

**New
Methods**

Aortic Root Reconstruction with TachoSil Fibrin Sealant Patch in Acute Type A Aortic Dissection

Radosław Gocoł, MD, Jarosław Bis, MD, Damian Hudziak, MD,
Łukasz Morkisz, MD, and Marek A. Deja, MD, PhD

Purpose: We propose a novel technique for reconstruction of the dissected aortic root with the use of TachoSil fibrin sealant patch.

Methods: Patients with acute type A aortic dissection involving the aortic root were included. Appropriately prepared TachoSil fibrin sealant patch was placed between the dissected layers of the aortic root to achieve their durable fusion. Thus, the false lumen was eliminated, and the anatomical and functional structure of the aortic wall was restored.

Results: In all, 13 patients mean aged 57 ± 10.3 years underwent surgery for acute type A aortic dissection with the use of TachoSil fibrin sealant patch. All patients survived the surgery. The mean follow-up time was 30.8 ± 16.4 months. Follow-up computed tomography angiography (CTA) scans confirmed no aortic root dissection in all patients.

Conclusions: This technique ensures durable restoration of the aortic wall structure, eliminates the secondary aortic valve regurgitation, and allows for the preservation of patients' native aortic valve.

Keywords: acute aortic dissection, aortic root reconstruction, aortic valve regurgitation

Introduction

Acute type A aortic dissection is defined as a disruption of the medial layer caused by intimal tear and redirection of the blood flow into the aortic wall. This event divides the aorta into a true and false lumen with communication between them occurring through intimal tears. The initial intimal tear is located in most cases (60%) in the ascending aorta.¹⁾

Nevertheless, surgeons have sought for years to devise a durable and effective approach to aortic root

reconstruction. The main goal is to achieve false lumen closure and restoration of aortic root anatomical structure. Another benefit of such a method is the preservation of the native aortic root and valve.

Several techniques of aortic root reconstruction have been proposed so far, including sandwich suture with felt strips reinforcement or tissue glue application.^{2,3)} While these approaches undoubtedly have their merits, they also have limitations and associated complication risk, which provoke a further search for new surgical solutions.

We propose a novel technique for reconstruction of the dissected aortic root with the use of TachoSil fibrin sealant patch.

Methods

Patients with acute type A aortic dissection involving the aortic root undergoing cardiac surgery according to ESC/EACTS guidelines on the treatment of aortic diseases were included in the study.⁴⁾

Those with a known history of primary aortic root aneurysm and/or aortic valve stenosis were excluded preoperatively. Intraoperative identification of bicuspid

Department of Cardiac Surgery, Upper-Silesian Heart Center, Katowice, Poland

Received: June 30, 2020; Accepted: September 24, 2020

Corresponding author: Radosław Gocoł, MD. Department of Cardiac Surgery, Upper Silesian Heart Center, ul. Ziołowa 45/47, 40–635 Katowice, Poland

Email: gocot@poczta.onet.pl



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives International License.

©2021 The Editorial Committee of *Annals of Thoracic and Cardiovascular Surgery*

aortic valve and/or aortic valve cusp perforations/calcifications precluding preservation of the native valve also resulted in exclusion from the study. Of note patients with coexisting aortic valve regurgitation secondary to the aortic root dissection were not excluded.

The effect of aortic root reconstruction procedure was evaluated at three time points: intraoperatively by transesophageal echocardiography (TEE), 7 days after surgery by transthoracic echocardiography (TTE) and at least 12 months after surgery by TTE and computed tomography angiography (CTA). The following parameters were assessed on echocardiography: aortic valve regurgitation, left ventricular ejection fraction (LVEF) as well as the diameters of aortic root, ascending aorta, and aortic arch. These diameters were also evaluated on CT scans in addition to identification of potential radiographic features of aortic root dissection.

Aortic regurgitation grade was established according to a four-point scale: 0: none or trivial, 1: mild, 2: moderate, 3: moderately severe, 4: severe.⁵⁾

Statistical analysis

Continuous data were presented as mean \pm standard deviation. Categorical data are presented as counts and percentages.

Surgical Technique

Standard surgical access via median sternotomy was used. Cardiopulmonary bypass (CPB) was established between the right atrium and the brachiocephalic trunk or common carotid artery (via the 8 mm diameter dacron graft sewn into the artery). If surgery of the aortic arch was performed, moderate hypothermia (26°C) and temporary brain perfusion with continuous monitoring of cerebral oximetry were used for cerebral protection. After cooling the patient to 26°C the CPB was stopped, the aortic arch branches were clamped and the head was selectively perfused, maintaining symmetrical oxygenation of both brain hemispheres at >70%. A transverse aortotomy was then performed at the level of the sinotubular junction. The heart was arrested with a cold del Nido cardioplegic solution.

If the reentry tear was located in the aortic arch, the arch was replaced. The ascending aorta was excised and the distal anastomosis with the dacron graft was performed using a sandwich suture. The graft was de-aired, clamped and the CPB was re-started with simultaneous re-warming of the patient.

Subsequently, the reconstruction of the dissected aortic root with the use of TachoSil fibrin sealant patch was attempted. The first step consisted of meticulous removal of thrombi found between the layers of the aortic root wall. The next step involved the preparation of TachoSil patch. After moisturizing with normal saline (**Fig. 1A**), it was folded and cut to the desired shape (**Fig. 1B** and **1C**) which would fit the space between the dissected layers of the aortic wall (**Fig. 1D**). Much effort was put into imitating the exact shape of the dissected area to ensure its complete elimination (**Fig. 1E**). Ultimately, to achieve a durable fusion of the dissected layers and restoration of their anatomical and functional structure, compression was applied for 5 minutes (**Fig. 1F**). Such reconstruction of the aortic root resulted also in the elimination of the secondary aortic valve regurgitation (**Fig. 1G**).

The last stage of the procedure involved the proximal anastomosis between the reconstructed root and the dacron graft with the use of the 5-0 prolene suture.

After de-airing of the heart, the aorta was de-clamped, and after a period of reperfusion and achieving the body temperature of 36.6°C the patient was weaned off the CPB. The function of the aortic valve was assessed in TEE.

Case Series

In the period between November 2014 and April 2018, 13 patients aged from 37 to 69 years (mean 57 ± 10.3 years) including eight males (61.5%) underwent emergency surgery for acute type A aortic dissection (**Fig. 2A** and **2B**). In all patients, the dissected aortic root was reconstructed with the use of the TachoSil® fibrin sealant patch and the ascending aorta was replaced. In four patients (30.8%), aortic arch was replaced. In nine patients, the CPB was established via the right common carotid artery (69.2%), and in four (30.8%) via the brachiocephalic trunk. Following grades of aortic valve regurgitation were identified at presentation: 0 in one patient (7.7%), 1 in four patients (30.8%), 2 in one patient (7.7%), 3 in two patients (15.4%), and 4 in five patients (38.5%). The aortic regurgitation was secondary to aortic root dissection in all cases. All patients survived the surgery. Intraoperative TEE assessment showed the excellent results of aortic root wall reconstruction and total elimination of the dissection in all patients. The aortic valve was competent in all patients.

Mean postoperative patients' stay in the intensive care unit was 4.3 ± 1.9 days and 12.8 ± 5.7 days in the cardiac surgical ward. Mean mechanical ventilation time was 22.6

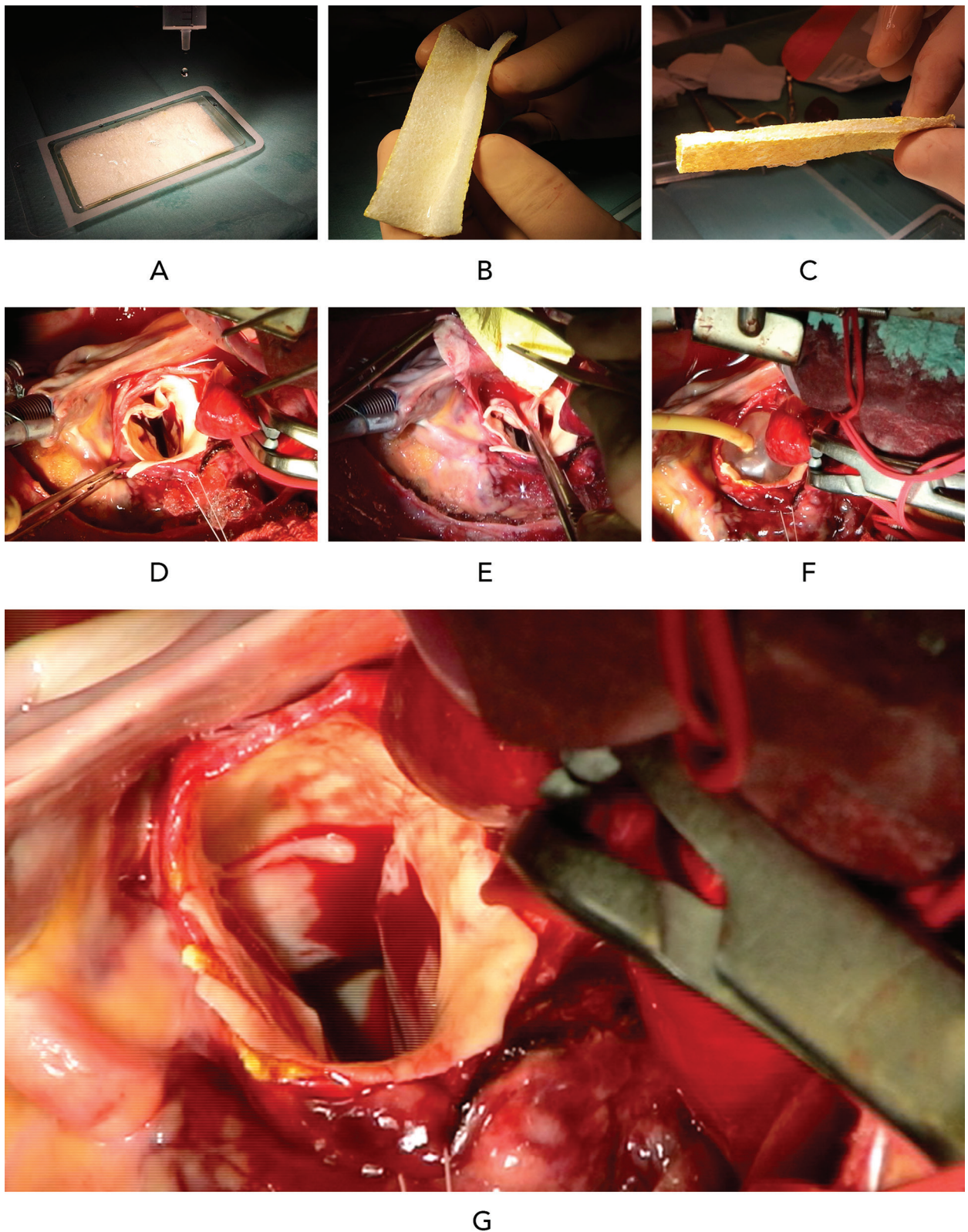


Fig. 1 Preparation and intraoperative application of the TachoSil fibrin sealant patch. (A) moisturizing of the patch surface, (B) folding of the patch, (C) patch ready for use, (D) aortic root dissection, (E) correct placement of the patch, (F) aortic wall compression, (G) reconstructed aortic wall

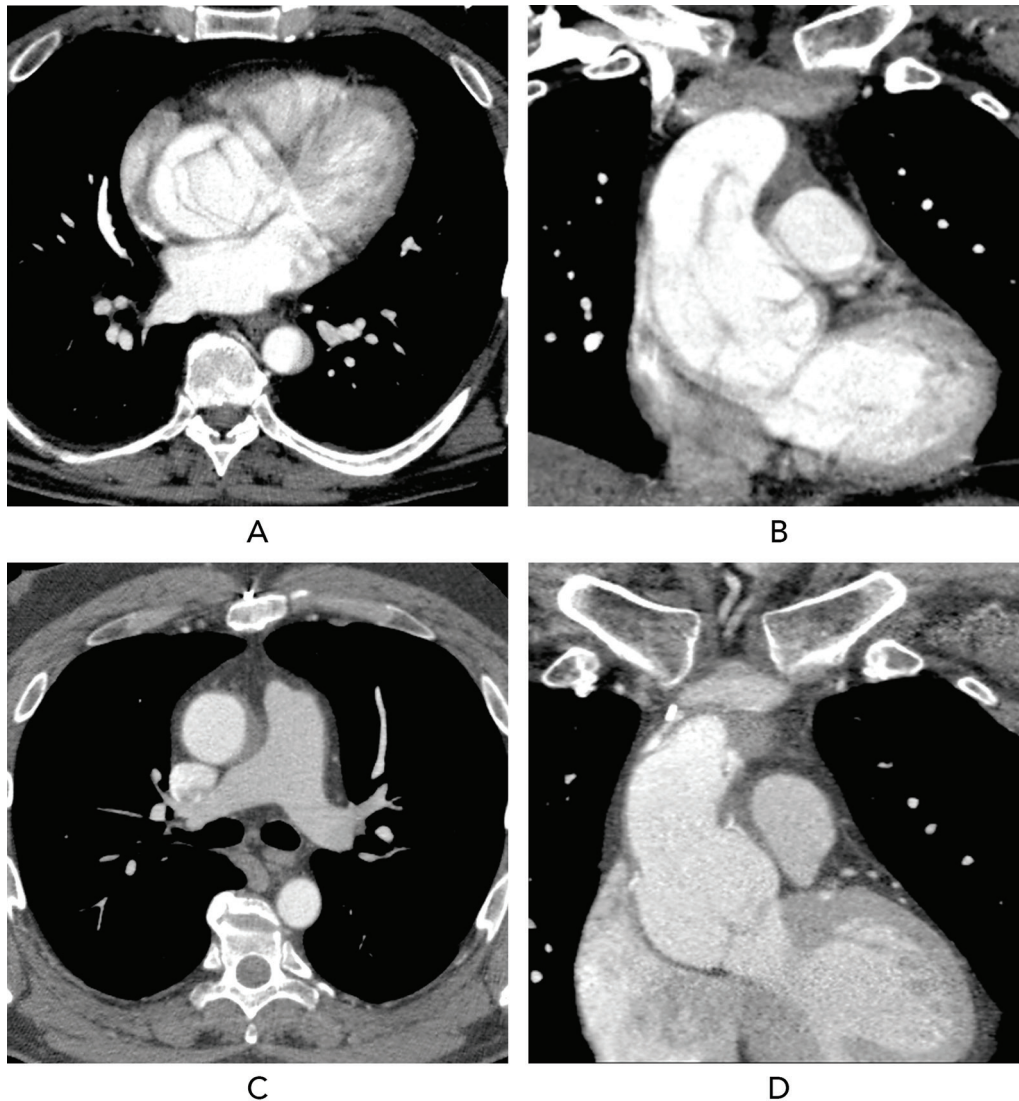


Fig. 2 CTA of the thoracic aorta: (A, B) preoperative CTA scans and (C, D) postoperative CTA scans. CTA: computerized tomography angiography

± 14.2 hours, and mean postoperative bleeding volume was 684.6 ± 267 mL. One patient (7.7%) required reoperation because of bleeding, three patients (23.1%) had delayed chest closure due to coagulopathy, one patient (7.7%) required temporary continuous veno-venous hemodiafiltration for acute kidney failure, two patients (15.4%) had prolonged mechanical ventilation, and delirium was noted in one patient (7.7%). No neurological complications occurred in any of the operated patients. Mean aortic cross-clamp time was 54 ± 17.4 minutes, mean CPB time was 181.2 ± 27 minutes, and mean time of selective brain perfusion was 35 ± 21.5 minutes. No features of persistent aortic root dissection were noted in the TTE performed on postoperative day 7 in any of the patients. However, a reduction of the aortic root diameter from the mean of

42.1 ± 6.2 mm to the mean of 37.4 ± 4.7 mm was observed. Similarly, the diameter of the ascending aorta decreased from the mean of 54.8 ± 9.6 mm to the mean of 30.7 ± 2.0 mm. There was no aortic valve regurgitation in eight patients (61.5%), and in five patients (38.4%) a mild, central regurgitation was present (**Table 1**).

The mean follow-up time was 30.8 ± 16.4 months (range: 12–60 months). All operated patients were free from TTE features of aortic root dissection in the follow-up. There was no aortic valve regurgitation in seven patients (53.8%), in five patients (38.4%) a mild regurgitation was present, and in one patient (7.7%) the regurgitation worsened from mild to moderate. Follow-up CTA scans confirmed no aortic root dissection in all patients (**Fig. 2C and 2D**) and the diameters of the aortic root

Table 1 Echocardiographic and computed tomography angiography data

Parameter	Preoperative TTE	Intraoperative TEE	7 days TTE	Follow-up TTE	Follow-up CTA
IA grade (No of pts)					
0	0	9	8	7	–
I	4	4	5	5	
II	1	0	0	1	
III	2	0	0	0	
IV	5	0	0	0	
Aortic root diameter (mm)	42.1 ± 6.2	–	37.4 ± 4.7	40.4 ± 6.0	40.4 ± 5.7
Ascending aorta diameter (mm)	54.8 ± 9.6	–	30.7 ± 2.0	32.3 ± 4.4	30.6 ± 1.6
Aortic arch diameter (mm)	–	–	–	–	28.6 ± 2.4
LVEF (%)	51.9 ± 6.9	–	55.7 ± 4.9	56.3 ± 5.0	–

CTA: computerized tomography angiography; IA: aortic valve regurgitation; LVEF: left ventricular ejection fraction; TEE: transesophageal echocardiography; TTE: transthoracic echocardiography

(40.4 ± 5.7 mm), ascending aorta (30.6 ± 1.6 mm), and aortic arch (28.6 ± 2.4 mm) were similar to those identified in the TTE (**Table 1**).

Comment

The methods of dissected aortic root reconstruction used in the current surgical practice, including sandwich suture with felt strips reinforcement or tissue glue application, despite their merits, have also limitations and associated complication risk, which provoke a further search for new surgical solutions. The sandwich suture fails to eliminate the dissection of aortic wall layers completely, and there have been cases of disruption of thus performed reconstruction. With regard to tissue glues, there have been reports of intraoperative embolization^{6,7)} and recurrent dissection of the areas covered with glue caused by tissue necrosis or insufficient adhesive force.⁸⁾ Despite that caveats, the idea of gluing together the layers of dissected tissue remains attractive. It seems that the method of aortic wall reconstruction with the use of TachoSil® patch presented herein is a more robust approach, deprived of the disadvantages of the techniques used so far. The reconstructed aortic wall maintains its elasticity and distensibility which facilitates the construction of the anastomosis. The TachoSil patch consists of biodegradable materials, which minimizes tissue toxicity and potential for tissue damage and necrosis.⁹⁾ The proposed technique is relatively straightforward which reduces the time of circulatory arrest and myocardial ischemia. Additional benefits are excellent durability of the reconstruction and no risk of embolic complications. The proposed method allows for the elimination of even severe aortic valve regurgitation secondary to aortic root dissection. Preserving the native aortic root greatly reduces the risk of perioperative complications,

bleeding in particular,¹⁰⁾ whereas preserving the native aortic valve eliminates the risks associated with biological or mechanical valve prosthesis.^{11,12)}

During the mid-term follow-up (30.8 ± 16.4 months), the aortic root diameter did not increase to the extent warranting surgical intervention in any of the patients. This suggests that the dissected aortic root reconstruction with the TachoSil fibrin sealant patch ensures sufficient durability to protect the root from distending.

Conclusion

The reconstruction of the dissected aortic root with the use of TachoSil fibrin sealant patch is a straightforward technique yielding excellent mid-term results. It ensures durable restoration of the aortic wall structure, eliminates the secondary aortic valve regurgitation, and allows for the preservation of patients' native valve.

Funding

This work was supported by statutory funds of Medical University of Silesia (KNW-1-141/K/9/K).

Disclosure Statement

None of the authors has a conflict of interest or financial disclosure statement to make.

References

- 1) Isselbacher EM. Diseases of the aorta. In: Braunwald E, Zipes DP, Libby P, ed. A textbook of cardiovascular medicine. Philadelphia: W.B. Saunders Company; 2001: 1422–56.

- 2) Okita Y, Okada K, Omura A, et al. Surgical techniques of total arch replacement using selective antegrade cerebral perfusion. *Annals of cardiothoracic surgery* 2013; **2**: 222–8.
- 3) Fukunaga S, Karck M, Harringer W, et al. The use of gelatin-resorcin-formalin glue in acute aortic dissection type A. *Eur J Cardiothorac Surg* 1999; **15**: 564–9; discussion 570.
- 4) Erbel R, Aboyans V, Boileau C, et al. ESC Committee for Practice Guidelines 2014 ESC guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). *Eur Heart J* 2014; **35**: 2873–926.
- 5) Zoghbi WA, Adams D, Bonow RO, et al. Recommendations for noninvasive evaluation of native valvular regurgitation: a report from the American Society of Echocardiography developed in collaboration with the society for cardiovascular magnetic resonance. *J Am Soc Echocardiogr* 2017; **30**: 303–71.
- 6) Modi A, Bull R, Tsang G, et al. Ostial left coronary stenosis following aortic root reconstruction with BioGlue. *Interact Cardiovasc Thorac Surg* 2011; **13**: 243–5.
- 7) LeMaire S, Carter SA, Won T, et al. The threat of adhesive embolization: BioGlue leaks through needle holes in aortic tissue and prosthetic grafts. *Ann Thorac Surg* 2005; **80**: 106–11.
- 8) Bingley JA, Gardner MA, Stafford EG, et al. Late complications of tissue glues in aortic surgery. *Ann Thorac Surg* 2000; **69**: 1764–8.
- 9) Lisy M, Kahlil M, Stock UA, et al. Fibrin sealant patch for repair of acute type a aortic dissection. *J Card Surg* 2013; **28**: 736–41.
- 10) Peterss S, Dumfarth J, Rizzo JA, et al. Sparing the aortic root in acute aortic dissection type A: risk reduction and restored integrity of the untouched root. *Eur J Cardiothorac Surg* 2016; **50**: 232–9.
- 11) Nakamura H, Yamaguchi H, Nakao T, et al. Reoperation for mid-term failure of a freestyle bioprosthesis using a full root technique—a surgical case. *Ann Thorac Cardiovasc Surg* 2011; **17**: 287–9.
- 12) Smolka G, Wojakowski W. Paravalvular leak - important complication after implantation of prosthetic valve. *E-Journal of Cardiology Practice* 2010, **9**(8).