Disc Impediment in Medtronic-Hall Aortic Valve Prosthesis Followed by Successful Reoperation

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Summary. *This case report describes the diagnostic and treatment challenges of the combined disc impediment caused by pannus ingrowth in combination with thrombus formation in a 21-mm Medtronic-Hall aortic valve prosthesis. A combined obstruction of a Medtronic-Hall prosthesis in the aortic position is a rare, but potentially fatal clinical condition for the first time reported in Vilnius University Hospital Santariškių Klinikos. Despite the difficulties in determining a correct diagnosis, our critically ill patient was clinically stabilized by partially successful thrombolysis and then successfully treated by a surgical thrombectomy together with pannus excision during the rotation of the disc within the valve housing 3 years after the valve implantation.*

Introduction

Although most commercially available mechanical prostheses have excellent durability, the hemodynamic performances of the prostheses can be changed by external factors, such as thrombus or pannus formation during the late postoperative period (1). The combined obstruction of mechanical prostheses caused by pannus ingrowth in combination with thrombus formation is a rare, but potentially fatal complication (1). Overall, the long-term follow-up results confirm that a Medtronic-Hall aortic valve prosthesis has excellent durability, very good hemodynamic performance, and exceptionally low thrombogenicity, leading to good long-term survival with low complication rates and a very low requirement for reoperation (2, 3). The main cause of valve thrombosis has been thought to be inadequate systemic anticoagulation (4). Sudden hemodynamic deterioration and high mortality associated with reoperation is very characteristic of the patients with prosthesis dysfunction. In critically ill patients with a thrombosed tilting disk prosthesis, the safest and easiest surgical techniques should be chosen: thrombectomy or prosthesis replacement or both. The article reports the treatment of 1 patient by a thrombectomy and the rotation of the disc within the valve housing several years after the valve implantation.

Case Report

A 57-year-old woman was admitted to our hospital because of intensive tearing chest pain mimicking typical angina pectoris and lasting for about 30 minutes. Additionally, she complained of dyspnea during physical exertion and palpitations that had lasted 2 months before admission. Her medical history revealed an aortic valve replacement (AVR) with a single leaflet (tilting disc) No. 21 Medtronic-Hall prosthesis in 2009 because of severe degenerative aortic valve stenosis.

On admission, the patient was clinically stable with the blood pressure of 155/110 mm Hg, normal aortic prosthetic valvular clicks, and normal pulmonary auscultation. Her electrocardiography showed a sinus rhythm (96 bpm) with the features of left ventricular (LV) hypertrophy, LV overload, and, possibly, ischemia in the anterolateral wall of LV. Based on the optimal international normalized ratio (INR) value of 2.6 and the elevated troponin I value of 4.5 μg/L (reference range, 0.00–0.03 μg/L), the decision to perform coronary angiography (COG) was made. Warfarin was postponed before the COG procedure for one day, and having an INR of 1.7 while bridging with therapeutic doses of low-molecular-weight heparin (LMWH), on the next day the COG was performed uneventfully. Significant lesions of the coronary arteries were excluded: the coronary angiogram revealed stenosis of about 50% in the proximal segment of the right coronary artery. Two hours after the COG, the patient suffered a brief episode of tearing chest pain followed by severe hypotension (systolic blood pressure of 60 mm Hg) and almost loss of consciousness despite receiving a standard medical treatment for non-ST-segment elevation myocardial infarction, which included double antiaggregant therapy (aspirin plus clopidogrel) and LMWH. The patient was transferred

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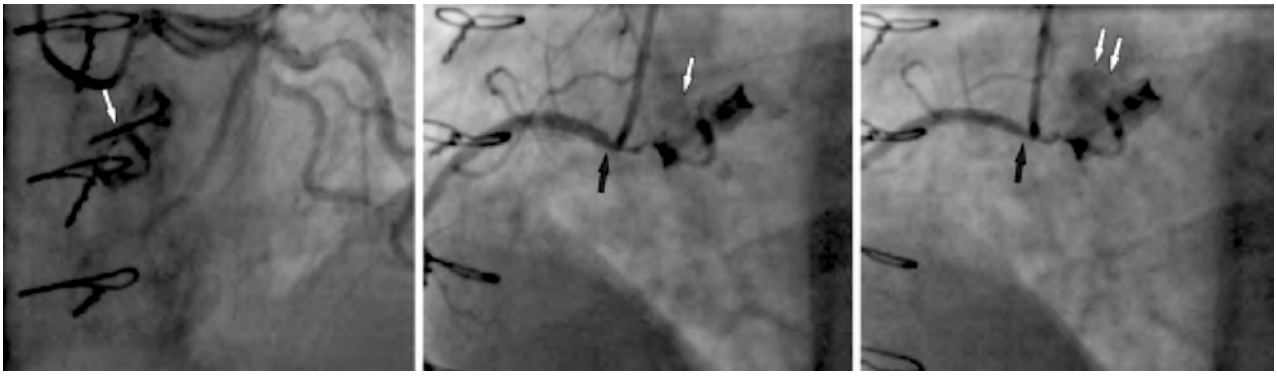
to the Coronary Care Unit (CCU) urgently, where she recovered spontaneously. A new ECG did not reveal any additional significant abnormalities. In the CCU, the patient repeatedly complained about tearing chest pain and dyspnea. On heart auscultation, the changes in prosthetic valve sounds were noticed with a decrease in the intensity of the mechanical valve closure sounds and a new aortic diastolic murmur. The coronary angiography films were examined repeatedly, and the disc impediment of the prosthetic valve was observed (Fig. 1). Urgent bedside 2-dimensional Doppler transthoracic echocardiography was performed, which confirmed the diagnosis of thrombotic disc impediment in the Medtronic-Hall aortic valve prosthesis (Fig. 2).

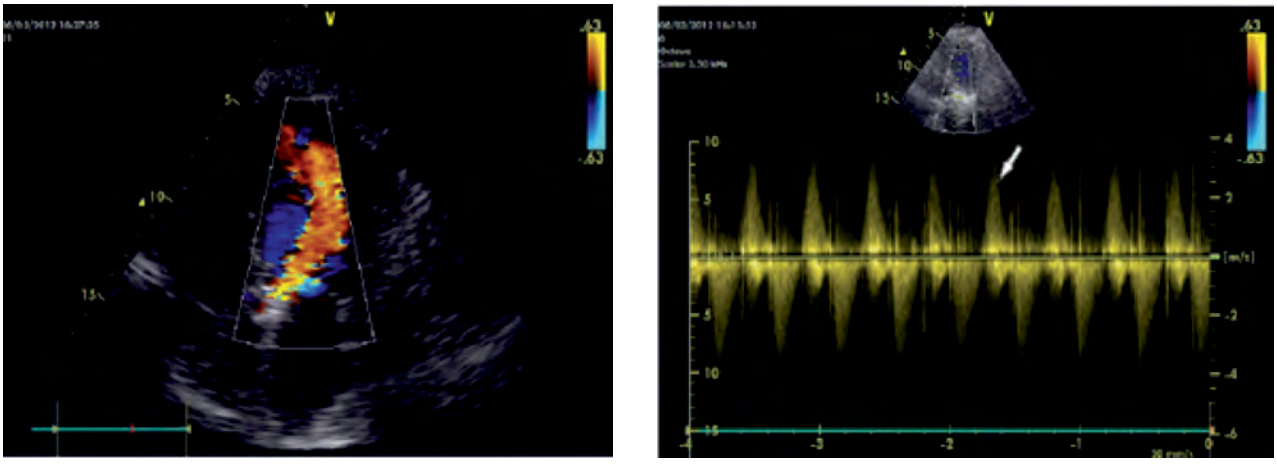
In the meantime, the clinical condition of the patient deteriorated rapidly, and the clinical signs of pulmonary edema and cardiogenic shock with sinus bradycardia followed by asystole were observed. Under intravenous anesthesia, the patient was intubated, and artificial lung ventilation was initiated together with the measures of cardiopulmonary resuscitation. Due to the critical patient's clinical condition, the decision of an acute thrombolytic treatment versus an immediate valve surgery was made in agreement with heart surgeons. According to the guidelines and standard dosage protocols for the treatment of acute thrombosis, off-label thrombolysis with the recombinant tissue plasminogen activator alteplase was attempted (a bolus of 10 mg followed by 90 mg in a continuous intravenous infusion for 2 hours). Bedside 2-dimensional Doppler transthoracic echocardiography was repeated showing only a small decrease in aortic regurgitation (acute 3/4 aortic regurgitation) and a minimal change in the mean transprosthetic gradient reach-



A B C

Fig. 1. Coronary angiograms showing an incomplete closure of the prosthetic valve and right coronary artery ostial stenosis

A, an incomplete closure of the prosthetic valve (white arrow); B, an incomplete closure of aortic prosthesis can be clearly seen from a different position (white arrow) together with about 50% ostial stenosis of the right coronary artery (black arrow); C, in the same position as B, the opened prosthesis can be seen (white arrows) with about 50% ostial narrowing of the right coronary artery (black arrow). Sternal wires after the aortic valve replacement are clearly seen in all the images.



A B

Fig. 2. Bedside 2-dimensional Doppler transthoracic echocardiography

A, in the apical 4-chamber view, 4/4 grade aortic regurgitation is clearly visible; B, continuous-wave Doppler shows the triangular velocity profile (white arrow) of the acute aortic prosthetic valve regurgitation (the prosthetic valve stays open causing free aortic regurgitation) and the elevated mean transprosthetic gradient of about 26 mm Hg.

ing 20 mm Hg. Although the effect of the thrombolysis was inadequate, the clinical condition of the patient was stabilized under artificial lung ventilation and the therapeutic doses of inotropic drugs. Anticoagulation using unfractionated heparin was performed with the strict monitoring of activated partial thromboplastin time.

An open-heart surgery under conventional cardiopulmonary bypass and through a median sternotomy was performed 16 hours after the thrombolysis. The tilting disc was rotated within the valve housing, and thrombectomy and pannus excision were performed with returning the tilting disc to almost the same previous position to ensure low-pressure gradients across the prosthesis and a maximum effective orifice area.

Intra-aortic balloon pump counterpulsation was initiated during the operation and discontinued 2 days after the stabilization of the hemodynamics. After the operation, the patient had recovery complicated with a wound infection and was discharged on day 30 after the operation. Before the discharge, the patient had 2-dimensional transthoracic Doppler echocardiography done, which showed a normal function of the prosthetic valve with the mean transprosthetic gradient of about 10 mm Hg and without the signs of pathological regurgitation. The patient was given anticoagulation therapy with oral warfarin to maintain the INR at about 3.0.

Discussion

Many authors have reported good outcomes for AVR using Medtronic-Hall valves of various sizes, and especially good results have been reported regarding the 22- and 24-mm Medtronic-Hall valve (2, 3, 5). Svennevig et al. (2) reviewed the long-term result of Medtronic-Hall valves in the aortic position and encountered only 5 patients (0.6%) with a pannus or thrombus among 816 consecutive patients. However, Cho et al. (5) performed 6 redo operations (5.1%) related to pannus formation among 117 patients, which is a markedly higher incidence of pannus formation in the aortic position Medtronic-Hall valves than reported previously. The incidence of the thromboembolic complications in the above-mentioned study (5) was also high: among 117 patients, 6 patients (5.1%) experienced a cerebral infarction, and 1 patient (0.8%) had a coronary artery thrombosis. The transprosthetic mean pressure gradient of the Medtronic-Hall valve in the aortic position frequently increased as a function of time, and this increase was more common in patients who had undergone a double valve replacement, especially in those implanted with a small Medtronic-Hall valve (20 mm) (5).

Of the 9082 patients who underwent valve replacement with a mechanical prosthesis between January 1967 and December 2008 in Vilnius University Hospital Santariškių Klinikos, 149 redo operations (1.6%) were performed due to prosthetic thrombosis or prosthesis-related thromboembolic complications, and only 7 redo operations (4.7% of all the redo operations) were performed because of a prosthesis (bileaflet or caged-ball valves) thrombosis in the aortic position (6). Thus, the above-described combined obstruction of the 21-mm Medtronic-Hall valve prosthesis is a rare clinical condition for the first time reported in our hospital.

Patients with prosthetic valves are at risk of thromboembolic complications, including systemic embolization, most commonly cerebral, and prosthetic thrombosis causing valve obstruction and/or regurgitation. The factors that contribute to the thrombogenicity of prosthetic heart valves include altered blood flow and hemostatic activation caused by vessel-wall disruption during surgery or exposure of artificial surfaces to the circulating blood (4). Stagnant flow can be caused by a valve occluder or growth of a pannus into the leaflets or the valve mechanism. In a surgical study of 112 obstructed mechanical valves, irrespective of the type of prosthesis, a thrombus alone was responsible for 77%, pannus formation for 11%, and pannus formation in combination with a thrombus, as in the above-described clinical case, for 12% (7). Thromboembolic complications are an important cause of morbidity and mortality in patients with a prosthetic heart valve, with an estimated incidence of clinical events ranging from 0.6% to 2.3% per patient-year, and occur in most cases in patients with mechanical valves who are inadequately anticoagulated or have additional risk factors such as atrial fibrillation, LV dysfunction (LV ejection fraction, $\leqslant$35%), left atrial dilation (left atrial diameter, >50 mm), previous thromboembolism, spontaneous echocardiographic contrast, and hypercoagulable condition (8). The incidence of obstructive valve thrombosis varies between 0.3% and 1.3% per patient-year in patients with mechanical valves (8). Patients with mechanical prostheses require lifelong anticoagulation with warfarin. Thrombogenicity of individual prostheses should also be taken into account when choosing an optimum international normalized ratio target for oral anticoagulation. For the patients with a Medtronic-Hall prosthesis in the aortic position (this type of prosthesis is considered to be a low-thrombogenicity prosthesis), the target INR is 3 (8).

The clinical manifestations of prosthetic valve dysfunction (PVD) include dyspnea, heart failure, and in case of thrombus formation, systemic embolization. Many reports have indicated that patients with prosthetic valve thrombosis may present with

a sudden deterioration in hemodynamics, and nonspecific symptoms may be present in 86% of patients for 1 week or longer (9). When, in a newly symptomatic patient, there is an unexpected rise in the transprosthetic gradient from a baseline determination or from established normal values for valves of that type and size or a new acute prosthetic regurgitation, the possibility of critical PVD should be considered. Suspicion should be higher if there has been a period of interrupted or subtherapeutic anticoagulation in the recent past as in the above-described clinical case. The use of subcutaneous LMWH should be considered as an alternative to unfractionated heparin for bridging (recommendation class IIa; level of evidence C) (10). However, despite their widespread use and positive results of observational studies, LMWHs are not approved in patients with mechanical prostheses due to a lack of controlled comparative studies with UFH (10).

The assessment of the exact cause of the PVD was difficult because of the critical clinical condition of the patient, requiring cardiopulmonary resuscitation. Transthoracic echocardiography and cinefluoroscopy can correctly detect prosthetic valve thrombosis in 85% of cases (9). As transesophageal echocardiography in most cases cannot be performed promptly, and 2-dimensional transthoracic Doppler echocardiography should be available at any time when symptoms occur and is the method of choice for an acute patient evaluation. Since thrombolytic therapy is an alternative to surgery only for thrombosis, a distinction between thrombosis and a pannus is important; echocardiography and clinical features are helpful in distinguishing between these entities. Based on the sudden deterioration of the patient's clinical status in the setting of temporarily inadequate anticoagulation, prosthetic valve thrombosis was suspected. On the other hand, the correct diagnosis was delayed because the restricted disc movement was overlooked by an invasive cardiologist not familiar with the PVD due to a high suspicion of acute coronary syndrome. Therefore, the prosthetic valves should be inspected carefully during cinefluoroscopy, irrespective of the reason for the performance of the latter diagnostic procedure.

Urgent or emergent surgery is the treatment of choice in critically ill patients with obstructive valve thrombosis, but it is associated with high operative mortality rates (15% to 20%) in such patients (8, 11). The intervention may involve a simple thrombectomy or valve replacement. A review published by Lengyel et al. (12) found fibrinolysis to be efficacious in 82% of cases, but with an associated 10% mortality rate and a 12.5% rate of systemic emboli. Thus, decisions about clinical management are challenging. This high complication rate has relegated fibrinolysis to second-line therapy, reserved mainly for the following (10): a) critically ill patients unlikely to survive surgery because of comorbidities or severely impaired cardiac function prior to developing valve thrombosis; b) situations in which surgery is not immediately available and the patient cannot be transferred. Because the risk of emergency operation in our case was very high, we performed rescue intravenous thrombolysis, which helped us stabilize the clinical condition and safely perform a successful redo operation. Fibrinolysis was only partially effective in the described case because it is less likely to be successful in chronic thrombosis or in the presence of a pannus, which can be difficult to distinguish from a thrombus.

The redo surgery showed that the leaflets were locked by subaortic pannus and thrombus formation, which manifested as acute severe regurgitation. The surgical option available for entrapped tilting disc valves is thrombectomy with pannus excision or replacement of the prosthesis or both. Thrombectomy and pannus excision from the downstream side of the valve are often difficult and are rarely used in our hospital because of a low incidence of this combined pathology. In our patient, the disc was rotated so that the major orifice of the prosthesis was oriented toward the greater curvature of the ascending aorta. This valve position provided the optimum blood flow and improved the valve performance. Orienting the larger orifice toward the greater curvature of the ascending aorta creates a near-physiological, or laminar, flow pattern (13). This is possible only with tilting disc prostheses as they possess 2 orifices and, hence, experience less turbulence. The same cannot be achieved with bileaflet valves because they possess 3 orifices. Consequently, the gradients across a Medtronic-Hall valve in the optimum position will be lower compared with bileaflet valves (e.g., a St. Jude Medical valve) of the same size in any orientation (13).

Conclusions

In summary, nonspecific cardiac symptoms along with changes in physical findings should be sufficient to suspect possible prosthetic valve dysfunction, and a thorough evaluation should be undertaken to confirm the diagnosis. A prosthetic valve should be inspected carefully during coronary angiography irrespective of the reason of performing the latter diagnostic procedure. Thrombectomy and pannus excision along with the rotation of the disc within the valve housing is an easy, safe, and economical procedure for critically ill patients.

Statement of Conflict of Interest

The authors state no conflict of interest.

References

1. Robles P, Jimenez Nacher JJ, Rubio A, Huelmos A, Lopez L. Intermittent aortic regurgitation in a case of mechanical prosthesis dysfunction. Int J Cardiol 2005;102:525-7.
2. Svennevig JL, Abdelnoor M, Nitter-Hauge S. Twenty-five year experience with the Medtronic-Hall valve prosthesis in the aortic position: a follow-up cohort study of 816 consecutive patients. Circulation 2007;116:1795-800.
3. Butchart EG, Li H, Payne N, Buchan K, Grunkemeier GL. Twenty years' experience with the Medtronic Hall valve. J Thorac Cardiovasc Surg 2001;121:1090-100.
4. Berkowitz SD. Antithrombotic therapy after prosthetic cardiac valve implantation: potential novel antithrombotic therapies. Am Heart J 2001;142:7-13.
5. Cho YH, Jeong DS, Park PW, Park KH, Sung K, Kim WS, et al. Serial changes of hemodynamic performance with Medtronic Hall valve in aortic position. Ann Thorac Surg 2011;91:424-31.
6. Grebelis A. Pakartotinės operacijos po širdies vožtuvų protezavimo. (Reoperations after heart valve replacement.) [dissertation]. Vilnius: VU; 2009.
7. Deviri E, Sareli P, Wisenbaugh T, Cronje SL. Obstruction of mechanical heart valve prostheses: clinical aspects and surgical management. J Am Coll Cardiol 1991;17(3):646-50.
8. Pibarot P, Dumesnil JG. Prosthetic heart valves: selection of the optimal prosthesis and long-term management. Circulation 2009;119:1034-48.
9. Sakamoto Y, Hashimoto K, Okuyama H, Ishii S, Shingo T, Kagawa H. Prevalence of pannus formation after aortic valve replacement: clinical aspects and surgical management. J Artif Organs 2006;9:199-202.
10. Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC); European Association for Cardio-Thoracic Surgery (EACTS), Vahanian A, Alfieri O, Andreotti F, Antunes MJ, et al. Guidelines on the management of valvular heart disease (version 2012). Eur Heart J 2012;33:2451-96.
11. Roudaut R, Serri K, Lafitte S. Thrombosis of prosthetic heart valves: diagnosis and therapeutic considerations. Heart 2007;93:137-42.
12. Lengyel M, Fuster V, Keltai M, Roudaut R, Schulte HD, Seward JB, et al. Guidelines for management of left sided prosthetic valve thrombosis: a role for thrombolytic therapy. J Am Coll Cardiol 1997;30:1521-6.
13. Kale SB, Saksena DS, Agnihotri YC, Ayyer KH. Thrombectomy with disc rotation of medtronic valves. Asian Cardiovasc Thorac Ann 2003;11:309-13.

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