Aortic Root Rupture during Transcatheter Aortic Valve Implantation in a Patient with Idiopathic Thrombocytopenic Purpura: Utility of Transesophageal Echocardiography in Early Detection and Description of a Semiconservative Surgical Management Approach

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Abstract

An 87-year-old man with idiopathic thrombocytopenic purpura and platelet count of $56 \times 10^9/L$ underwent transesophageal echocardiography (TEE)–guided transcatheter aortic valve implantation using a femoral approach. Post valve deployment, a new pericardial effusion was noted which was successfully drained. Despite this, the patient became hypotensive needing vasopressor support with reaccumulation of pericardial fluid. Emergent sternotomy was performed and a perforation of the right ventricular apex was noted which was sealed with a pledgeted suture. Continued bleeding prompted further exploration; the aorta was seen to be mottled in conjunction with clear aortic root hematoma on TEE and a diagnosis of root rupture was made. This was semiconservatively managed without conversion to a full aortic root repair or replacement procedure. Multiple sutures were applied to the periaortic space and the bleeding sealed with use of BioGlue (Cryolife Inc., Kennesaw, GA) and Surgicel (Ethicon Inc., Somerville, NJ). The postoperative course was stable and the patient remained well at 3-month follow-up.

Keywords

- ▶ aortic valve stenosis
- ▶ percutaneous aortic valve replacement
- ▶ emergent sternotomy
- ▶ surgical conversion
- ▶ pericardiocentesis

We present a case of transcatheter aortic valve implantation (TAVI) performed with transesophageal echocardiography (TEE) guidance in a patient with idiopathic thrombocytopenic purpura (ITP). The case was complicated by aortic root rupture which was detected early because of TEE monitoring and was managed semiconservatively in the catheterization laboratory. To the authors' knowledge, this is the first description of aortic rupture in TAVI in a patient with ITP.

Case

An 87-year-old man with severe aortic valve stenosis and New York Heart Association class III symptoms underwent TAVI using a femoral approach and TEE guidance. The Society of Thoracic Surgeons score and logistic EuroSCORE were only 4.6 and 18.6%, respectively, but he was deemed high risk due to his age, reduced mobility from multiple previous cervical spine surgeries, and recent diagnosis of ITP. On preoperative transthoracic

echocardiography (TTE), the left ventricular outflow tract (LVOT) measured 20 mm, aortic root measured 28 mm, and mean/peak aortic valve gradients measured 41/60 mm Hg with an aortic valve area of 0.65 cm². Biventricular function was normal and there was trace aortic regurgitation (AR). Computed tomography showed aortic annulus of 28.3 × 24.4 mm with an area of 570 mm². Coronary angiography showed 50% stenosis of the mid left main and mildly irregular remaining coronary arteries. It was decided to treat the left main disease conservatively because of absence of angina. Hematology was consulted and the patient received pretreatment with oral prednisone for 1 week. On the day of TAVI, his platelet count was 56 × 10⁹/L.

The procedure was performed under general anesthesia (GA). A temporary pacing wire was inserted via the right internal jugular vein. Under rapid pacing, valvuloplasty was performed with a 22 mm NuMed (Cornwall, Ontario, Canada) balloon followed by implantation of the 29 mm Edwards Sapien XT (Edwards Lifesciences Corporation, Irvine, CA) valve. The deployment was successful with trivial AR and an AR index of 33.6%.¹ Although the patient was hemodynamically stable, a new pericardial effusion was noted on TEE (►Fig. 2) along with a decrease in blood pressure from 140/60 mm Hg predeployment to 110/65 mm Hg postdeployment with a heart rate of 90 bpm. Urgent pericardiocentesis was performed draining 140 mL of blood. Despite successful aspiration, the patient became increasingly hypotensive requiring vasopressor support. Reaccumulation of pericardial effusion was seen on TEE over a period of 10 minutes and a decision was made to proceed to emergency sternotomy in the catheterization laboratory. The heart was accessed within 5 minutes of the decision for sternotomy, under cardiac bypass, which prevented the patient from progressing to full cardiac

arrest. A perforation of the right ventricular (RV) apex was identified and repaired with a pledgeted suture. Despite this, there remained ongoing bleeding in the periaortic space and additional TEE images clearly showed new posterior aortic root thickening (seen as nonhomogenous thickening with echolucent areas) consistent with an aortic root hematoma. In conjunction with a mottled appearance of the aortic root, an aortic root rupture was diagnosed (►Fig. 2; ►Videos 1 and 2). After careful exploration, the periaortic space was closed primarily, using 3–0 polypropylene sutures onto the fat of the RV overlying the aortic root, and attached to the adventitia of the aorta. Multiple sutures were used, as it was felt that open repair of the root perforation and potentially replacement with a Bentall procedure would be fraught with significant morbidity. Residual bleeding was sealed using Surgicel and BioGlue. Three units of packed red blood cells and two units of apheresis platelets were transfused. After a long period of observation under stable conditions, the chest was closed and the patient monitored on the cardiac surgical intensive care unit. In the subsequent 48 hours, he remained stable without recurrence of pericardial effusion and the aortic valve was patent with trivial AR. ►Figs. 1 and 2 show TEE images pre- and post-TAVI, respectively.

At 3-month follow-up, the patient remained well with improvement of symptoms.

Videos 1 and 2

Online content including video sequences viewable at: www.thieme-connect.com/products/ejournals/html/10.1055/s-0034-1381962.

Fig. 1 Transesophageal echocardiography before transcatheter aortic valve implantation. Arrows indicate the aortic root.

Fig. 2 Transesophageal echocardiography after transcatheter aortic valve implantation. (a) Arrows indicate pericardial effusion and (b–d) aortic root hematoma.

Discussion

Aortic root rupture is a rare complication of TAVI procedures with a 100% mortality rate.² In most cases, it is managed with conversion to aortic replacement if not immediately fatal. Hence, it is important for TAVI teams to routinely establish patient wishes during preoperative discussions regarding emergency conversion to sternotomy. A contingency plan should always be in place for the setup of cardiac bypass and conversion to sternotomy in the catheterization laboratory. In cases of previous cardiac bypass, the operating surgeon should be acquainted with the location of the left internal mammary artery and other patent grafts with respect to the sternum. When aortic rupture is suspected, cardiopulmonary bypass should be instituted and conversion to open aortic valve replacement should be prepared for. This report provides evidence for the feasibility of a semiconservative surgical management strategy in the catheterization laboratory for aortic root rupture with TAVI.

We found one description of aortic root perforation with contrast extravasation on angiography which was managed with valve-in-valve Edward Sapien XT implantation, where the patient died on day 3.³ One additional report suggests feasibility of management with biomatrix and lattice adjuncts using digital compression.⁴ In our case, the patient was hemodynamically stable when the pericardial effusion developed. As it was initially felt that the effusion may have resulted from the temporary pacing wire, the wire was withdrawn slightly within the right ventricle and it was decided to perform pericardiocentesis and monitor the patient's hemodynamics. When his condition deteriorated,

despite drainage of the effusion, with a steady reaccumulation of fluid on TEE along with a need for vasopressor support, sternotomy was performed and the RV explored. The aortic root rupture was identified due to continued ooze in the periaortic space even after the RV perforation was pledgeted. Careful exploration, application of pledgeted sutures in to the fat of the RV overlying the aortic root and the aortic adventitia, digital compression, and topical hemostasis proved to control the bleeding. In a reported series of six cases of aortic rupture with TAVI, bleeding occurred from the base of the left ventricle in three cases, the annulus in one case, the left coronary sinus in one case, and the right coronary sinus in the last case.⁵

Bleeding in case of TAVI can occur at the time of predilation valvuloplasty, valve implantation, or valve postdilation. In theory, small microtears occur with majority procedures and are affixed and sealed after prosthetic valve implantation, and are therefore not of clinical consequence.⁵ Four factors that can cause major bleeding of hemodynamic consequence during TAVI include: (1) Significant discrepancy between prosthetic valve and aortic annulus size with an extremely oversized valve. TAVI valves are typically oversized around 10 to 20% for the annulus size; (2) Significant calcification of the aortic valve leaflets, aortic annulus, LVOT, and aortic root; (3) Aggressive postdilation after prosthetic valve implantation to reduce paravalvular AR; and (4) Injury to a coronary artery or shearing injury to the left ventricle from instrumentation, especially with transapical TAVI.^{5–7}

Successful semiconservative surgical control of bleeding in our case along with supportive treatment with transfusion of red blood cells and platelet pools precluded the need for

conversion to an aortic repair/replacement procedure which has high mortality risk in the elderly TAVI population. The surgical hemostatic adjuncts that we used, namely Surgicel and BioGlue, are commonly employed in contemporary cardiac surgical practice. Surgicel is an absorbable mechanical hemostat made of oxidized regenerated cellulose and BioGlue is a synthetic adhesive made of glutaraldehyde and bovine serum albumin, which produces cross-linking to seal defects. In a small randomized controlled trial (RCT) of 69 patients, Surgicel achieved hemostasis in a mean of 3.3 minutes and in 65% cases, no additional therapy was needed. In a prospective RCT of 151 patients undergoing cardiac and vascular repair, BioGlue achieved complete anastomotic hemostasis in 81% compared with 57% with standard repair alone.⁸

This case was clearly compounded by the fact that the patient had ITP with a low platelet count. Pre- and/or postoperative steroids have been used along with gamma globulins in some cases to boost platelet numbers and reduce bleeding. Expert hematology opinion should be sought in all cases.

TAVI procedures may be performed under fluoroscopy guidance alone or with TEE, at the discretion of individual centers.⁹ Increasingly, TAVI under conscious sedation rather than GA has gained support due to shorter recovery and hospital stay.¹⁰ This case however highlights the critical role played by continuous TEE surveillance in TAVI procedures in rapid detection of complications despite favorable hemodynamics. Absence of TEE would have delayed the diagnosis and management of pericardial effusion potentially changing the outcome despite successful valve deployment. In addition to facilitating baseline imaging for valve sizing and assisting with deployment position, TEE provides crucial operative monitoring and assessment of postdeployment AR.¹¹ Additionally, in this case, use of GA and the presence of a cardiac surgeon as a co-operator assisted in performing emergency sternotomy rapidly to treat the source of bleeding.

Heart teams are important for TAVI procedures from a case selection, case planning, decision making, and operative perspective. The operative team in our unit includes the interventional cardiologist, cardiac surgeon, cardiac anesthetist, and nursing and perfusion staff from both the operating room as well as the catheterization laboratory. In our case, this close working relationship was crucial for early detection and rapid action once the bleeding could not be curtailed with pericardiocentesis. From the decision for sternotomy, obtaining access to the heart within 5 minutes was made possible due to a seamless sequence of steps from all the staff to the instructions of the operating surgeon and cardiologist. The operative liaison between cardiology, cardiac anesthesia, and cardiac surgery

facilitated immediate decision making guided by TEE for sternotomy and successful management of the root rupture.

Conclusion

Aortic root rupture is a serious complication of TAVI which can be managed semiconservatively in the catheterization laboratory with emergent sternotomy and adjunctive hemostasis using topical agents. Intraoperative TEE can facilitate rapid detection of procedure-related complications. GA and TEE-assisted TAVI should be seriously considered in high-risk cases.

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