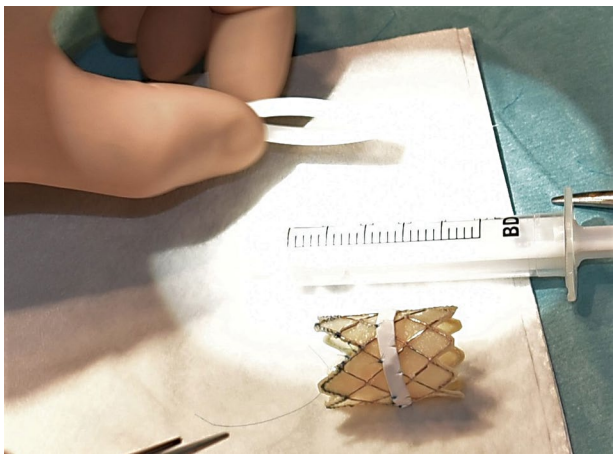

Figure 2. With the fully expanded valve washed consecutively for 9 min, a 3-mm stripe of incised ePTFE (polytetrafluoroethylene) was cut and secured to the stent using interrupted superficial sutures with delicate bites limited to anchor metal elements only

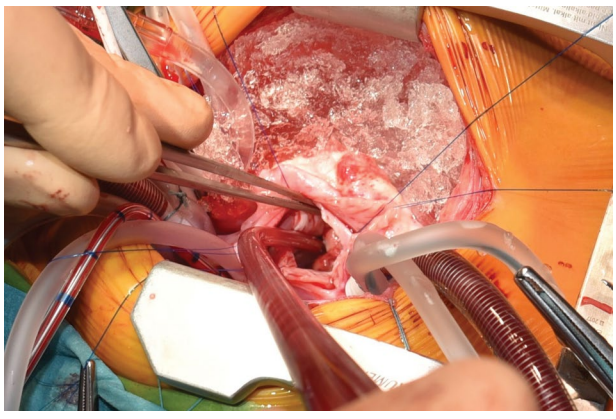

Figure 3. The vegetations of the both mitral valve leaflets were found and resected, with good exposure of completely damaged leaflets and chordae

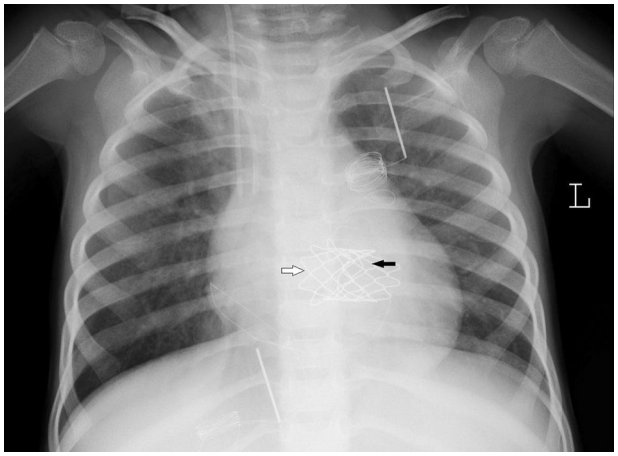

Figure 4. During the dilation, the balloon was maintained at 4 atm pressure, while all three circumferential semi-continuous sutures were tightened and tied. The position of the Melody valve was confirmed in postoperative chest X-ray: note flaring of the stent in the atrial part (white arrow) with resected distal segment (black arrow) to prevent left ventricular outflow tract obstruction

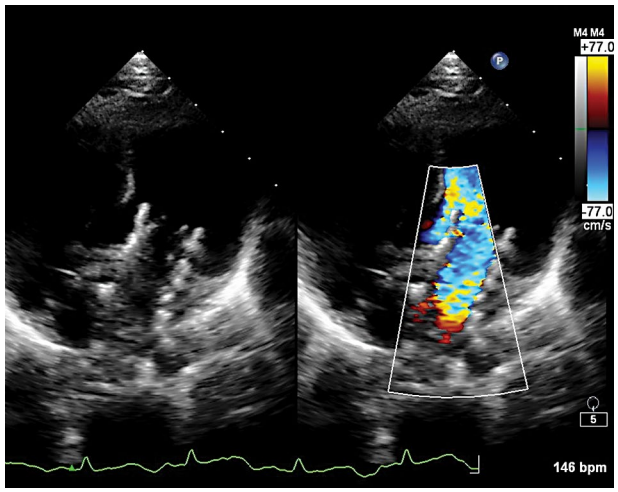

Figure 5. There was some residual paravalvular flow from the ventricular side with communication to the left atrium, which closed spontaneously — regular control transthoracic echocardiography examination performed before the discharge

-designed programme of postoperative comprehensive cardiac rehabilitation was carried out, and continued at home. The child was treated with heparin until oral aspirin was initiated, and chronically continued [5, 6].

Antibiotic administration was continued up to six weeks due to therapeutic European Society of Cardiology-guidelines for bacterial endocarditis treatment [7]. Further TTE controls confirmed good Melody valve function in the mitral position. The patient was discharged home six weeks postoperatively with negative blood cultures, and inflammatory parameters

returned to normal range (C-reactive protein, procalcitonin levels).

Mid-term TTE controls three months postoperatively showed constantly competent mitral valve. The patient returned to her normal life activity in New York Heart Association class I.

DISCUSSION

Surgery in paediatric patients with AE is still rare, so there are still a limited number of articles available concerning MV repairs in small children. There is no doubt that MV repair is superior to replacement, especially in the subgroup of patients with expected long-life survival, growth potential, and contraindications to anticoagulation [8]. Healy at al. [9] described successful repair of anterior mitral leaflet in a 1.9-kg infant with endocarditis, and concluded that MV reconstruction, if technically possible, should be the therapy of choice in cases of bacterial endocarditis, particularly in children and adolescents. Mid-term results presented by Takahashi et al. [8] also confirm these observations.

There is growing list of promising reports of successful Melody-MVR procedures in children [10]. Despite mid-term follow-up there are some significant arguments for utility of stented expandable bioprostheses for mitral replacement in small children. Although the design of the device made it favourable for implantation into the right ventricular outflow tract, its characteristics provide alternative implantation into a mitral position. The length of the Melody Valve (usually 2.5 cm) predisposes protrusion into the LV cavity, with risk of (LVOTO). There is no typical sewing cuff to anchor the Melody device to the atrioventricular valve annulus, so the modification of the valve stent with additionally sewed cuff, and specific implantation technique, are necessary to allow implantation, provide stable position in the mitral annulus, and avoid LVOTO [5]. The preparation of the Melody valve was performed before initiation of the procedure with cardiopulmonary bypass to limit the duration of cross-clamp and extracorporeal circulation, as recommended.

The decision to use a Melody valve in AE was made with the belief that biological stented prosthesis could be superior to any artificial valve in a septic surrounding. With regard to surgical principles all infected tissues were carefully excised before implantation of the Melody prosthesis. The technique of semi-continuous suture implantation comes from the personal experience of the surgeon.

The reports of Melody-MVR confirm good function at short-term follow-up, although there is not (at the time of writing) a known report of Melody valve implantation in the MV position in acute endocarditis. The risk of endocarditis for an implanted Melody was reported and analysed for prostheses implanted in the right ventricular outflow tract, and in-vitro studies [11, 12]. The risk of infection and damage of the Melody valve exposed for bacterial infection is similar to other biological valves, and implanted homografts [13]. Other complications including LVOTO were reported in 10% of patients [4]. Balloon expansion of the valve at up to four years following implantation has been successful at preserving valvular competence and low gradient. There were no reported reoperations for Melody dysfunction, and perivalvular leak or Melody-related LVOTO were casually reported [3]. It is naturally supposed that perivalvular leaks can be managed after the improvement of transcatheter techniques (e.g. valve balloon expansion), while severe LVOTO might require reoperation, or replacement of the implanted device.

CONCLUSIONS

1. Paediatric Melody MVR appeared to be a safe and effective treatment for paediatric patients with rapid AE.
2. In our opinion, acute phase of MV endocarditis in the presented patient was not a contraindication for primary Melody-MVR procedure.
3. Future development of devices specifically designed for implantation into atrioventricular positions with sewing cuffs appropriate for children remains reasonable.

Conflict of interest: *none declared*

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Wszczepienie zastawki Melody® w pozycję mitralną u dziecka z infekcyjnym zapaleniem wsierdzia — alternatywna technika hybrydowa

Ireneusz Haponiuk[1, 2], Maciej Chojnicki[1], Radosław Jaworski[1], Mariusz Steffens[1], Konrad Paczkowski[1], Aneta Szofer-Sendrowska[1], Marta Paśko-Majewska[1], Katarzyna Gierat-Haponiuk[2, 3], Anna Romanowicz[1], Wiktor Szymanowicz[1]

[1]Oddział Kardiochirurgii Dziecięcej, Szpital Św. Wojciecha COPERNICUS, Gdańsk-Zaspa
[2]Katedra Fizjoterapii, Wydział Rehabilitacji i Kinezjologii, Akademii Wychowania Fizycznego i Sportu, Gdańsk
[3]Klinika Rehabilitacji, Gdański Uniwersytet Medyczny, Gdańsk

Streszczenie

Wstęp i cel: Infekcyjne zapalenie wsierdzia jest rzadką chorobą w populacji pediatrycznej. Dzieci z infekcyjnym zapaleniem wsierdzia zazwyczaj wymagają pilnych operacji naprawczych lub wymiany zastawek serca.

Metody: W niniejszej pracy przedstawiono przypadek wymiany pierwotnie zniszczonej zastawki mitralnej na zastawkę Melody wszczepioną hybrydowo u 2-letniego dziecka z infekcyjnym zapaleniem wsierdzia. U dziecka doszło do masywnej niedomykalności zastawki mitralnej zniszczonej przez proces infekcyjny i krytycznej niewydolności wielonarządowej.

Wyniki: Dziecko operowano niezwłocznie po 2-tygodniowej szerokospektralnej antybiotykoterapii, kiedy doszło do nagłego pogorszenia stanu ogólnego pacjenta. Zastawka mitralna była całkowicie zniszczona przed masywne wegetacje bakteryjne na płatkach i pierścieniu zastawki. Zastawka Melody TVP 22 została poszerzona do 16 mm na balonie TyShak i implantowna w pozycję mitralną (Melody-MVR) z dobrym efektem.

Wnioski: Zgodnie z aktualną wiedzą, w przypadku uszkodzenia zastawki mitralnej należy podjąć próbę jej rekonstrukcji. Zastawka Melody może być wzięta pod uwagę jako dobra proteza zastawki mitralnej u dziecka z całkowicie nienaprawialną zastawką w przebiegu infekcyjnego zapalenia wsierdzia.

Słowa kluczowe: zastawka Melody®, infekcyjne zapalenie wsierdzia, kardiochirurgia dziecięca, wymiana zastawki mitralnej u dzieci

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Adres do korespondencji:
dr hab. n. med. Ireneusz Haponiuk, Oddział Kardiochirurgii Dziecięcej, Szpital Św. Wojciecha, Al. Jana Pawła II 50, 80–462 Gdańsk, tel: +48 58 76 84 881, e-mail: ireneusz_haponiuk@poczta.onet.pl
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