CASE REPORT

Ascending aortic aneurysm exposed to direct impingement of eccentric flow jets through a tilting-disc valve prosthesis

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Abstract

Single-leaflet tilting-disc aortic valve prostheses are known to generate eccentric transvalvular flow jets. These prostheses are routinely inserted with the major valve opening directed toward the non-coronary sinus to achieve more favorable hemodynamic performance. From the viewpoint of blood flow dynamics, the structural and functional properties of tilting-disc aortic valves resemble those of congenital bicuspid aortic valves with right- and left-coronary leaflet fusion, which have been associated with aortopathy in the ascending aorta. Here we describe the case of a patient who had undergone aortic valve replacement in 1987 with a Björk-Shiley tilting-disc valve and required reoperation for ascending aortic aneurysm 29 years later. Eccentric flow jets through the tilting-disc valve directly impinged on the posterior wall of the ascending aorta including the aortotomy suture line, possibly contributing to the development of the saccular aneurysm in the ascending aorta.

INTRODUCTION

Single-leaflet tilting-disc aortic valve prostheses (e.g. Björk-Shiley, Medtronic-Hall, and TTK Chitra) are known to generate eccentric transvalvular flow jets [1]. These prostheses are routinely inserted with the major valve opening directed toward the non-coronary sinus to achieve more favorable hemodynamic performance [2, 3]. From the viewpoint of blood flow dynamics, the structural and functional properties of tilting-disc aortic valves appear to resemble those of congenital bicuspid aortic valves (BAV) with right- and left-coronary leaflet fusion, which have been associated with aortopathy in the ascending aorta. Here we describe the case of a patient who had undergone aortic valve replacement (AVR) in 1987 with a Björk-Shiley tilting-disc valve and required reoperation for ascending aortic aneurysm 29 years later. Eccentric flow jets through the tilting-disc valve directly impinged on the posterior wall of the ascending aorta including the aortotomy suture line, possibly contributing to the development of the saccular aneurysm in the ascending aorta.

CASE REPORT

An 80-year-old woman, who had undergone aortic valve replacement with a 23-mm Björk-Shiley valve and open mitral commissurotomy at our hospital for multivalvular rheumatic heart disease at age 51, had chest tightness during exertion after many years of uneventful, asymptomatic clinical development. Follow-up transthoracic echocardiographic examinations over the past several years showed a normal left ventricular
volume and ejection fraction, and moderate mitral stenosis (mitral valve area: 1.5 cm²) and an elevated peak prosthetic aortic jet velocity of 300-350 cm/s had been maintained within the boundary area without worsening. Cardiac computed tomography (CT) angiography revealed no significant obstructive coronary disease, but an unexpected saccular ascending aortic aneurysm (maximum transaortic diameter: 51 mm) arising from the posterior ascending aortic wall just above the sino-tubular junction. (B) Cardiac CT angiography (systolic images) confirmed that the Björk-Shiley valve was tilted by the elevation of the prosthesis in the right-coronary sinus. Red dashed line: Aortic annulus (basal ring), Green solid line: Prosthetic valve ring, Green solid arrow: Prosthetic valve leaflet. Physiologic opening angle calculated between the leaflet of the prosthetic aortic valve and the aortic annular plane was 45 degrees. (C, D, and E) Prosthetic heart valve assessment with cardiac CT (systolic images). Short axis view (C), frontal view (D), and lateral view (E) of the Björk-Shiley spherical-disc valve in the aortic position. Multiplanar reconstruction (MPR) image analysis revealed a normal leaflet opening angle of 60 degrees.

Figure 1: (A) Cardiac computed tomography (CT) angiography revealed a saccular ascending aortic aneurysm (maximum transaortic diameter: 51 mm) arising from the posterior ascending aortic wall just above the sino-tubular junction. (B) Cardiac CT angiography (systolic images) confirmed that the Björk-Shiley valve was tilted by the elevation of the prosthesis in the right-coronary sinus. Red dashed line: Aortic annulus (basal ring), Green solid line: Prosthetic valve ring, Green solid arrow: Prosthetic valve leaflet. Physiologic opening angle calculated between the leaflet of the prosthetic aortic valve and the aortic annular plane was 45 degrees. (C, D, and E) Prosthetic heart valve assessment with cardiac CT (systolic images). Short axis view (C), frontal view (D), and lateral view (E) of the Björk-Shiley spherical-disc valve in the aortic position. Multiplanar reconstruction (MPR) image analysis revealed a normal leaflet opening angle of 60 degrees.
that the BAV (bicuspid aortic valve) cusps (left-coronary and right-coronary cusps), demonstrating predicted aortic diameter and growth rate [8]. The narrow functional opening angle of the tilting disc valve prosthesis might have affected not only the elevated peak prosthetic aortic jet velocity but also the development of ascending aortic aneurysm in our case.

As for the pathogenesis of BAV-related aortopathy, there has been an ongoing nature-nurture debate between the genetic theory (i.e. the intrinsic aortic wall vulnerability causes aortopathy) and the hemodynamic theory (i.e. eccentric flow jets through a bicuspid aortic valve cause aortopathy: asymmetrical aortic dilation) [8]. If BAV-related aortopathy is caused mainly due to hemodynamic factors, asymmetrical dilatation of the ascending aorta could be assumed to develop in the same process as in late complications after AVR with a tilting-disc valve prosthesis. Re-evaluation of long-term results with tilting-disc valve prostheses in the aortic position, based on recent advances in the methodology of fluid mechanics [9, 10], is warranted in order to verify the pure hemodynamic theory of aortic aneurysm formation, excluding the influence of genetic factors.

SUPPLEMENTARY MATERIAL

Supplementary material is available at the Journal of Surgical Case Reports online.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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