Retrieval of a leaflet escaped in a Tri-technologies bileaflet mechanical prosthetic valve

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The escape of the prosthetic heart valve disc is one of the causes of prosthetic dysfunction that requires emergency surgery. The removal of the embolized disc should be carried out because of the risk of a progressive extrusion on the aortic wall. Several imaging techniques can be used for the detection of their localization. In this report we describe a 32-year-old man who underwent mitral valve replacement with a Tri-technologies bileaflet valve three years ago, and was admitted in cardiogenic shock. Transesophageal echocardiography showed acute-onset massive mitral regurgitation. The patient underwent emergency replacement of the prosthetic valve. Only one of the two leaflets remained in the removed prosthetic valve. The missing leaflet could not be found within the cardiac cavity. The abdominal fluoroscopic study and plain radiography were unable to detect the escaped leaflet. The abdominal computed tomography scan and the ultrasound showed the escaped leaflet in the terminal portion of the aortic bifurcation. To retrieve the embolized disc laparotomy and aortotomy were performed three months later. The escaped leaflet shows a fracture of one of the pivot systems caused by structural failure. This kind of failure mode is usually the result of high stress concentration.

KEYWORDS
Leafl et escape; Acute prosthetic valve dysfunction; Tri-technologies; Embolization; Ultrasoundography; Computed tomography

Introduction

Leafl et escape due to fracture of a mechanical valve prosthesis has been previously reported for monoleaflet (Omnicarbon and Björk-Shiley convex-concave valves), bileaflet mechanical prostheses (Edwards-Duromedics and Edwards-Tekna) and recently for Tri-technologies prostheses valve.1,2

Acute prosthetic valve dysfunction due to leafl et escape, is a critical condition which is associated with a high morbid- ity and mortality rate and requires immediate replacement of the prosthetic valve. The removal of the embolized disc should be carried out because of the risk of a progressive extrusion on the aortic wall, but this surgery can be differed and carried out programmed with smaller risk. Several techniques of images can be used for the detection of their localization.

Case report

This article reports a case previously published3 of a 32-year-old man who underwent mitral valve replacement with a Tri-technologies bileaflet valve three years ago, and was admitted to the intensive care unit in cardiogenic shock.

Fluoroscopy could not provide data on prosthetic function due to radiolucency of the discs (Figure 1). Transesophageal echocardiography showed only one of the two leaflets of the prosthetic valve, with acute and massive mitral regurgitation. The patient underwent emergency replacement of the prosthetic valve. Only one of the two leaflets remained in the removed prosthetic valve. The missing leaflet could not be found within the cardiac cavity. The patient made a rapid recovery.

The abdominal fluoroscopic study and plain radiography were unable to detect the escaped leaflet. The abdominal computed tomography scan and the ultrasound

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(Figure 3) showed the escaped leaflet in the terminal portion of the aortic bifurcation. The removal of the embolized disc was deferred and performed with lower risk three months later. Median laparotomy and a transverse abdominal aortotomy were then performed (Figure 4) and the patient had no subsequent complications. The patient’s recovery was uneventful.

The gross observation of the retrieval disc (Figure 5A) showed only one pivot, the second one was missing as the result of the fracture. Close-up of the fractured pivot system was clearly delineated in the stereoscopic view (Figure 5B).

Scanning electron microscope observations were carried out in an Environmental Scanning Electron Microscope (JSM-6360 LV) at 30 kV accelerating voltage. The fracture caused by the structural failure was well evidenced (Figure 6A) and a crack was clearly delineated as the result of the inherently brittle nature of pyrolytic carbon (Figure 6B). This kind of failure mode is usually the result of high stress concentration.

**Discussion**

Primary structural failure of currently available mechanical valves is extremely rare. Mechanical valve failure has shown to be a limitation of some models of valve prostheses in the past. Examples of mechanical failure with specific valves models that are no longer used include disc embolization from bileaflet tilting-disc valves and struts fracture in certain models of single- and double-disc valves.

Minimal information is available regarding the clinical use of the Tri-technologies valve, which has been used in clinical practice.

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**Figure 1** Fluoroscopy shows a Tri-technologies prosthetic valve with two adjacent radiopaque rings, one being longer than the other. In the smaller ring there is a little vertical slot. Fluoroscopy could not provide data on prosthetic function due to radiolucency of the discs.

**Figure 2** Computed tomography scan showing the location of the escaped leaflet in the terminal aorta (arrow). (A) and (B): without and with intravenous contrast injection.

**Figure 3** Ultrasound shows the escaped leaflet (arrows) as a linear hyperechogenic object in the lumen of terminal portion of the abdominal aorta.
Argentina, Brazil, France, Germany, India, Italy, Spain and Turkey. A review of the relevant literature reveals that most reports of leaflet escape come from valves in the mitral position. This may be due to the greater direct systolic pressure supported by mitral disc during systole and subsequent greater mechanical stress of the mitral valve as compared with the aortic valve.

The Tri-technologies prosthetic heart valve (Belo Horizonte, Brazil) is a low-profile mechanical bileaflet prosthesis made of solid pyrolytic carbon and designed to rotate in situ. The two leaflets open at 85° and are housed in the orifice ring by two tabs that are inserted into orifice hinges. Even though carbon fibers are placed in the valve leaflets to increase their radiopacity, the leaflets of most valves are virtually invisible in standard radiographs.

We have previously reported that fluoroscopy is a very useful tool in the functional evaluation of prostheses with radiopaque discs; however, it provides no functional information in prostheses with radiolucent discs manufactured in Brazil (Tri-technologies and HP-Biplus) or in valves that are only slightly radiopaque, made in Russia (Jyros). Tri-technologies prosthetic valve can be distinguished with fluoroscopy by the presence of two adjacent radiopaque rings, one being longer than the other (Figure 1). In the smaller ring there is a little vertical slot.

The type of imaging used to locate the missing distal fragment depends on the patient’s condition and the type of prosthetic valve.

In the present study several imaging techniques were attempted, including plain radiography, fluoroscopy, ultrasound and computed tomography scan (CT). However, only CT scan and ultrasound provided conclusive results. These
findings underline the importance of understanding the effectiveness of each radiographic technique under different conditions to avoid unnecessary examinations.

The embolized leaflet normally does not create severe problems, but must be found and retrieved because a progressive extrusion through the arterial wall can happen. So these imaging interventions to locate the escaped leaflet can be delayed until the patient has recovered. That is the reason why the abdominal surgery in our case was performed after three months of recovery for the patient.

The fractured or escaped valve fragments are usually difficult to locate within the heart as they usually embolize. The most commonly reported location of the escaped leaflet is in the arterial system between the aorta and the femoral artery. When the leaflet escape happens without breaking in pieces, considering the size of the escaped leaflet, the most common site to find it is the aortic bifurcation and it can only be retrieved surgically with laparotomy and aortotomy, as in the present case. But when the disc breaks in two or more fragments, it could be found in the common iliac arteries and depending on its sizes, percutaneous retrieval of the fragments could be attempted. When the site of embolization is the femoral arteries, the fragments of the disc could be extracted with a little incision in the groin.

Similar as previously described in the pyrolytic carbon valve, in this case, the fracture of the pivot system was caused as a result of high stress concentration.

**Conclusions**

The appropriate manner of treating acute prosthetic dysfunction is first to replace the defective valve as quickly as possible. The retrieval of any embolized fragments of the valve is of secondary importance and elective surgery may be carried out, with much lower risk, at a later date.

The most appropriate radiographic techniques for locating missing leaflet are the abdominal CT scan and abdominal ultrasound. These techniques not only provide information about the possible complications secondary to vascular wall damage, but also support dates for a possible percutaneous retrieval procedure. Because of progressive extrusion through the arterial wall, the leaflet escape must be found and retrieved, even if the patient is asymptomatic.

**References**