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First uses of HAART 300 rings for aortic valve repair in Poland – 4 case studies

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Abstract

Introduction: Aortic valve reconstructions using geometric annuloplasty rings HAART 300/200 open new era in aortic valve surgery. The HAART technology resizes, reshapes, stabilizes and simplifies aortic valve repair. The HAART aortic repair rings are designed to be implanted directly into aortic annulus (under aortic valve leaflets).

Aim: We present first in Poland 4 cases of aortic valve reconstructions using geometric annuloplasty rings HAART 300.

Material and methods: Two patients had type IA aortic insufficiency (due to El-Khoury classification) – they were treated by HAART 300 ring insertion and ascending aorta prosthesis implantation. Third patient, Marfan with type IB aortic insufficiency was repaired by HAART 300 ring implantation followed by remodeling (Yacoub) procedure. Fourth patient with type II aortic insufficiency (due to RCC prolapse) was repaired by HAART 300 implantation and cusp plication.

Results: All patients shows good results on 6 months postoperative 3D TTE examinations.

Conclusions: Presented technique is reproducible and simplify aortic valve reconstructions.

Key words: aortic valve reconstruction, ring HAART 300.

Introduction

The surgical techniques used for aortic valve repair are constantly improving [1]. Based on the concept of functional aortic annulus (FAA) proposed by El-Khoury (2009), most of the recent innovations focused on the stabilization of the atrioventricular junction (AVJ) [2, 3].

Streszczenie

Wstęp: Rekonstrukcje zastawki aortalnej z zastosowaniem pierścieni HAART 300/200 otwierają nową erę w chirurgii zastawki aortalnej. Technologia HAART zmienia wymiar i kształt, stabilizuje i upraszcza naprawę zastawki aortalnej. Pierścienie HAART są zaprojektowane do implantacji prosto w pierścieniu aortalnym (pod płatkami zastawki aortalnej).

Cel: Przedstawiamy pierwsze cztery w Polsce przypadki rekonstrukcji zastawki aortalnej z użyciem pierścieni HAART 300 (*geometric annuloplasty rings*).

Materiał i metody: U 2 pacjentów z typem IA niedomykalności aortalnej (wg klasyfikacji El-Khoury'ego) wszczepiono pierścienie HAART 300 i implantowano protezy aorty wstępującej. U trzeciego pacjenta, Marfan (typ IB niedomykalności aortalnej), wszczepiono pierścien HAART 300, a następnie wykonano remodeling sposobem Yacoub'a. U czwartego pacjenta z prolapsem płatką prawowieńcowego (typ II) przeprowadzono anuloplastykę, wszczepiając pierścien HAART 300, oraz korekcję prolapsu metodą plikacji.

Wyniki: U wszystkich pacjentów wyniki rekonstrukcji w kontrolnym badaniu 3D TTE w ciągu 6 miesięcy po leczeniu operacyjnym były dobre.

Wnioski: Przedstawiona technika jest powtarzalna i upraszcza rekonstrukcję zastawki aortalnej.

Słowa kluczowe: rekonstrukcja zastawki aortalnej, pierścien HAART 300.

From Cabrol's subcommissural annuloplasty, through Lansac's external band and David's partial external band, to Schäfers's suture annuloplasty, the goal was to achieve the optimal stabilization of the atrioventricular junction.

Still, none of the methods mentioned above restored the natural, elliptical shape of the aortic ostium.

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The use of an internal geometric annuloplasty ring (HAART), proposed by Rankin in 2011, not only restores the appropriate dimensions of the AVJ, but also stabilizes it and, most importantly, reconfigures the aortic ostium to its optimal, elliptical shape [4].

The construction of the HAART ring was based on mathematical calculations obtained by analyzing human aortic valves (both harvested from cadavers and observed intravitaly with contrast-enhanced computed tomography) [5, 6] (Fig. 1).

The HAART rings are available as HAART 300, for tricuspid aortic valve repair, and HAART 200, for bicuspid valves (Fig. 2).

Moreover, the HAART 200 ring reconfigures the location of the commissures of an insufficient bicuspid aortic valve to the 50/50 position, which significantly facilitates cusp correction and, as a result, comprehensive valve repair [7].

The titanium stent of the ring is coated with Dacron fabric, while the number of “posts” (angled 10 degrees outwards to ease implantation) depends on the number of commissures – two for the bicuspid valve and three for the tricuspid valve.

Aim

The aim of the study is to present the patient qualification criteria, surgical treatment, as well as short- and medium-term postoperative results of the first 4 HAART 300 ring implantations conducted in Poland for aortic valve repair.

Material and methods

The patients selected for the first 3 aortic valve repair procedures with the use of HAART 300 rings suffered from tricuspid aortic valve insufficiency and ascending aortic aneurysm (type IA insufficiency – 2 patients) and aneurysm of the sinuses of Valsalva – Marfan syndrome (type IB insufficiency – 1 patient).

The fourth patient qualified for aortic valve reconstruction with use of the HAART 300 ring exhibited right coronary cusp (RCC) prolapse without dilation of the ascending aorta (type II insufficiency).

The selection of properly sized rings for aortic valve repair was possible thanks to the HAART 301 measurement set with 19, 21, 23, and 25-mm spherical “sizers” (AVJ size after reconstruction depends on the size of the implanted ring).

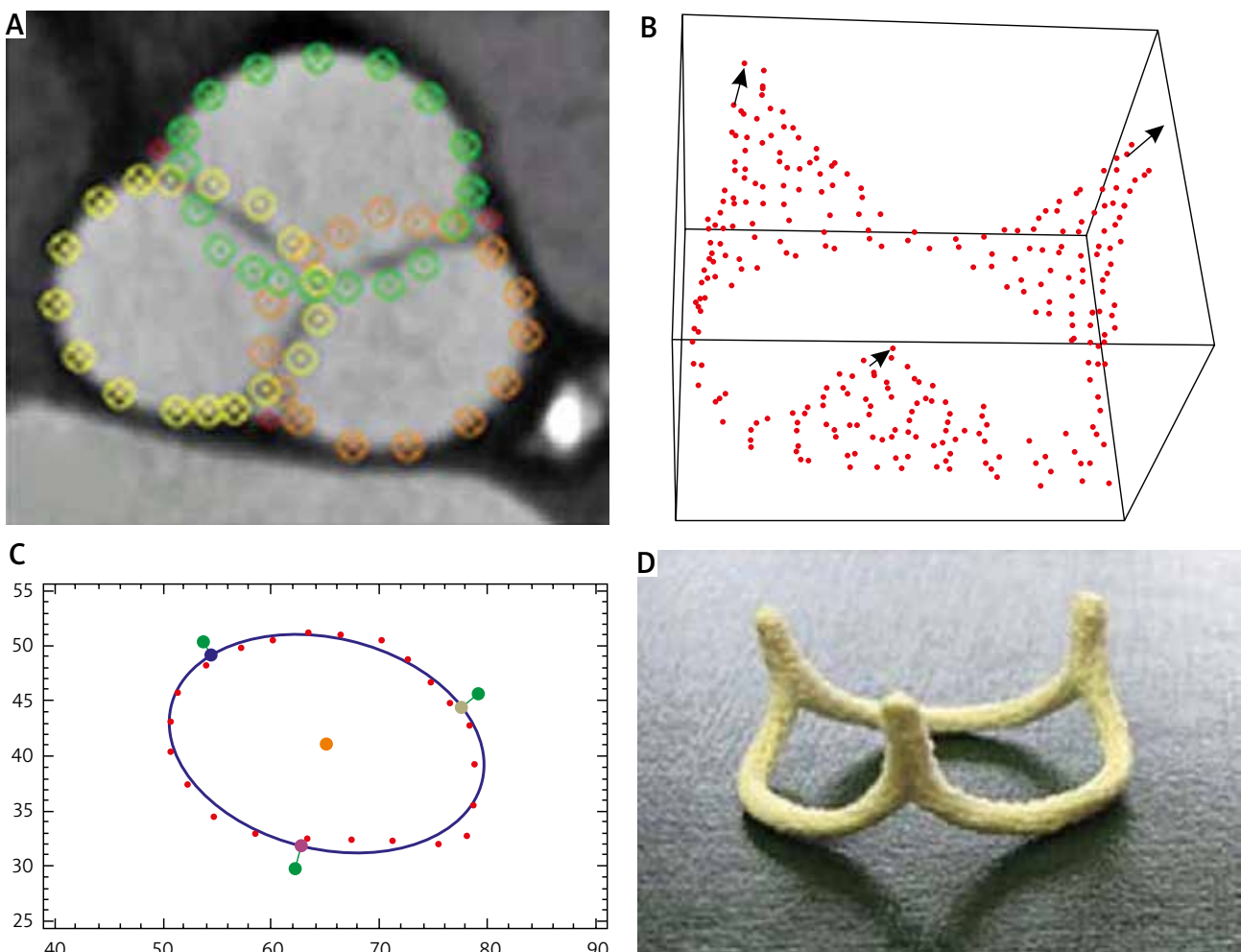


Fig. 1. Geometric annuloplasty ring HAART 300 – stages of construction

The abovementioned spherical “sizers” of the HAART 301 set were consecutively placed in the sinuses of Valsalva to measure the length of the free edges of individual aortic cusps (length – L).

An appropriate size of the HAART 300 ring was selected for implantation based on the desired size of the ring after reconstruction (diameter – D), which should be $D = L/1.5$ [13].

All presented patients underwent preoperative measurements of the gH (geometric height) of aortic cusps, which exceeded 18 mm, enabling effective valve repair.

The method of implantation consists in placing 3 Cabrol’s sutures under the commissures (through the ring), while the remaining sutures are placed around the ring once it is brought below the native aortic cusps.

Monofilament Prolene 4-0 RB-1 sutures are used for the implantation. After exiting under the aortic cusps, they are tied inside the sinuses of Valsalva in such a way that the knots do not interfere with the movement of the cusps [8, 9].

In patients with ascending aortic aneurysms, supracoronary implantation of an ascending aortic prosthesis was performed after the implantation of the HAART 300 ring. In the patient with Marfan syndrome, Yacoub’s remodeling was performed using a prosthesis with artificial sinuses of Valsalva.

The diameters of the implanted prostheses were 5–7 mm larger than the size of the implanted rings (in accordance with the principles of remodeling and reimplantation techniques used in aortic valve insufficiency) [14].

The stabilization and reconfiguration of AVJ achieved with previous implantation of an internal HAART 300 ring facilitates the implantation of vascular prostheses in the areas of the aortic bulb and the ascending aorta as well as the reconstruction of aortic cusps.

Results

All patients undergoing repair of insufficient aortic valves with the use of HAART 300 rings exhibited good immediate, short-, and medium-term repair outcomes.

Intraoperative assessment was based on eH (effective height) measurements of the reconstructed cusps, which were between 10 and 11 mm for 3 of the presented patients and 12 mm for the patient with Marfan syndrome.

Immediate assessment was based on TEE examination in the operating theater, while short-term assessment – on TTE on the 6th postoperative day.

Medium-term assessment 3, 6, and 12 months after the surgical treatment was based on 3D TTE examination [10, 11].

In TTE there was a correlation between the size of AVJ and the size of the implanted ring.

In 1 patient, echocardiographic examination revealed residual valve regurgitation after the reconstruction; in the remaining 3, TTE showed minor aortic valve insufficiency.

Follow-up 3D TTE conducted 3, 6, and 12 months after the surgery confirmed the stability of the repair and residual/minor gradient through the implanted rings (without any hemodynamic significance) [12].

Below we present the results of echocardiographic examinations: preoperative (top image) and postoperative with an implanted HAART 300 ring (bottom image) of the described 4 patients; all examination results are presented in Table I.

Patient 1

Patient 1, female, age 68. Ascending aortic aneurysm (diameter: 56 mm). Moderate central aortic insufficiency (grade 2), type IA. NYHA II, CCS 1, EF 57%, coronarography: no lesions. Surgical procedure (first implantation of a HAART 300 ring in Poland – 28.06.2016). AVP HAART 300 (ring 19) plus supracoronary AoAsc graft (Jotec 26 mm). Cardiopulmonary bypass – 210 min. Aortic cross-clamping time – 153 min. Crystalloid cardioplegia (Custodiol). Follow-up TEE in the operating theater – after reconstruction – residual/minor central AI (grade 0/1). Intraoperative and postoperative course uneventful. Discharged home on the 7th postoperative day. Follow-up TTE after 3, 6, and 12 months after surgical treatment – residual/minor central

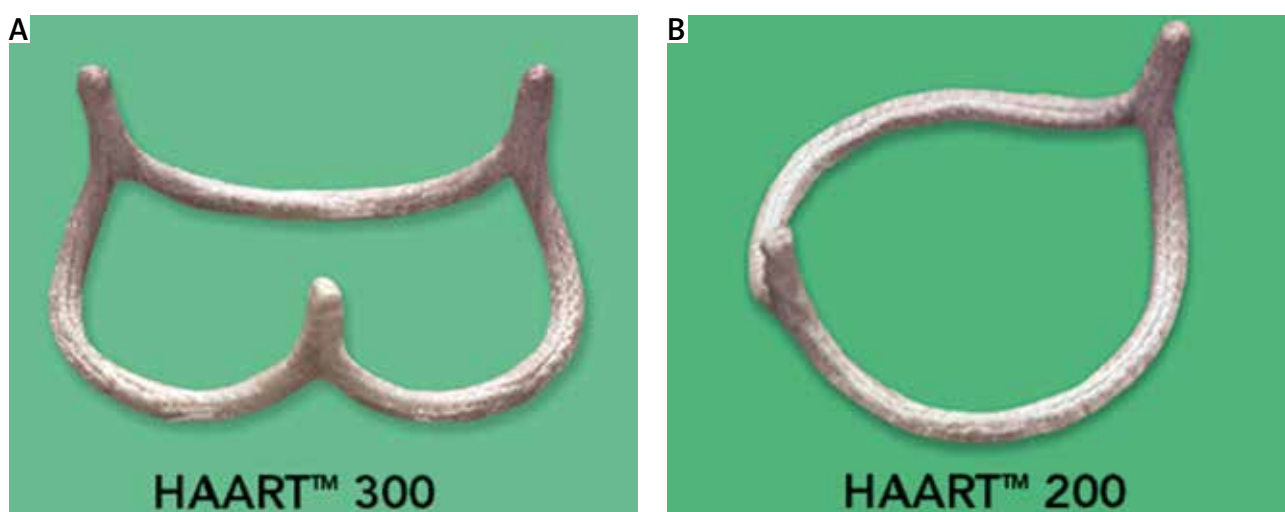
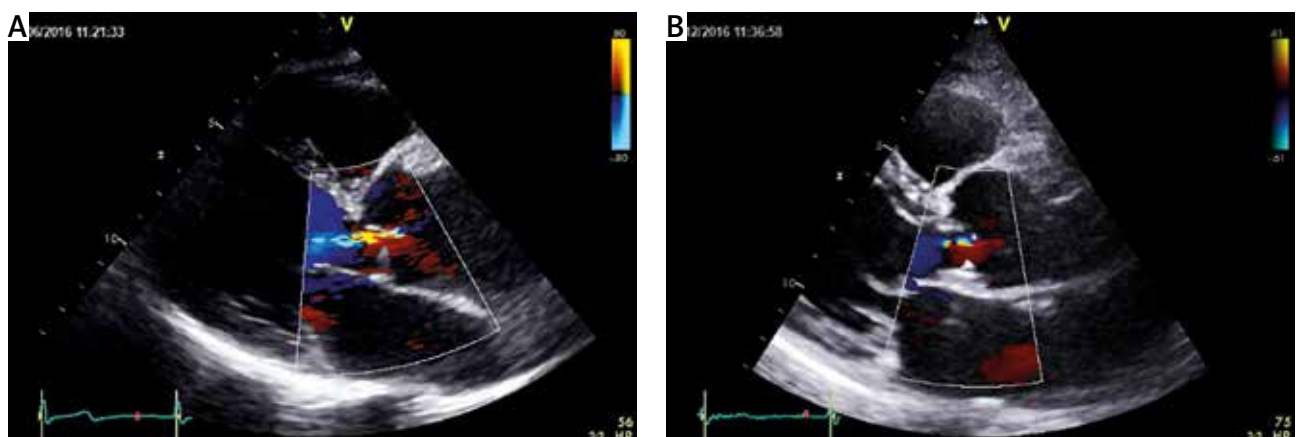


Fig. 2. Geometric annuloplasty rings – HAART 300 and HAART 200

Table I. Preoperative and postoperative echocardiographic parameters of the patients

Parameter	Patient 1		Patient 2		Patient 3		Patient 4	
	Before	After	Before	After	Before	After	Before	After
EDD [cm]	5.3	4.7	5.4	5.3	5.2	4.9	6.4	6.3
ESD [cm]	3.7	3.3	3.3	3.5	3	3.2	4.7	4.6
EDV [cm]	124	102	140	125	138	100	189	170
EDVI [ml/m ²]	75	62	71	63	71	52	86	77
ESV [ml]	53	40	64	60	52	42	95	81
ESVI [ml/m ²]	32	24	32	30	27	22	43	37
LVEF (%)	57	61	54	52	62	58	50	52
LVOT [cm]	2.1	2	2.5	2.5	2.2	2.1	3.1	3.1
AVJ [cm]	2.2	1.6 (ring)	3.2	1.9 (ring)	2.5	1.7 (ring)	3	1.7 (ring)
Bulb [cm]	4.3	4.1	5	3.9	4.9	4.2	4	3.9
STJ [cm]	4.1	graft	4.1	3.4	4.9	graft	3.3	3.2
AA [cm]	5.4	3.3 (graft)	3.4	3.1	5.6	2.9 (graft)	3.5	3.6
AV Vmax [m/s]	1.11	1.67	103	120	1.41	1.49	1.3	2.22
AV max PG [mm Hg]	5	11	4.2	5.8	8	8.9	6.8	19.8
AV mean PG [mm Hg]	2.6	6.2	2.8	3.2	4.5	4.5	4.4	13
Coaptation length [cm]		0.7		0.8		1		1
AR VC [cm]	0.4	0.15	0.3	0.1	0.5	Residual	0.5	0.2
AR PHT [ms]	442	469	537	884	410	717	198	559
R PISA [cm] V _a 40 cm s ⁻¹	0.5	0.3	0.5	0.3	0.6		0.8	0.4
AR EROA [cm ²]	0.16	0.05	0.14	0.05	0.24		0.3	0.1
AR Rvol [ml]	36	11	41	12	40		55	17
RF (%)	51	18	54	18	47		59	19
Jet direction	Central	Central	Central	Central	Central	Central		Eccentric – towards anterior mitral leaflet
AR type	IA		IB		IA		II	

**Fig. 3.** Patient 1

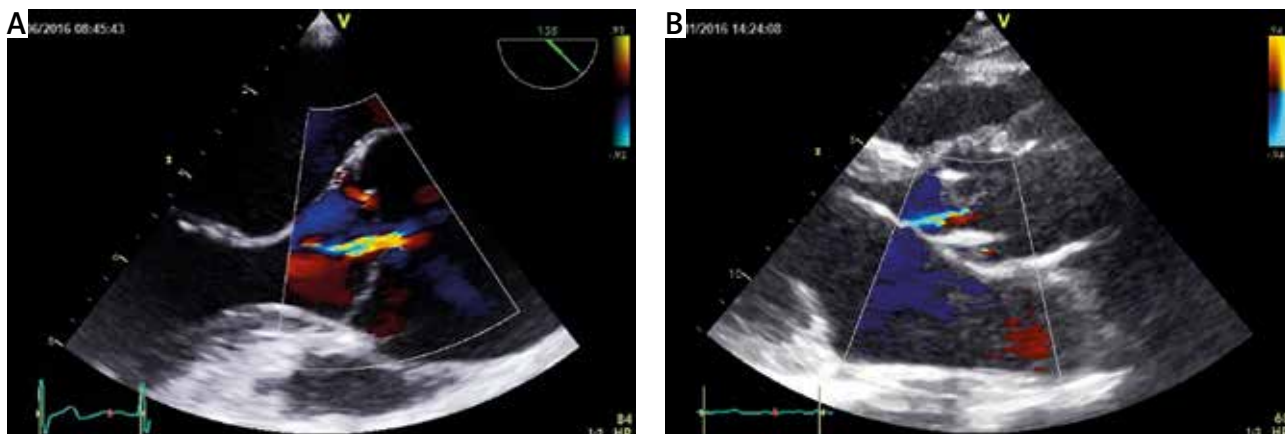


Fig. 4. Patient 2

AI – stable image. Good medium-term result of valve repair (Fig. 3).

Patient 2

Patient 2, male, age 24. Marfan syndrome. Aortic bulb aneurysm (diameter: 51 mm). Moderate central aortic insufficiency (grade 2), type IB. NYHA I, CCS 1, EF 54%. Surgical procedure – AVP HAART 300 (ring 23) plus remodeling with Yacoub’s method (prosthesis with sinuses of Valsalva – Vascutek Terumo 28 mm).

Cardiopulmonary bypass – 261 min. Aortic cross-clamping time – 209 min. Crystalloid cardioplegia (Custodiol). Additional myocardial protection with hypothermic left heart jacket (HLHJ). Follow-up TEE in the operating theater – after reconstruction – residual/minor central AI (grade 0/1). Intraoperative course uneventful. Discharged home on the 9th postoperative day. Late pericardial drainage due to fluid accumulation in postoperative course (2 weeks after surgery). Follow-up TTE after 3, 6, and 12 months after surgical treatment – residual/minor central AI – stable image. Good medium-term result of valve repair (Fig. 4).

Patient 3

Patient 3, male, age 58. Ascending aortic aneurysm (diameter: 58 mm). Moderate central aortic insufficiency

(grade 2), type IA. NYHA II, CCS 1, EF 62%, coronarography: no lesions. Surgical procedure – AVP HAART 300 (ring 21) plus supracoronary AoAsc graft (Jotec 28 mm).

Cardiopulmonary bypass – 120 min. Aortic cross-clamping time – 81 min. Crystalloid cardioplegia (Custodiol). Follow-up TEE in the operating theater – after reconstruction – residual insufficiency (grade 0). Intraoperative and postoperative course uneventful. Discharged home on the 6th postoperative day. Follow-up TTE after 3, 6, and 12 months after surgical treatment – residual insufficiency, stable image. Good medium-term result of valve repair (Fig. 5).

Patient 4

Patient 4, male, age 51. Moderate tricuspid aortic valve insufficiency (grade 3), type II. Right coronary cusp prolapsed. NYHA II, CCS 1, EF 50%, coronarography: no lesions. Surgical procedure – AVP HAART 300 (ring 21) plus RCC plication (2x Prolene 6-0).

Cardiopulmonary bypass – 137 min. Aortic cross-clamping time – 114 min. Crystalloid cardioplegia (Custodiol). Follow-up TTE in the operating theater – moderate/minor AI – jet towards AML (grade 0/1). Intraoperative and postoperative course uneventful. Discharged home on the 6th postoperative day. Follow-up TTE after 3, 6, and

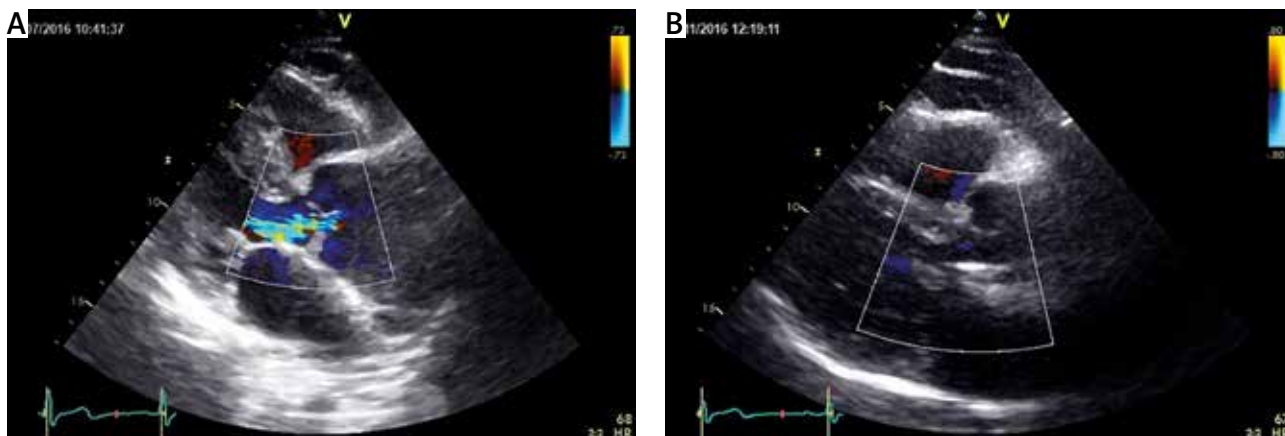


Fig. 5. Patient 3

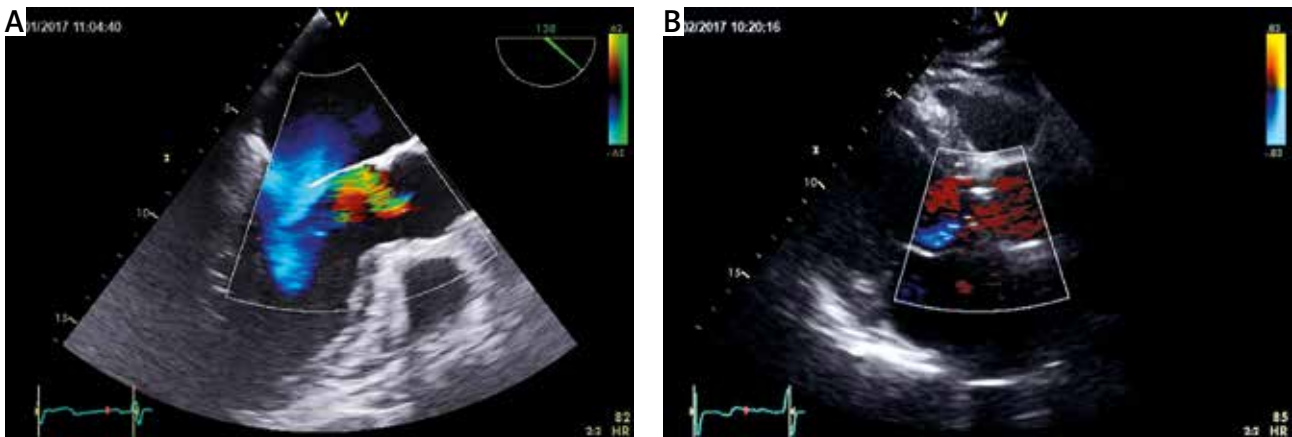


Fig. 6. Patient 4

6 months after surgical treatment – moderate/minor central AI – jet towards AML (grade 0/1). Good medium-term result of valve repair, but, due to residual RCC prolapse, the patient requires more frequent echocardiographic follow-up examinations (Fig. 6).

Conclusions

The presented method for aortic valve repair successfully restores the size of the atrioventricular junction (AVJ) to the physiological norm calculated for a given patient (established with the use of the HAART 301 measurement set). Implantation of a HAART 300 ring enabled the reconfiguration of the aortic ostium from round and dilated back to physiological – elliptical. The HAART 300 rings, thanks to their construction (rigid rings), permanently stabilize the atrioventricular junction (AVJ) and, as a result, facilitate the reconstruction of insufficient aortic valves, including the plication of cusps in cases of prolapse.

Disclosure

Professor J. S. Rankin is a consultant for BioStable. Others authors report no conflict of interest.

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