

Traumatic tricuspid valve rupture treated by minimally invasive thoracotomy

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Isolated valvular lesions consequent to non-penetrating trauma are rare. We present a case of a traumatic tricuspid valve rupture in a 51-year-old woman seriously involved in a motor vehicle accident 20 years earlier. She underwent tricuspid valve replacement performed via a minimally invasive thoracotomy in the right fourth intercostal space. The advantages of minimally invasive thoracotomy are discussed.

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Due to the increase in high-speed car accidents, blunt chest trauma is being reported ever more often in emergency rooms. Cardiac trauma is infrequent and in most cases largely consists of myocardial contusions; cardiac rupture is rarer, involving both ventricles with a similar frequency, followed by the right and left atria^{1,2}. Septal ruptures have been also reported and valvular injuries are uncommon; the frequency of atrioventricular valvular post-traumatic insufficiency is similar for both valves and less than 100 cases of tricuspid involvement have been reported³.

Case report

A 51-year-old woman referred blunt thoracic trauma in an automobile accident she had had 20 years earlier. Apart from minor chest contusions, she seemed not to have any other lesions. A routine echocardiogram performed a few months later showed tricuspid valve insufficiency. It is well documented that the heart was normal before the trauma. She was clinically well and she was controlled on an annual basis by means of transthoracic echocardiography. Three years ago she started to complain of fatigue and worsening effort dyspnea. Echocardiography, performed 10 months ago, revealed massive tricuspid regurgitation and rupture of the chordae tendinae of the anterior leaflet of the tricuspid valve (Fig. 1).

She underwent right heart catheterization that showed: a mean right atrial pres-

sure of 8 mmHg, a pulmonary artery pressure of 32/10/18 mmHg, a wedge pressure of 9 mmHg, a cardiac output of 9.45 l/min, and a cardiac index of 5.89 l/min/m².

Angiography confirmed the diagnosis showing a moderately dilated right atrium and severe tricuspid regurgitation. The left atrium, left ventricle and the coronary arteries were normal.

On physical examination she presented a loud parasternal systolic murmur and a raised jugular venous pulse.

On March 18, 2002, she underwent surgery performed by means of a minimally invasive right thoracotomy, 6 cm in length, in the right fourth intercostal space (Heart-Port®, Heart-Port Inc., Redwood City, CA, USA). Cardiopulmonary bypass was instituted through a femoral access, the aorta was clamped by means of a balloon inflated in the ascending aorta and crystalloid cardioplegic solution was infused in the aortic root. The enlarged right atrium was opened and the tricuspid valve was inspected: the insufficiency was due to rupture of several chordae tendinae of the anterior leaflet that was also lacerated on its free edge. The leaflet was repaired with a running 5-0 Prolene suture (Ethicon, Edinburgh, UK) and a new cord was constructed with Gore-Tex (W.L. Gore & Assoc., Flagstaff, AZ, USA) connecting the papillary muscles to the anterior leaflet. On testing the valve, there was a gross incompetence due to the reduced dimensions of the anterior leaflet. Therefore, the tricuspid valve was replaced with a Carpentier-Edwards prosthesis (size 29 mm).



Figure 1. Transthoracic echocardiography, Doppler study: massive regurgitation in the right atrium during cardiac systole.

The postoperative course was complicated by the development of a nodal rhythm that resolved after 4 days of prednisolone therapy. The patient was discharged on the sixth postoperative day.

Discussion

Rupture of the cardiac valves may be due to trauma, strain and bacterial infections. Valve rupture must be suspected in patients with a history of severe blunt trauma who develop congestive heart failure.

The deceleration trauma is responsible for various cardiac injuries: cardiac contusions represent the most frequent lesion and usually have a benign clinical course although they may cause arrhythmias and also ventricular thrombi associated with regional wall abnormalities. Septal and free wall ruptures are frequent; however, acute valvular dysfunction is rare.

Rupture of the cardiac valves after closed chest trauma may be due to acute compression of the heart between the sternum and the column resulting in an increased cardiac pressure^{4,5}. Then, the heart, that is suspended in the mediastinum by the great vessels, may shift forward, during a deceleration. The consequent stress is localized mainly at the atrial and valvular levels and determines lacerations of these structures. Damage to the atrioventricular apparatus may occur in early systole during isovolumetric contraction, when the deceleration forces may contribute to dramatically increase the intraventricular pressure: the result can be lacerations of the chordae tendinae, papillary muscle rupture, and leaflet disruption⁶. Another mechanism, often delayed, is an initial papillary muscle contusion followed by necrosis and valve regurgitation. The symptoms of valvular damage may appear immediately after the injury, mainly for the mitral and aortic valves, or after a relatively asymptomatic period lasting months or years, and this occurs mainly for the tricuspid valve.

Chest X-ray may reveal cardiac enlargement and mediastinal enlargement (if associated with the cardiac chamber structures). The electrocardiogram may reveal sustained arrhythmias, Q waves and ST-segment abnormalities. The creatine kinase serum levels may be increased. All these parameters suggest echocardiography that may allow a rapid diagnosis of valvular involvement after a blunt chest trauma.

Traumatic insufficiency of the tricuspid valve is often much better tolerated than mitral valve regurgitation^{4,7}; this is determined by the lower pressures in the right heart and the patient can become symptomatic several years later. The most encountered pathology is anterior leaflet prolapse caused by rupture of chordae tendinae or papillary muscle⁸; later, annular dilation consequent to right ventricular dysfunction ensues⁹.

In the reported case, surgery was performed via a minimally invasive approach, through a right port-access thoracotomy using a Heartport platform. From February 1998 to September 2003, 16 patients (4 males, 12 females, mean age 56.62 ± 14.86 years, range 29-72 years) underwent a surgical procedure on the tricuspid valve through a minimally invasive approach at our Center; in 7 cases the procedure was a re-operation. The surgical procedures performed are shown in table I. Minithoracotomy was performed in the right fourth intercostal space through a 6 to 8 cm long skin incision. The endovascular cardiopulmonary bypass system ensures safe installation of the extracorporeal circulation through a 3 cm groin incision with venous and arterial cannulation of the femoral vessels: aortic occlusion and cardioplegic infusion may be achieved through the endoaortic clamp catheter. This system was used in 12 patients. In 3 patients the new endo-direct system was used. This system allows direct aortic cannulation through an 8 mm port in the right first intercostal space¹⁰, with venous cannulation being performed percutaneously through the femoral vein. The port access proved to be of great value in re-operation procedures: it is less invasive and adhesion dissection is reduced. It is not necessary to isolate all the cardiac structures and consequently the procedure is safer especially in those

Table I. Surgical procedures performed via minimally invasive thoracotomy.

Procedure	No. cases	No. redo
TVR	5	2
TVP	1	0
TVP + ASDR	1	0
TVR + ASDR	1	1
TVP + MVR	4	2
TVP + MVP	2	0
TVR + MVR	2	2

ASDR = atrial septal defect repair; MVP = mitral valvuloplasty; MVR = mitral valve replacement; TVP = tricuspid valvuloplasty; TVR = tricuspid valve replacement.

cases with patent grafts because adhesion dissection and patent graft lesions are avoided. The approach allows a direct access to the right and the left atria once adequate surgical exposure is completed. In our series one patient who underwent a redo operation for tricuspid valve substitution and atrial septal repair died on the fourth postoperative day of hypoxic cardiac arrest; the mortality rate is 6.25% and all the other patients were discharged and are alive.

Our results show that although minimally invasive cardiac valvular surgery may be more time-consuming, the patient ultimately benefits by recovering more rapidly and leaving the hospital sooner with a better cosmetic result, less pain and a significantly shorter recovery period.

Traumatic valvular rupture should be immediately suspected in patients who present with heart murmurs after blunt chest trauma. In case of 1) a history of trauma, 2) a normal heart before trauma, 3) the sudden onset of valvular insufficiency, and 4) the exclusion of other causes of cardiac damage, tricuspid valve rupture should be always be included in the differential diagnosis. Echocardiography is mandatory for the diagnosis and should be performed in every patient who sustained a non-penetrating chest trauma.

Conservative surgery using reparative techniques should always be attempted, because repaired valves do not require anticoagulant therapy and are associated with a lower risk of endocarditis and thromboembolism. Still, valve replacement is the procedure most often performed^{4,11} as in the reported case where the

conservative approach was unsuccessful due to the extent of the valvular lesion.

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